METHODOLOGIES FOR CLIMATE PROOFING INVESTMENTS AND MEASURES UNDER COHESION AND REGIONAL POLICY AND THE COMMON AGRICULTURAL POLICY

FINAL REPORT

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[1] Main authors not mentioned again

METHODOLOGIES FOR CLIMATE PROOFING INVESTMENTS AND MEASURES UNDER COHESION AND REGIONAL POLICY AND THE COMMON AGRICULTURAL POLICY

Key findings and recommendations

Climate change is already happening. In the coming years the effects of climate change will be felt more severely in Europe, affecting people, buildings, infrastructure, industries and ecosystems. The EU is stepping up efforts to adapt to a changing climate. This report investigates the potential contribution from the Common Agricultural Policy (CAP) and Cohesion Policy (CP). Both policies can contribute significantly to improving climate adaptation in the EU, hand in hand with the efforts of Member States.

Threats, Impacts, Damage Costs and Adaptive Capacity

1. Climate change poses important risks to people's health and assets, infrastructure and economic activities across virtually all sectors. While all regions will be exposed to impacts, the Mediterranean region of the EU and the Central & Eastern region are likely to be most affected. It therefore follows that the extent of damages will vary accordingly.
2. Over the period leading up to 2020, river flooding, and to a lesser extent coastal flooding and storms, is expected to lead to high economic costs. Health impacts from heat waves are expected to be severe, especially in the Mediterranean areas. Water supply will also be at risk.
3. The adaptive capacity of a Member State can be deployed to significantly reduce its overall climate vulnerability and hence lower the future damage costs of climate change. The analysis of adaptive capacity that is relevant to Cohesion Policy and CAP shows a clear split between the less developed Member States in Eastern and Southern Europe with lower adaptive capacity, and the more developed Member States in Northern and Western Europe with higher adaptive capacity.

Cohesion Policy and CAP expenditure categories most sensitive to climate change

4. Under both Cohesion Policy and CAP, many different categories of expenditure are likely to be sensitive to climate change related impacts.
5. For CP, in most Member States, priorities for climate proofing include transport infrastructure (especially road and rail), water infrastructure (especially waste water) and energy infrastructure (especially regarding Cohesion Policy funding for renewables). In Southern Member States (of the Mediterranean region), the focus would in particular be on water infrastructure as well as health related expenditures to meet the challenges from droughts and heat waves.
6. Regarding the CAP, expenditure in the physical infrastructure of the agricultural sector are extremely varied as a wide range of initiatives can be funded. These include the ongoing potential to fund manure storage, anaerobic digesters, livestock housing, water harvesting and storage, and irrigation. There is a need to ensure that the infrastructure being funded is able to withstand future climate impacts and ideally contribute to the adaptation needs of the sector as a whole.

Options to climate proof Cohesion Policy and CAP expenditure

7. In order to improve the resilience of the expenditure categories exposed to climate change threats, a mix of "grey" (as related to infrastructure), "green" (as related to the environment/ecosystems/green infrastructure), and "soft" (as related to human capital and adaptive capacities) adaptation options need to be promoted in future Cohesion Policy and the CAP. The set of implemented options will vary throughout the EU, and will depend on the nature and severity of the climate change threats as well as on regional circumstances, including adaptive capacity.

8. Soft options include a range of measures including the implementation of information and communications technologies to awareness raising measures. Early warning systems, for example, based on the provision of meteorological data using remote sensing techniques, can help to identify the risks to human health associated with heat waves.
9. Grey options are those related to the enhancement of infrastructure and can include: improvements to the delivery of water supply, alterations to road surfaces to withstand higher temperatures, and dike reinforcement for flooding and sea level rise.
10. Green options include many biodiversity measures such as the installation of green infrastructure in cities (e.g. tree lined streets and green roofs) for cooling (and in some cases flood mitigation), and the maintenance and expansion of protected areas that improve the connectivity of networks of different protected areas via wider use of green infrastructure, which in turn helps support ecosystem resilience. Support to ecosystem-based adaptation strategies to climate change could create significant co-benefits for both biodiversity and the sustainable development of regions within the EU.
11. The study shows that certain options can have high benefit-cost ratios, although these ratios will vary depending on the Member State context and the applicable climate scenarios. These options include: early warning systems, buffer strips for agricultural land, storm retention reservoirs, on-farm water harvesting, awareness raising for SMEs, measures to adapt to river and coastal flooding, adapting rail tracks to higher temperatures and adapting electricity grids. Other options with positive benefit cost ratios include: floodplain management, the planting of winter cover for agricultural land to avoid soil erosion, improvement of animal rearing conditions and high-efficiency ventilation. For options with lifetimes extending beyond 2020, (our analysis focused on the costs and benefits of implementation in the 2014-2020 period), the benefits are likely to be even greater than those quantified within the scope of this study.

Cohesion Policy: Opportunities for climate proofing in the 2014-2020 programming period

12. The analysis of the Commission's proposals for Cohesion Policy in 2014-2020, indicates that the expenditure for the categories of projects that are most exposed to climate change risks could be used to fund the following:

    a. basic infrastructure in four economic sectors: energy production and distribution; transport (all modes, but especially rail); environment (water and waste in cases where these entail both technological and ecosystem based solutions); and public buildings, including health infrastructure and residential housing;
    b. nature, ecosystem services and natural/cultural assets in relation to tourism; as well as
    c .urban development and buildings, especially where exposed to heat waves and flood risk.

    These types of expenditure fall under four of the Common Strategic Framework (CSF) thematic objectives and would require particular attention from a climate proofing point of view. The scope and scale of proofing however shall be determined by the magnitude of the funding allocations for the different expenditure types, as well as the level of adaptive capacity of the respective Member State.

CAP: Opportunities for climate proofing in the 2014-2020 programming period

13. The CAP offers opportunities for supporting targeted adaptation options for agriculture, forestry and biodiversity as well as within rural areas more generally. Climate adaptation features much more strongly as an objective within the Commission's proposals for 2014-2020 than has been the case in the past. Pillar 2 of the CAP, notably Rural Development Policy, arguably plays the most important role in the development of rural climate adaptation measures. Relevant

measures include those that support the development of human capital in the form of capacity building and the provision of advice, those that provide investment for farming infrastructure, forestry activities and those that support environmentally beneficial land management activities. In addition, under Pillar 1 (i.e. direct payments), greening payments could provide significant levels of funding for the following three options with the potential to improve the resilience of agricultural land to climate impacts: diversified crop rotations, the promotion of permanent grassland and the promotion of ecological focus areas. The requirement for Member States to set up a Farm Advisory Service that covers climate adaptation is also important.

Capacity Building Needs and Guidance

14. While conditions in Member States differ, as a general rule, more active capacity building support is needed for countries with low adaptive capacity, i.e. those in Eastern and Southern Europe, and more careful, targeted and complementary support for countries with high adaptive capacity in Western as well as in Northern Europe. Information sharing between the two regions should be actively promoted, with the ultimate objective of encouraging cooperation between Member States.
15. The programme cycles for Cohesion Policy and Rural Development Policy are useful frameworks for organising capacity building measures in terms of content and timing. They also highlight the need to increase the capacity of public authorities and other stakeholders to enable the better inclusion of climate change adaptation into mainstream policy. The use of these programming cycles serves as a reminder that capacity building must target the full policy cycle to have the desired impact.

Executive Summary

1. Introduction

This is the executive summary for the project contract "Methodologies for Climate Proofing Investments and Measures under Cohesion and Regional Policy and the Common Agricultural Policy" (Contract No 07.1303/2011/603488/SER/CLIMA.C3) by the Institute for European Environmental Policy (IEEP) together with Ecologic Institute, Milieu, GHK and Environment Agency Austria.

The EU has set itself an ambitious decarbonisation agenda for combating climate change through reducing greenhouse gas (GHG) emissions. However, climate change is already happening and impacts will unfold more severely over the coming decades, affecting people, buildings, infrastructure, industries and ecosystems. Hence the EU has started to step up its efforts to adapt to a changing climate in a number of relevant policy fields. Two of the EU's most important policies, namely Cohesion Policy and the Common Agricultural Policy (CAP), are of key relevance in this respect as they account for the large majority of EU spending. Consequently they will have a major impact on the development of EU's urban and rural economies, infrastructures and ecosystems and their services.

Investments and spending under both policies must be robust in their effectiveness and value under different climate change scenarios. The White Paper on Climate Change Adaptation[2] has stressed the need for this kind of climate-proofing of investments, alongside an integration of adaptation concerns into the main policies, programmes and plans that guide expenditures. Through this approach CAP and Cohesion Policy can also substantially support climate adaptation.

To date, what has been missing is a detailed assessment of the potential threats, risks, damage costs and existing adaptive capacities of Member States in the realm of CAP and Cohesion Policy, as well as an appraisal of options and strategies through which CAP and Cohesion Policy can adapt to a changing climate. The aim of this study is to contribute to the closing of this gap and to recommend ways and offer guidance to public authorities in Member States on how to climate mainstream and proof expenditures and measures under Cohesion Policy and CAP.

The study findings are hence of direct relevance for the programming of CAP and Cohesion Policy expenditure under the next EU Multi-Annual Financial Framework (MFF) that will run from 2014 to 2020. The study findings are based on a variety of information sources, including numerous interviews with policy-makers and public stakeholders at the EU and national level and three dedicated workshops that took place in different parts of the EU.

[2] EC (2010) White paper on climate change adaptation. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009DC0147:EN:NOT

2. Threats, Impacts, Damage Costs and Adaptive Capacity

The inherent uncertainty in predicting the pace and scale of climate change means that any assessment of the relative significance of different threats over space and time can only be indicative. However, in order to inform and shape policy and to design precautionary measures, whilst recognising the uncertainties, the study has sought to provide a general indication of the distribution and relative scales of these impacts that are anticipated in the 2014-2020 period.

Climate change poses important risks to people's health and assets, infrastructure and activities across the European economy, with significant variations as to where the risks are expected to be greatest and which sectors (i.e. receptors) will be affected. The main climate change threats for a series of key receptors are summarised in Table 1.

Table 1. Summary of the main anticipated impacts of climate change by receptor

Receptor	Types of impact associated with the threats from climate change
Population – Health	Mortality risks from a range of threats. The largest threat is from heat waves, especially in urban areas. Impacts from some threats such as lower air quality and disease are less well understood.
Population – Buildings	Damage from floods and storms are the most significant. In addition households in the Mediterranean and Central/Eastern regions are likely to incur increased energy costs for cooling.
Industry	Industry and commerce is likely to be affected by floods and storms. Higher costs for energy and water are expected. Losses in labour productivity due to heat related stress may also occur (although offset by cooling systems).
Tourism	Higher temperatures and water shortages may cause reductions in summer tourist numbers in the Mediterranean and Central/Eastern regions, offset in part by increased numbers at the beginning and end of the tourism season. Ski seasons are also likely be adversely affected.
Energy supply	Energy demand is likely to increase for cooling, especially in the shorter-term until building standards and designs adjust. Energy supply costs are also likely to increase as the availability of water for cooling, and for hydro and biomass energy production, is reduced. Damage from floods, storms and soil erosion are also likely to be significant. Costs will be passed onto users. In the longer-term new energy plant designs should adapt.
Water infrastructure	Water scarcity and sea water intrusion requiring additional water treatment will increase water supply costs (e.g. from increased distribution and pumping costs). Treatment costs may rise for waste-water treatment plants that discharge to rivers with reducing flows.
Transport	Transport infrastructure is at risk from floods, storms and temperature extremes. Indirect costs to users and the economy are potentially significant. Significant damage already occurs. Increased risks include floods, soil erosion and fires, with particular impact on railways.
Biodiversity	It is reasonably certain that adverse biodiversity impacts will increase as a result of climate change. Impacts are expected to be minor for most habitats and species up to 2020, but to increase considerably beyond 2050, leading to substantial changes in the location and extent of habitats and the distribution and population sizes of many species.
Agriculture	Water scarcity is already being experienced in some areas of Europe and longer and more frequent droughts are anticipated in large parts of Southern Central and Eastern Europe, as well as parts of Northern Europe, with significant risks to crop yields. More arid conditions are likely to exacerbate soil degradation as a result of wind erosion and will also cause heat stress for livestock. There is less clarity about the likely changes in precipitation that might be experienced. The higher incidence of these types of extreme weather events (e.g. droughts, storms) is likely to severely disrupt crop production and increase the unpredictability and variability of crop yields. These higher temperatures

	and increased rainfall are also likely to lead to a noticeable increase in the incidence of disease, pests and pathogens, including the spread of invasive alien species.
Forestry	There is ample evidence that temperature extremes (e.g. forest fire risk) are a major threat, whilst (increased) pest/disease, storms and soil erosion are also likely to have potentially high negative impacts.

Sources: Own assessment

The likely level of regional variation of these impacts on the receptors for four macro-regions[3] is shown in Table 2. Based on this assessment it appears that the grouping of countries in the Mediterranean region and in the Central & Eastern region will be most affected. Without due measures to mitigate GHG emissions, impacts beyond 2020 are likely to be increasingly severe.

Table 2. Likely level of regional variation in the impacts for the period to 2020

Region	Health	Buil-dings	Industry	Tourism	Energy supply	Water supply	Transport	Bio-diversity	Forestry	Agri
Northern	Low	High	Low	Low	Low	Low	Medium	Medium	Medium	Me-dium
North-West	Low	High	Low	Low	Low	Low	High	Medium	Medium	Me-dium
Mediterranean	High	Low	High	High	High	High	Low	Medium	Medium	High
Central & Eastern	High	Medium	High	Medium	High	High	High	Low	Medium	Medi um

Source: own assessment based on a broad literature scan

The assessment of anticipated climate change damage costs was based on review of the available literature that describes the type and scale of impact relevant to regional development[4]. The results of these studies suggest that the largest damage costs, by some magnitude, are likely to be as a consequence of river flooding (Table 3), walthough the difficulties of assessing in particular the incidence of storms and their impacts need to be recognised. Studies of EU-wide impacts of prolonged periods of extreme weather events (e.g. heat waves and winter ice/snow) have only examined the impacts on individual receptors (such as heat waves on health or winter conditions on transport), rather than across the whole region.

[3] EEA regions: The distributions are based on climate threats and are therefore represented in relation to EU territory, rather than to national boundaries. Some geographic regions cut across some Member States and for the purpose of our analysis we have made double allocations for those Member States (France, Germany and Denmark). These Member States are relatively evenly split between the EEA regions. The Member States are hence allocated to EEA regions as follows:

North: FI, SE, EE, LV, LT

North-West: DK, NL, FR, BE, IE, UK , DE

Mediterranean: ES, PT, IT, CY, MT, EL

Central & Eastern : LU, DE, PL, HU, CZ, SK, SL, AU, BG, RO, FR, DK

[4] In order to establish some measure of consistency and comparability in the damage cost estimates, the reported estimates are those relating to the scenario that appears most frequently in the various studies (climate scenario A1B). The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B). This excludes damage from prolonged extreme weather events.

Table 3. Potential impacts from flooding and storms, by region in the 2020s, € million per annum

	Coastal flooding (2005 prices)	River flooding (2010 prices)	Storms (2006 prices)	Approximate total for the specified threats	Cost (€) per capita	Cost as % GDP
Northern	200	1,600	300	2,000	95	0.4%
North-west	3,600	6,800	1,700	12,100	74	0.3%
Mediterranean	300	2,400	600	3,300	25	0.1%
Central & eastern	1,100	9,600	800	11,600	62	0.3%
Total EU	5,200	20,400	3,400	29,000	58	0.2%

Numbers may not sum due to rounding
Sources:
Coastal flooding: Brown et al, 2011, based on scenario A1B, and a mid-range estimate of sea level rise
River flooding: Feyen & Watkiss, 2011, based on scenario A1B and an average of results from different climate models
Storms: Wehrli et al (EEA), 2010 and Heck et al (Swiss Re), 2006

A high exposure to potential climate change impacts does not necessarily imply that these impacts happen. The adaptive capacity of a Member State is a key determinant of its overall climate vulnerability and hence of the future damage costs of climate change. Funding through CAP and Cohesion Policy could be a key means of building adaptive capacity. This study has embarked on a novel approach to appraise the adaptive capacities of EU Member States, paying particular attention to the specific conditions and needs under CAP and Cohesion Policy. It has developed baseline assessments for all of the EU-27 Member States, which provides a helpful overview orientation.

The analysis confirms the finding from other relevant studies, namely that there is a clear split between the adaptive capacities of Member States in Eastern and Southern Europe and Member States in Northern and Western Europe. This holds true for meeting climate change impacts with regard to both CAP and Cohesion Policy expenditure. For those countries where our assessment finds considerable low adaptive capacities additional funding under Cohesion Policy and/or CAP targeting capacity-building could help with the overall climate change efforts across the EU and initiate adaptation activities in these Member States as well. This support would benefit from the development of a more coherent and systematic framework to climate change adaptation on a EU level as well.

3. Sensitivities of CAP and Cohesion expenditure to climate change

Under both Cohesion Policy and CAP, different areas of expenditure are likely to be sensitive to climate change related impacts from threats, such as flooding, storms, and extreme temperatures. Those receptors that are characterised by large expenditure and that have been identified as potentially facing medium or high climate change impacts require particular action for climate proofing.

Under Cohesion Policy, the expenditure categories related to infrastructure are priorities for climate proofing efforts in those Member States classified as less developed regions (mostly those in the Central & Eastern region). Currently these receive large amounts of funding: transport infrastructure (especially road and rail), water infrastructure (especially waste water) as well as energy infrastructure (especially regarding Cohesion Policy funding for renewables). In those Member States where all, or nearly all, regions are classified as “developed” under Cohesion Policy, the expenditure

category "Industry & Commerce" is identified as a priority area (see e.g. Austria, Belgium, Denmark, etc.). Developed regions receive no or only very limited funding for infrastructure development. For the Southern Member States (in the Mediterranean region) the focus needs to be on water infrastructure as well as on health related expenditure to meet the challenges from increasing drought and heat waves.

For funding under CAP, the picture is less diverse in our assessment framework. "Agriculture" receives the largest amount of funding in all Member States and will thus be the focus of climate proofing activities. Investments in physical infrastructure in the agricultural sector are largely financed through Pillar 2 and are extremely varied, from funding manure storage and anaerobic digesters to water harvesting and storage units, to equipment for food processing, to farm machinery, livestock housing and so on. In addition a large proportion of expenditure is channelled via Pillar 2 to encourage environmental land management activities. Therefore, future expenditure in these areas will need to ensure that the infrastructure being funded is able to withstand future climate impacts and ideally contribute to the adaptation needs of the sector. The specific objectives need to be fine-tuned at the national or regional level to meet the different threats from climate change. Biodiversity and forestry receive lower shares of funding from CAP but should also remain a focus as they will face considerable threats from climate change as well.

4. Options for mainstreaming and climate-proofing of Cohesion Policy and CAP

In order to improve performance and to strengthen the climate resilience of the expenditure categories at risk, 75 different adaptation options were identified. The appraisal of options followed the distinction of the White Paper on adaptation of 'grey' (technology-based), 'green' (or ecosystem/environment-based) and 'soft' (behavioural, managerial, informative-based) policy options. An overview of options is provided inBox 1.

Box 1: Summary of relevant adaptation options by receptor

Health /population: The most relevant options are 'soft' policy options. They include warning, monitoring and information systems. 'Grey' and 'green' options can be used to help enhance the resilience of health infrastructure to extreme heat and precipitation, e.g. through passive cooling of hospitals or green roofs.

Residential/buildings: Options are predominantly 'grey' options, such as robust construction of buildings and design options involving better insulation or passive cooling systems.

Biodiversity: Biodiversity-related options are primarily 'green' options, supplemented by 'soft' options. 'Soft' options relate to the monitoring of biodiversity, especially trends in animal and plant populations. 'Green' options involve the protection and expansion of protected areas and their connectivity. Ecosystem-based adaptation strategies can create significant co-benefits for biodiversity and sustainable regional development.

Agriculture (including soil) and forestry: 'Grey' and 'green' options are relevant. 'Soft' options focus on the provision of information to farmers regarding climate change impacts and adaptation measures, including information and monitoring systems and insurance tools. 'Grey' options focus mainly on water management (to improve irrigation efficiency for example), adaptation of infrastructure (buildings/animal shelters), and soil and crop management. 'Green' options include many crop and soil management options that aim to mitigate soil erosion, e.g. plant winter cover and reduced or conservation tillage. The effectiveness of water management and flooding options can be optimised when combined with green options.

Industries (excluding tourism and utilities): 'soft' and 'grey' options are relevant. 'Soft' options could include specific awareness raising campaigns, or training to support companies in developing their own adaptation

strategies. 'Grey' options include those focussing on the adaptation of buildings (offices and industrial plants) and general infrastructure (e.g. roads on company premises, own energy production facilities, etc.).

Tourism: Relevant options are predominantly 'grey'. The adaptation of travel destinations will require new infrastructure, although this will be highly dependent on regional climate impacts and options will differ between regions. 'Soft' options include marketing and information campaigns.

Water utilities/water management: Many options for this receptor are 'grey' options regarding water infrastructure, especially waste water infrastructure. Often, the options can be applied usefully in combination with green options or consist of a mixture of green and grey options, e.g. in urban areas green spaces, retention systems and open and green water channels can be combined with grey options like water storage capacity in reservoirs. River restoration to create buffer zones is one major 'green' option regarding flooding. Some 'soft' options exist, including monitoring systems, information campaigns on drought adaptation.

Energy: Most options focus on infrastructure and power generation, as well as demand side management. 'Grey' options related to power generation ensure that generation is able to cope with changing climatic conditions, and that transmission is maintained through the enhancement of electricity grids.

Transport: Most relevant options are classified as 'grey' options, such as adjusting road asphalt to cope with heat and extreme precipitations. 'Soft' options relate to travel and logistic information and weather forecasts.

Crosscutting options: 'Crosscutting' options either address more than one impact, sometimes within one sector, or within a number of sectors. This includes a broad range of 'soft' and 'grey' options, supplemented by 'green' options. 'Soft' options such as early warning systems for example, provide data related to a range of impacts (for example forest fires, extreme heat or storms). Crosscutting options also include all grey options related to sea-level rise and river flooding, e.g. dike reinforcement and heightening, as they have benefits for several policy fields. Options that are implemented in urban areas and specific geographic regions (such as mountainous regions), such as urban and regional planning, can also be considered to be cross-cutting.

A selection of relevant options was then subject to a more detailed cost-benefit assessment. These options were chosen on the basis of their potential to prevent a medium to high share of relevant climate threats and their urgency and thus relevance for implementation within the 2014-2020 programming period. Table 4 illustrates the benefit-cost ratios estimated at the EU level.

Table 4. Benefit-to-cost ratios for a range of options

High B-C-ratio (> 2)	Medium B-C ratio (1< x ≤ 2)	Low B-C-ratio (< 1)
• Early warning system • Buffer strips • Storm retention reservoirs • On-farm water harvesting • Awareness raising for SMEs • Options to adapt to river flooding • Options to adapt to coastal flooding • Adapting rail tracks to higher temperatures • Adapting electricity grids	• Floodplain management • Planting of winter cover • Improvement of animal rearing conditions • High-efficiency ventilation	• Cooling of hospitals • Improved forest management • Anti-hail nets • Sustainable urban drainage systems • Adapting roads to higher temperatures • Adapting roads to increasing precipitation

High or medium efficiency is expected for 'soft' options like early warning systems or awareness raising for SMEs as they require rather low upfront costs and can lead to high benefits. Their efficiency, however, is often dependent on the interplay with other policy options. Similarly, 'green' options seem to have good benefit-to-cost ratios. In comparison to 'grey' infrastructure options, upfront investment costs for 'green' options are rather low. Options which focus on improving the

resilience of key infrastructures also have high or medium benefit-to-cost ratios. For some of the options, the analysis at EU level leads to a low benefit-to-cost ratio, indicating that they might be inefficient. However, those options might have much better benefit-to-cost ratios when appraised for a single Member State with a specific high vulnerability. This is for example the case for both road transport related options (Table 4). These need to be targeted at regions and Member States with high vulnerabilities. This underpins the need for a detailed assessment of options and their relevance on an EU and on a domestic level.

Both the list of 75 options as well as the methodology for the benefit-to-cost analysis and its application in 14 cases can provide valuable insights for managing authorities when programming the next round of expenditure under the 2014-2020 MFF.

5. Cohesion Policy: Opportunities for mainstreaming and climate proofing in the 2014-2020 programming period

The analysis of the Commission's proposals for the 2014-2020 Cohesion Policy indicates that the Cohesion Policy expenditure under the forthcoming MFF perspective that is mostly exposed to climate change risks includes:

- *basic infrastructure* in four sectors: energy production and distribution; transport (all modes, but especially rail), environment (water and waste in cases where these entail both technology and ecosystem based solutions), and public buildings (including health infrastructure) and housing; and
- *nature, ecosystem services and natural/cultural assets* in relation to tourism;
- *urban development and buildings*, especially from heat waves and flood risk.

These categories include expenditure that falls under four of the Common Strategic Framework (CSF) thematic objectives, which are eligible for funding under both the ERDF and the Cohesion Fund. The scope and scale of climate proofing however should be determined by the magnitude of funding allocations per expenditure type, as well as the level of adaptive capacity of the respective Member State.

This study also shows that there are a number of novel provisions in the draft Regulations which are likely to encourage better consideration of climate change risks and the promotion of adaptation activities. Novel requirements and measures include a dedicated thematic objective for risk prevention and climate change adaptation; integrating climate change in the definition of sustainable development as a horizontal principle; maintaining the principle of partnership; as well as integrating climate adaptation needs and resilience considerations in project selection and in annual implementation reports. At the same time, our analysis points to a range of clarifications and improvements which are needed in the legislative and implementation frameworks for Cohesion Policy both at EU and national/regional levels. These relate *inter alia* to earmarking, assessment procedures for climate adaptation needs as well as performance frameworks and indicators. Much of the success of climate proofing efforts will depend on how specific actions and procedures are designed and undertaken at the national and regional levels where the programming, implementation and monitoring take place.

The major core of Cohesion Policy funding is spent on developing regions in Central Eastern and Southern Europe. The policy is therefore well-placed to support and foster ongoing efforts to install policy approaches to climate change adaptation. Member States/regions will need to factor in climate change adaptation considerations in their sectoral planning processes and ensure that a sufficient share of the projects' budget is dedicated to proper prevention and adaptation measures.

There will be competition between different thematic objectives in Cohesion Policy. It is, therefore, important to promote climate change expenditure in a smart way. Where possible, priority should be given to options that realise important synergies with climate change mitigation (e.g. *inter alia* energy efficient adaptation of commercial premises, industrial plants, homes and buildings, higher energy efficiency of ventilation systems, protection of buildings from storms and extreme precipitation) or bring about co-benefits for other sectors such as industry, transport, water management and social inclusion (e.g. *inter alia* awareness raising for companies regarding adaptation to climate change, increased robustness of transmission grids to storm damage, sustainable urban drainage systems). This would help to promote climate adaptation under different thematic objectives.

Little awareness and knowledge and capacity constraints are main barriers to foster the climate proofing of projects. Better use should be made of technical assistance instruments and funding for training/education/institutional capacity building from the European Social Fund. JASPERS in particular should be modified to provide technical support to specific climate change related services in programmes and projects to 1) managing authorities (e.g. during the programming of Operational Programmes) and 2) project developers (e.g. by assessing climate change risks in cost-benefit analyses and/or introducing adaptation options in the project design stage).

6. CAP: Opportunities for climate proofing in the 2014-2020 programming period

CAP offers opportunities for supporting targeted adaptation options for agriculture, forestry and biodiversity as well as within rural areas more generally. Climate adaptation features much more strongly as an objective within the Commission's proposals for 2014-2020 than has been the case in the past. There are a number of important requirements that have been proposed or introduced that should help to increase the visibility of climate adaptation as an issue to be addressed. These include:

- The inclusion of climate action as part of the three overarching objectives for the CAP
- The inclusion of climate adaptation and risk management as a thematic objective in the Common Strategic Framework
- The introduction of ex ante conditionalities relating to climate adaptation (e.g. risk management, water efficiency and energy efficiency)
- The inclusion of climate adaptation as a cross-cutting objective that Member States must demonstrate they are addressing across all measures used in their Rural Development Programmes – also reinforced in the requirements stipulated for programme content
- The suggested earmarking of 25% of the EAFRD component of rural development funding for 'climate change mitigation and adaptation and land management', through three land management measures
- The requirement for the Farm Advisory System to include advice on climate adaptation and broaden its scope beyond cross-compliance to rural development measures
- The strengthening of cross compliance GAEC requirements in relation to soils
- The introduction of green direct payments in Pillar 1, which could contribute to increasing the resilience of agricultural land to climate impacts
- The introduction of the EIP on Agricultural Productivity and Sustainability.

In terms of the availability of measures to fund specific options and actions on the ground, the current CAP proposal provides a sound basis for funding the different priority adaptation options identified in the study. Pillar 2 of the CAP, i.e. Rural Development Policy, plays the most important role in this regard and there are a number of rural development expenditure lines that are most relevant for funding adaptation options, such as support for the development of human capital in the

form of capacity building and the provision of advice, investments in infrastructure related to farming and forestry activities, and support for environmentally beneficial land management activities. Rural development measures are deliberately multi-objective and many of the rural development measures identified do not solely address climate adaptation needs. Their principal focus may be on other objectives which also improve the resilience of rural areas to climate change, but they may also be applied in ways which would be counterproductive for climate adaptation. A prime example of potential risks of this kind is where expenditure is used in ways that encourage the unsustainable use of water. It is therefore essential that sufficient safeguards are put in place to ensure that funding does not lead to negative consequences for adaptation.

In addition, under the proposed changes to Pillar 1, particularly direct payments, greening payments could provide important funding for three environment climate options at farm management level (diversified crop rotations, permanent grassland and "ecological focus areas"). The requirement for Member States to set up a Farm Advisory Service that covers climate adaptation is also important, although the beneficial impact will depend on the nature and content of the service developed in Member States. Including climate adaptation considerations in project selection and eligibility criteria could make a major contribution if it was included as a requirement.

Member States do not always take advantage of the flexibility embodied in the programming process for developing Rural Development Programmes (RDPs). Although the potential to address climate adaptation needs exists in theory, this may not be identified as a priority for implementation at the national or regional level in practice. This situation should improve for the 2014-2020 programming period, given that Member States will be required to demonstrate how they address adaptation in relation to all spending priorities. However, the actual implementation and effectiveness ultimately depends on the interest of farmers and other land managers or rural actors.

The assessment of barriers and capacity needs in relation to climate adaptation shows that there is still some way to go to ensure RDPs and the activities they fund are sufficiently climate proofed for the next programming period. Key areas where improvements are needed relate to the evidence base, information dissemination and guidance and institutional capacity.

7. Capacity Building Needs and Guidance

Knowledge and information gaps, as well as capacity constraints characterise the environment of many public authorities as they struggle to adjust to shrinking budgets and fewer personnel. Hence, capacity-building is a key prerequisite for success. This study has developed a capacity building strategy and technical guidance for Cohesion Policy and CAP as well as capacity building material to support the strategy.

Issues discussed are all inter-related and many can be addressed simultaneously through different capacity building measures, including written guidance, workshop-style training, mentoring programmes and other measures. In some cases, advice and guidance on administrative reforms will be required that would enable new staff, to focus on and support project preparation, implementation and monitoring.

7.1 Cohesion Policy

Capacities for general adaptation to climate change impacts as well as for mainstreaming and climate proofing Cohesion Policy expenditure differ across Member States. However, our analysis points to a number of generic shortcomings common to many Member States, though varying in degree. As a general rule, more active capacity building support is needed for countries with low adaptive capacity in Eastern and Southern Europe and more careful, targeted and complementary support for

countries with high adaptive capacity in Western and Northern Europe. The sharing of experience between Member States should be actively promoted.

Overall, authorities and project beneficiaries alike need greater awareness about the impacts of climate change on relevant programmes and projects**.** This requires that information is provided in formats that are accessible and digestible. A better understanding is also needed of the tools at the disposal of authorities to practically support them with integrating specific adaptation options into programmes and eligible funding expenditure is also needed. In addition, authorities need more guidance on how they can integrate climate change issues across the programme and project cycles, starting with programming documents, through to project implementation and monitoring. This project developed relevant guidance based on the Cohesion Policy programme cycle which is a useful framework for organising capacity building measures in terms of content and timing. It also highlights aspects of that stage which will require increasing the capacity of public authorities and other stakeholders to enable the better inclusion of climate change adaptation. Capacity building must target the full programming cycle to have the desired impact.

7.2 Common Agricultural Policy

As with Cohesion Policy, capacity needs under the CAP will vary considerably across Member States, and the overall relevance of climate change impacts will be higher in Eastern and Southern countries.

The concept of 'climate proofing' must be clarified and understood. Likewise, it is crucial to clarify the overall idea that climate change adaptation is an important issue for all areas of CAP spending. The need to for climate proofing CAP expenditure should be extended beyond measures that focus directly on climate adaptation to ensuring that non-climate focused investments and land management activities are resilient to future climatic impacts.

Related to this, authorities also require a greater understanding of the methods and tools at their disposal for mainstreaming climate change adaptation into Rural Development Programmes. If the relevant legal frameworks for climate change adaptation in a Member State are unclear or under-developed, it is more difficult to integrate these issues into Rural Development Programmes and Partnership Agreements.

A lack of knowledge and information is the main reason why climate change adaptation is not a priority. Awareness - especially amongst politicians and policy makers - of climate change threats, potential climate change impacts and associated damage costs needs to increase. Clarity and knowledge on the costs of adaptation measures and associated benefits from early action needs to be enhanced – as this can be a powerful catalyst for action.

The lack of technical knowledge on the type of specific adaptation measures required and their cost/benefit and time horizon characteristics leads to uncertainties about how to integrate adaptation needs into programme design and implementation. Continuous capacity building on concrete types of measures would help to fill this gap.

Innovative tools and procedures for integrating climate change adaptation across the programme need to be collected and made available for all relevant actors in the Member States. The CLIMATE-ADAPT-platform should be used for networking and information exchange but also existing networks like the ENRD, the National Rural Networks and emerging networks, such as those to be developed under the new EIP, can be involved in information and expertise sharing.

Uncertainty about the way in which measures can be used to address climate adaptation priorities results in a disincentive for farm advisory services as well as farmers to implement activities that

could improve resilience to climate change in practice. Therefore it would be valuable to enhance the link between what is technically recommended and what is fundable under different elements of the CAP and different rural development measures.

GLOSSARY

Adaptation: The term used to describe responses to the effects of climate change. The Intergovernmental Panel of Climate Change IPCC defines adaptation as 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.' Adaptation can also be thought of as the ongoing process of managing changing climate risks.

Adaptation options: Used in the context of Cohesion Policy, 'adaptation options' are concrete ways in which programmes and projects can build in resilience to climate change. Some options directly target climate change adaptation.

Adaptive Capacity: The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities, or to cope with the consequences.

Climate mainstreaming: In the context of this study, 'climate mainstreaming' is used to mean the integration of climate change adaptation into other policy areas, focusing on the integration of climate concerns and responses into relevant policies, plans and programmes at different levels of governance.

Climate proofing: In the context of this study, 'climate proofing' refers to the process of cross-checking that all elements of a programme and its implementation, including specific measures and projects, address climate change issues. This involves ensuring that funding is resilient to future climate impacts.

Common Strategic Framework (CSF): A document that provides a strategic framework of actions to improve the complementarity, coordination and EU added value of planned Cohesion Policy expenditure for 2014 – 2020 for the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF)

Cost-benefit ratio for adaptation options: A quantitative assessment (as far as possible) of the ratio between the cost of investing in the option and the benefit of saving future damage costs.

Earmarking: 'Earmarking' is a tool for setting a minimum requirement for the share of funding allocated to a specific priority.

Ex-ante conditionalities: Conditions related to policy, legal or capacity that must be in place in the Member States before funds are disbursed. The Partnership Agreement (see below) must explain how the conditionalities are fulfilled or will be within two years.

Financial instruments: Form of financial support provided from the EU budget in order to address a specific policy objective by way of loans, guarantees, equity or quasi-equity investments or participations, or other risk-bearing instruments, possibly combined with grants.

Grants: A form of direct financial contribution, by way of donation, from the EU budget in order to co-finance either an action intended to help achieve an objective forming part of an EU policy; or the functioning of a body which pursues an aim of general European interest or has an objective consistent with EU policy.

Grey options: Relate to infrastructure and infrastructural solutions to climate change.

Green options: Relate to biodiversity, ecosystems and green infrastructure as a solution to adaptation needs.

JASPERS: A technical assistance instrument of the EU which offers technical support to the new Member States to prepare major projects for EU co-financing under Cohesion Policy.

JESSICA: 'Joint European Support for Sustainable Investment in City Areas' is an initiative of the European Commission developed in co-operation with the European Investment Bank (EIB) and the Council of Europe Development Bank (CEB). It supports sustainable urban development and regeneration through financial engineering mechanisms.

Maladaption: Actions taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups. Unsuccessful adaptation alone does not constitute maladaptation, as it might not lead to an increase in vulnerability.

Multi-annual Financial Framework (MFF): The MFF is a document that sets out the EU's spending priorities. It lays down maximum amounts (ceilings) for each broad category of expenditure (headings) for a clearly determined period of time (several years).

Operational Programmes: Basic planning document for the expenditure Cohesion Policy funds. They are typically developed for regions and/or sectors (e.g. transport, energy, etc.).

Partnership: The Commission proposals in the draft Common Provisions Regulations specifies that Member States shall organise a partnership for preparing the Partnership Agreement and the Operational Programmes.

Partnership Agreement: This document sets out the Member State's strategy, priorities and arrangements for using the CSF Funds in an effective and efficient way to pursue the Union strategy for smart, sustainable and inclusive growth. It is prepared by the Member State with the involvement of partners in line with the multi-level governance approach, and is approved by the Commission following assessment and dialogue with the Member State.

Rural Development Programmes: This is the basic planning document for spending under rural development policy and the EAFRD. They are typically developed at the Member State or regional level.

Soft options: Address human capital and adaptive capacity needs

Thematic Objectives: The eleven key sectoral objectives to be funded by Cohesion Policy 2014-2020 and set forth in the proposed General regulation. Thematic Objective (5) is 'promoting climate change adaptation, risk prevention and management'.

Union Priorities in Rural Development Programmes: The proposed regulation for the European Agricultural and Rural Development Fund sets out six priorities for rural development. One of these is 'Resource efficiency and shift towards a low carbon and climate resilient economy'.

Vulnerability: Vulnerability to climate change is a measure of potential future impacts (a function of exposure and sensitivity) and a range of political, institutional, socio-economic and technical components (adaptive capacity).(Adapted from the Fourth Assessment Report of IPCC, 2007).

1 Introduction

This is the final report for the project contract "Methodologies for Climate Proofing Investments and Measures under Cohesion and Regional Policy and the Common Agricultural Policy" (Contract No 07.1303/2011/603488/SER/CLIMA.C3) by the Institute for European Environmental Policy (IEEP) together with Ecologic Institute, Milieu, GHK and Environment Agency Austria. The aim of this study is to help close gaps in the current understanding of the potential impacts of climate change, sensitivities of investments and their social, environmental and economic costs.

The EU has set itself ambitious objectives for combating climate change. In addition to efforts to mitigate climate change, the European Commission is also taking action to strengthen climate adaptation in the EU and has a critical role in promoting best practice, via support, guidance and conditions for infrastructure development.

The White Paper[5] on climate adaptation stresses the relevance of integrating adaptation needs and opportunities into key policy areas, i.e. mainstreaming adaptation responses into all areas of EU policy that are affected by climate change and making sure that overall investment and measures are "climate-proof", i.e. remain robust in their effectiveness and value under different climate change scenarios. A significant proportion of the EU Budget is allocated to the Common Agricultural Policy (CAP) and Cohesion Policy. Both policy areas will also be affected by the impacts of climate change and also include huge opportunities to foster better climate adaptation.

This report describes the main findings of the study and is supported by the following other outputs:

- Capacity Building Strategy for Cohesion Policy
- Capacity Building Strategy for CAP
- Technical Guidance for Cohesion Policy
- Technical Guidance for CAP
- Capacity Building Material for Cohesion Policy
- Capacity Building Material for CAP
- Supplementary Material Report

The core of this report is about climate mainstreaming and proofing measures and related expenditures under CAP and Cohesion Policy from the perspective of adaptation to climate change.

1.1 Background and policy context

The next Multi-Annual Financial Framework (MFF) of the EU (2014-2020) will be of decisive importance for the EU's ability to cope with the emerging realities of a changing climate. Although limited in scope compared to the public budgets of the Member States, the EU budget can have significant multiplier effects in important policy areas such as energy or transport and can help to build institutional capacity at a European scale. It also plays an important role in areas such as agriculture, where there is an EU common policy, and Cohesion Policy. Much of EU spending directly or indirectly affects the achievement of EU's climate change objectives.[6]

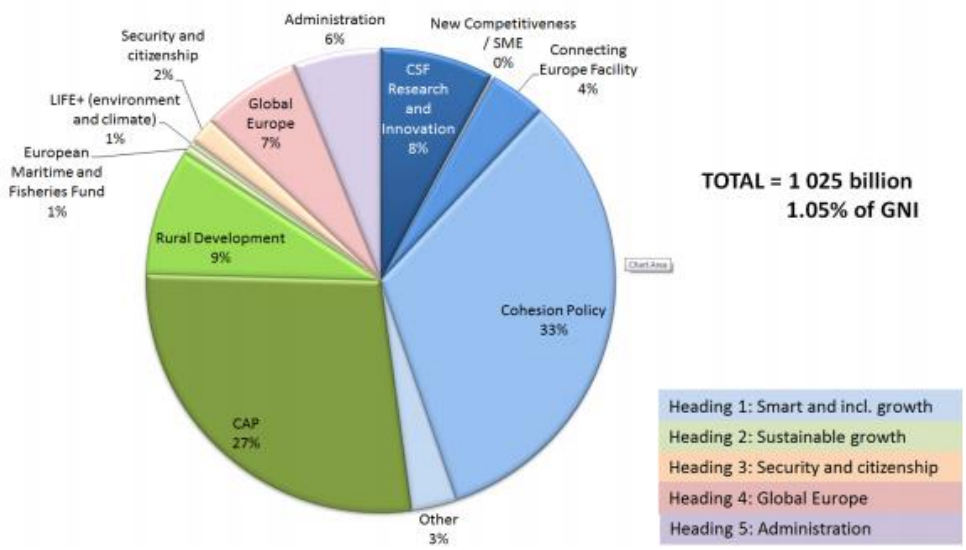
There has been a growing recognition that the 2014-2020 EU MFF needs to better reflect the climate challenge in order to prepare the EU for a more sustainable future. The need to better address

[5] EC (2010) White paper on climate change adaptation. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009DC0147:EN:NOT

[6] Medarova-Bergstrom, K., Volkery, A., Schiellerup, P., Withana, S., Baldock, D. (2011) Strategies and Instruments for Climate Proofing the EU Budget. IEEP, Brussels.

climate change (also in connection with resource efficiency and energy security) was highlighted in the Commission's Communication on 'The EU Budget Review' presented in October 2010.[7] In June 2011, the Commission tabled its proposals for the 2014-2020 MFF, proposing that at least 20 per cent of the MFF should be spent on climate change relevant activities.[8] Figure 1 provides an overview of proposed allocations under the post-2013 MFF. With a proposed expenditure of €1,025 billion, it is envisioned that the next MFF would be strongly aligned to the Europe 2020 Strategy and its Flagship initiatives. Following Commission proposals, the Common Agricultural Policy (with €372 billion of proposed funding) would remain a sizeable element of the overall budget but would now account for a fractionally smaller share than the EU's Cohesion Policy (€376 billion).

Figure 1: Proposed budget allocations under the post-2013 MFF



Source: Medarova-Bergstrom, K. and Volkery, A. (2012): Practical Options for Climate Change Mainstreaming in the 2014-2020 EU Budget report, Brussels/London

With a relatively small sum allocated to the LIFE instrument as the core instrument for dedicated climate change spending, the mainstreaming of climate change concerns across all relevant EU funds has been put forward as the principal mechanism for raising additional financial resources to finance climate change mitigation and adaptation activities. The aspirational objective of making a fifth of the 2014-2020 MFF relevant for climate change related activities will require a more articulate focus on how spending under the CAP and Cohesion Policy funds can be utilised for the purpose of climate change mitigation and adaptation. Given our increasing understanding of threats from climate change to vulnerable economic and social activities and eco-systems, a key policy challenge for the post-2013 MFF is to better integrate the adaptation angle into Cohesion Policy and CAP funds. These funds should be proactively used for financing adaptation measures, where relevant. Such a strategy will usefully underpin the emerging strategic policy framework of the European Adaptation Strategy to Climate Change, which is expected to be published in spring 2013. Moreover, action is needed to ensure that the remaining sum of investments under CAP and Cohesion Policy is robust to conditions of a changing climate. Infrastructure, for example, is likely to have to cope with very different climatic conditions in the future. If no action is taken to make investments robust to the potential

[7] EC (2010) The EU budget review, Communication from the Commission COM(2010)700, Brussels, 19/10/2010

[8] EC (2011) A Budget for Europe 2020, Communication from the Commission, (COM (2011)500), 29.06.2011, Brussels.

varying conditions of climate change, an opportunity to spend EU funds in ways consistent with the needs of adaptation and EU added value will be missed.

Operationalising an effective approach to both climate mainstreaming and proofing CAP and Cohesion Policy is a major undertaking that needs to encompass the whole cycle of programming, implementing and monitoring/evaluation of funds. It needs to be understood as a continuous process and interplay between the EU, national and local authorities. In this sense, three inter-related strategic threads for an approach towards climate mainstreaming and proofing emerge:

- *Policy needs:* A better understanding of climate change threats and related impacts and damage costs per Member State and region is needed in order to gauge priority areas for policy action and delineate those adaptation options that are most useful to take forward, i.e. to achieve the strongest EU value added. Information on climate change threats, impacts, costs and benefits of policy options is still largely scattered, posing a tremendous challenge for political decision-making processes ahead.
- *Policy opportunities*: Different promising policy options align themselves differently to the very logic of the CAP and Cohesion Policy. This "goodness of fit"-angle is important to consider as well as to carefully assess what is being already proposed under the proposals for the post-2013 CAP and Cohesion Policy. Different entry points exist for strengthening the case of climate mainstreaming and proofing in both future negotiations about the post-2013 CAP and Cohesion Policy as well as subsequent stages of funds programming, which will need to be considered, as will barriers to taking forward climate mainstreaming and proofing approaches.
- *Policy capacities*: Even the most carefully designed policy approach can fail if the capacities on the ground are not sufficient to meet related policy demands and requirements. Understanding available adaptive capacities and related needs for capacity-building through improved technical guidance forms a key cornerstone for any strategy towards climate mainstreaming and proofing CAP and Cohesion Policy.

Work under this project was designed to specifically respond to these challenges.

1.2 Main intervention logic of the work carried out under the project

The aim of this study was to help close gaps in the current understanding of potential impacts of climate change, the sensitivities of investments to climate change and their social, environmental and economic costs. The study started by identifying the potential threats and impacts of climate change that are of most relevance to Cohesion Policy and CAP, assessing associated damage costs and appraising the adaptive capacities in Member States. This information was then used to identify the areas of expenditure most sensitive to climate change impacts for Cohesion Policy and CAP. Based on this, a baseline was developed for the EU-27 of climate change threats and impacts associated with potential CAP and Cohesion Policy investments, as well as expenditure needs in Member States until 2020.

Another key aim of the study was to identify and analyse available options for improving adaptation of climate change that lend themselves to support from CAP and Cohesion Policy. On the basis of the information generated through the problem analysis, further research identified a list of 75 concrete options to foster climate adaptation under either Cohesion Policy or CAP, out of a considerably larger collection of policy options. This list of options provides a major contribution to the forthcoming debate about programming CAP and Cohesion Policy expenditure, as it can provide managing authorities with a comprehensive overview of possible actions. A 'decision-tree' was established for options selection, including transparent information on EU added value, urgency, effectiveness, efficiency and relevance. Following up on the high level assessment of options, a list of options was

chosen for a detailed cost-benefit analysis. The methodology used for this appraisal is documented and can help managing authorities to make better informed decisions in the future.

A detailed assessment of the Commission's proposals for CAP and Cohesion Policy under the 2014-2020 programming period was undertaken in order to identify existing opportunities and constraints to climate mainstream and proof these. Finally the study looked at the needs for capacity building at Member State level in the context of climate change adaption in relation to CAP and Cohesion Policy and developed relevant guidance documents. Close interaction with relevant stakeholders underpinned this exercise.

An important caveat with regard to the findings presented in this study relates to a lack of sufficient data and information on quantitative estimates for relevant impacts and damage costs on a sectoral basis, which are comparable on an EU level, particularly in agriculture and forestry. While a broad body of literature exists with regard to overall climate change impacts and related sensitivities and exposure of Member States, this is not directly linked to information on expenditure under the CAP and Cohesion Policy. In this context, this project is a major step forward as it provides a first comprehensive attempt to systematically link these two dimensions.

Another methodological challenge concerns the status of the political negotiations on the draft Regulations governing the 2014-2020 CAP and Cohesion Policy. These are in their early stages. The positions of quite a few Member States are not yet fully formed, and we are still waiting for relevant legislative proposals to provide the necessary detail, which makes the assessment of opportunities and prospects for climate change proofing difficult. It also means that the capacity-building and technical guidance materials need to be read with the caveat that they refer to an expectation of Cohesion Policy and CAP objectives, structure, priorities and process that may change in the finalisation of the Regulations. Furthermore, the programming process at the national and regional levels are also yet to commence therefore data collection related to the potential role of the future CAP and Cohesion Policy for the mainstreaming of climate change adaptation is quite difficult to obtain.

The political uncertainties are also relevant as they affect the discussion about the selection of options that might be promoted in the context of future CAP and Cohesion Policy. This project has established a formal decision tree to enable the development of a medium sized list of policy options that can help with fostering adaptation efforts and the greater climate resilience of CAP and Cohesion Policy investments under the 2014-2020 MFF (a total of 75 options). In their mere substance the options should remain unaffected by changes in the legislative context conditions. However, the degree of difficulty of their implementation might change.

1.3 Key conceptual approaches

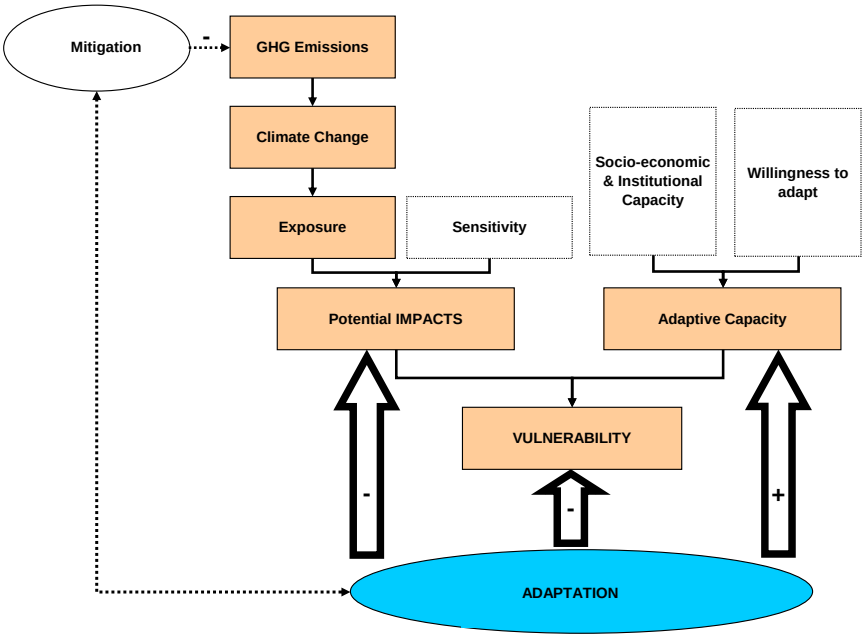
This sub-chapter discusses key conceptual approaches that are used throughout the report, namely 'vulnerability' to climate change and 'climate mainstreaming' and 'climate proofing' of CAP and Cohesion Policies. These are complex concepts, which are subject to different interpretations and are used in very different ways in different public policy discussions. The understanding provided in this study follows a careful review of the most recent literature, as well as studies carried out for the European Commission and other institutions. Additional definitions can be found in the Glossary section.

1.3.1 Defining Vulnerability

'Vulnerability' to climate change in its general meaning is a measure of the potential future impacts (i.e. a function of exposure and sensitivity) and a range of political, institutional, socio-economic and

technical components (adaptive capacity) (IPCC 2007; EEA 2008, Hinkel 2011 in Schauser et al. 2011) (see Figure 2 below).

Figure 2: Conceptual diagram for climate change impacts, vulnerability and adaptation.



Source: Isoard, Grothmann and Zebisch (2008) quoted in EEA (2008)

Adaptation needs to be understood in two ways: financing climate adaptation measures, such as policies or technologies implemented in order to respond to the vulnerabilities that result from the impacts of climate change; and existing adaptive capacity. Hence some measures will respond to impacts on infrastructure and physical capital, and some will help build the human capital needed to respond to climate change.

1.3.2 Defining climate proofing and mainstreaming

The concept of 'climate-proofing' has only recently entered into the policy discussions on the EU budget. It is often used interchangeably with the concept of 'climate mainstreaming', or also climate integration, in spite of some recent attempts to bring more clarity to these concepts[9] . They refer, however, to different, though inter-linked, activities.

As part of this study we will use the following definitions:

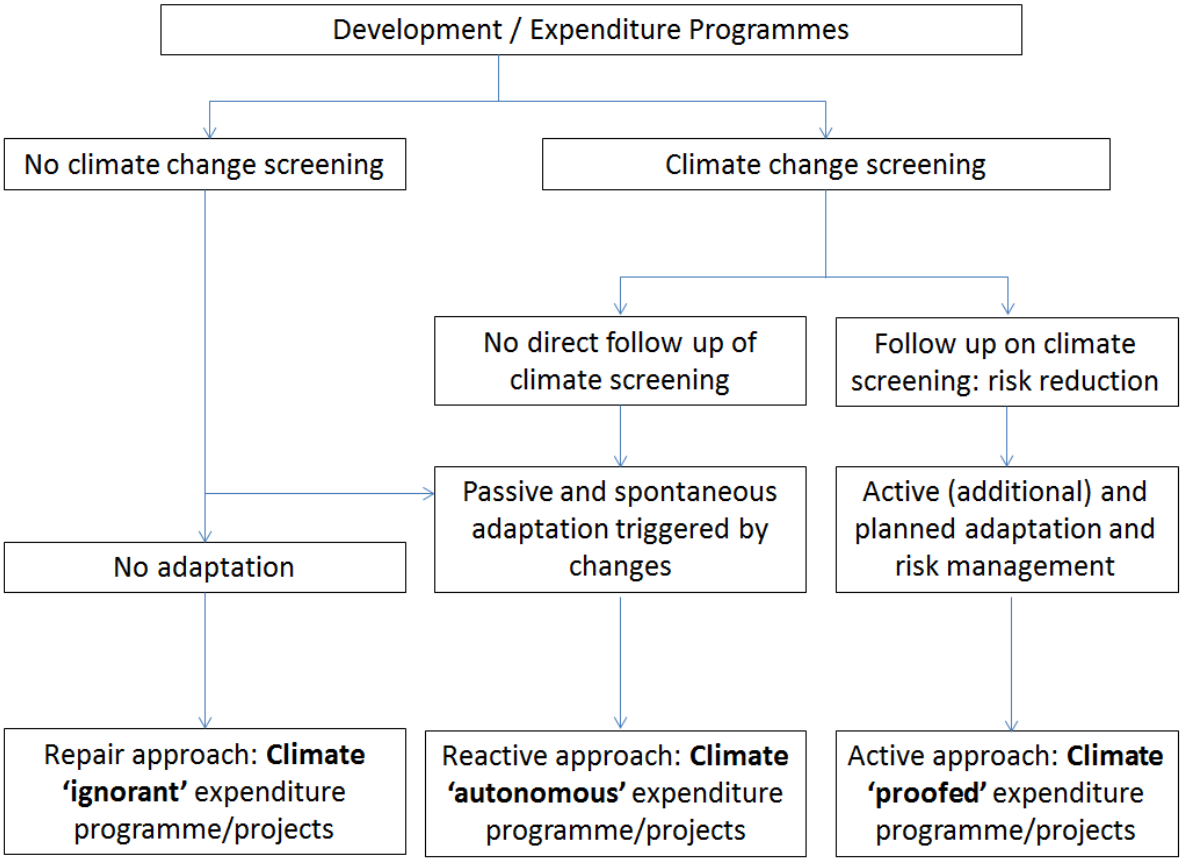
- **Climate mainstreaming:** As part of this study 'mainstreaming' refers to the integration of climate change adaptation into other policy areas, focusing on the integration of climate concerns and responses into relevant policies, plans and programmes at different levels of governance.

- **Climate proofing:** As part of this study 'climate proofing' will refer to the process of cross-checking that all elements of a programme and its implementation, including specific measures and projects, address climate change issues.

[9] Medarova, Keti, Volkery, Axel, Baldock, David, Schiellerup, Pernille and Withana, Sirini (2011) Strategies and instruments for climate-proofing the EU budget. Report for the European Climate Foundation. Brussels: IEEP.

Climate mainstreaming and proofing thus represents an approach to reduce the potential impacts of climate change through the anticipation and allocation of respective programme expenditure and project design for planned adaptation and risk management. While the upfront costs of such an approach are higher than for other approaches to dealing with climate change adaptation under expenditure programmes, namely not screening for climate risks at all or rely on autonomous, or passive adaptation, the overall socio-economic benefits are much larger due to the avoided damage and repair costs as well as avoided inappropriate investments (see Figure 3).

Figure 3. Climate risk screening and response in expenditure programmes



Source: Adapted from UNDP[10]

1.4 Structure of this report

Chapter 2 presents the results of work undertaken to collate and summarise the available information on potential climate change threats and qualitative and quantitative impacts in areas of relevance to CAP and Cohesion Policy expenditure. This is followed by the presentation of the results of the assessment of Member States' adaptive capacity. It concludes with the development and assessment of a baseline of climate change impacts and threats to CAP and Cohesion Policy investments, as well as expenditure needs in Member States until 2020. Information on the impacts, threats, expenditures and adaptive capacities is compiled into summary tables that provide easily accessible information for each Member State.

[10] UNDP (2009) Guidelines for Climate Change Proofing in UNDP Projects and Programmes in Armenia. UNDP.

Chapter 3 appraises potential adaptation options to climate-proof CAP and Cohesion Policy. It begins by developing a typology of adaptation options. An overview of the options assessed is provided, followed by the results of an assessment of the costs and benefits of a short-list of options that were selected on the basis of their potential to prevent significant climate threats and their urgency, and thus relevance, for implementation within the 2014-2020 programming period. Our typology reflects a number of issues that will help Member States prioritize options for climate proofing CAP and Cohesion Policy. The chapter concludes with an appraisal of existing EU policies and measures and identifies which of these are most relevant for ensuring that expenditure under Cohesion Policy and CAP is 'climate proofed'. The aim is to assess to what extent existing regulatory, voluntary and strategic instruments already envision measures that can help to climate proof CAP and Cohesion Policy in the 2014-2020 programming period and determine possible modifications/adjustments of instruments where these might be needed.

Chapter 4 and 5 assess the potential of the Commission proposals on the Cohesion Policy and CAP for the 2014-2020 programming period to address climate change adaptation needs and priorities; consider the views of government officials and other stakeholders or climate experts on the potential and limitations of the proposed legislative texts for climate proofing future expenditure; and identify key barriers and highlight gaps in the knowledge and capacity needs that can hinder the integration of climate adaptation needs and options into the implementation of the future Cohesion Policy and CAP in practice. At the end it draws policy recommendations about how to improve the resilience of expenditures to climate impacts and extreme weather events.

Chapter 6 provides a summary of the assessment of the capacity needs of Member States in relation to climate proofing CAP and Cohesion Policy and presents the main capacity building measures for each policy area that are proposed to be included in the capacity building strategies that have been developed as part of this project.

2 Climate Change Threats, Impacts and Damage Costs

2.1 Introduction

This chapter provides the results of work undertaken to collate and summarise the available information on possible climate change threats and the qualitative and quantitative impacts in areas of relevance to CAP and Cohesion Policy expenditure. It also presents the results of the assessment of Member States' adaptive capacity. The potential threats and impacts of climate change provide the context for work carried out to identify and review measures to reduce or limit the threats to relevant expenditures under CAP and Cohesion Policy and reduce damage costs through funding adaptation and climate proofing expenditure. As such the key findings relate to the **relative** significance of different impacts, indicating the priority areas for climate proofing CAP and Cohesion Policy expenditure, rather than estimating the **absolute** magnitude of impacts.

Whilst the threats of climate change can be described at a regional level, the level of uncertainty over future threats prevents a detailed analysis at Member State level. The impacts of these threats across EU regions will vary and so do the distribution of sectors of relevance to climate proofing CAP and Cohesion Policy expenditure. The current levels of adaptive capacity also vary regionally and lead to differential levels of vulnerability of relevant sectors across regions.

We have also analysed overall objectives and current spending practice of both CAP and Cohesion Policy and identified those areas of expenditure which are most strongly affected by climate change threats and impacts, based on a review of a wide range of studies (See Supplementary Material Report for the list of studies examined). However, only a small number of studies provide any estimates of quantitative EU level damage costs. The qualitative impacts of climate change have been discussed comprehensively in separate receptor reports for the most relevant sectors/receptors, which are biodiversity, water infrastructure, transport, tourism, industry, health, energy supply, buildings, agriculture, and forestry (see Supplementary Material Report). More detailed results on damage costs and different climate scenarios used in the studies analysed for damage costs are also presented in the Supplementary Material Report.

The available assessments of the damage costs from climate change threats have focused on establishing the overall costs from climate change but for some threats, there is also the possibility of some benefits. For example, higher summer temperatures will benefit some agricultural producers, increase some forestry yields and lower heating costs. In terms of establishing the need for proofing EU expenditures against the damage costs, and considering adaptation options, the focus has been on establishing the gross level of costs, rather than net costs (adjusting for the benefits from climate change).

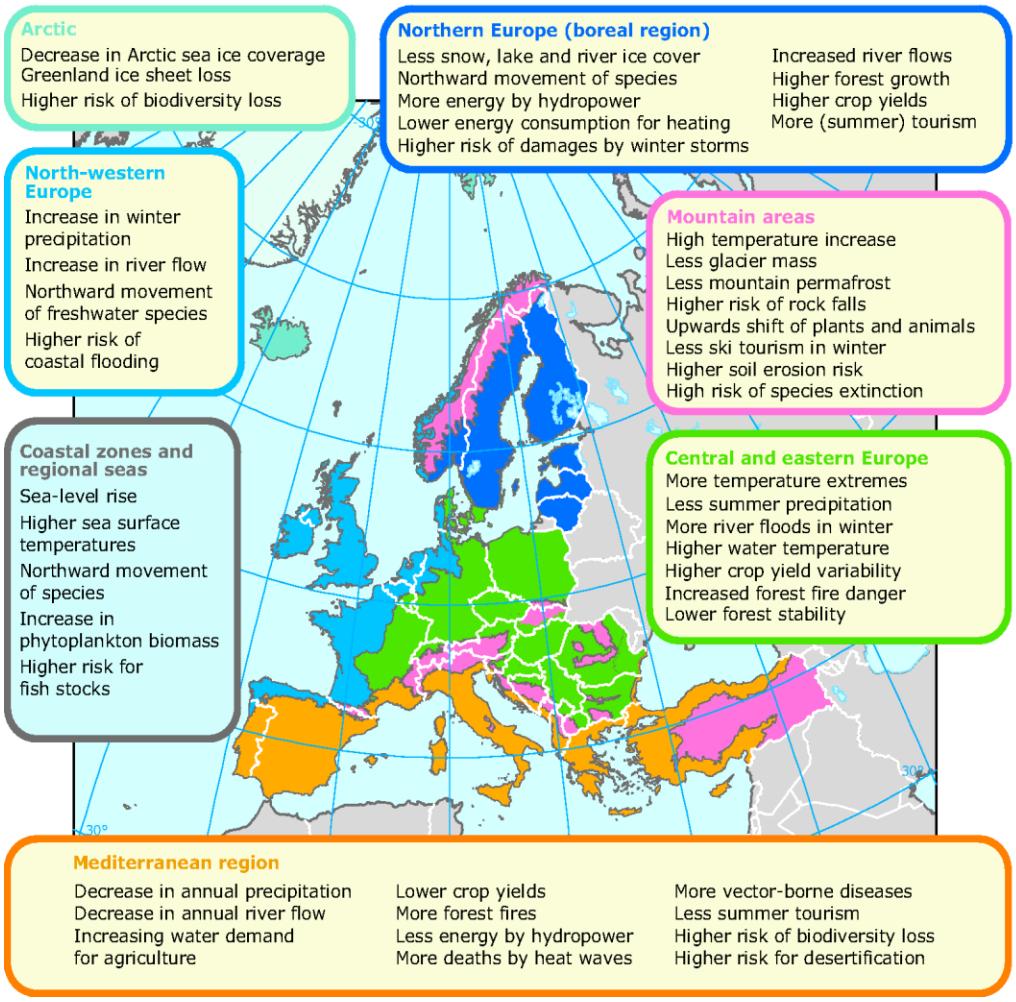
However, in so far as policy responses at MS level are more geographically specific, it is important to recognise in setting adaptation priorities that climate change will provide some regional level benefits. In some cases, benefits may more than offset the damage costs. For example, in more northern regions, despite the increase in energy costs associated with the greater use of air conditioning in the summer, these costs will be more than offset by reductions in winter heating bills. But even in the cases of net benefits, it may still be cost-effective to design adaptation options to address the damage costs induced by climate change.

2.2 Important methodological issues

2.2.1 Defining regions

Potential climate change impacts and vulnerabilities in the EU 27 have been analysed by a range of different projects and assessment processes in recent years. It is clear that some impacts of climate change will be inevitable given past greenhouse gas emissions. Assuming that scenarios with stronger temperature increases (e.g. >2 degree Celsius) and higher sea level rises are likely to result in more severe economic damage for the EU, Figure 4 offers a snapshot picture of the most relevant impacts across different climatic regions of Europe.

Figure 4: Environmental and socio-economic impacts of climate change in Europe (EEA 2010)



Vulnerable regions include particularly the Mediterranean basin, north-western and central-eastern Europe and the Arctic, together with many coastal zones and other areas prone to river floods, mountains and cities. The EEA assesses Northern Europe to be the only region with net economic benefits from climate change, mainly driven by the positive effects in agriculture (EEA 2010).

For the purposes of this study we have used the four regions defined by the EEA to assess the climate change impacts for the receptors that are relevant for Cohesion Policy and CAP. These regions are shown in Table 5.

Table 5. Regions used to identify climate change impacts and damage costs.

Region	Member States
Northern	FI, SE, EE, LV, LT
North-West	DK, NL, FR, BE, IE, UK , DE
Mediterranean	ES, PT, IT, CY, MT, EL
Central & Eastern	LU, DE, PL, HU, CZ, SK, SL, AU, BG, RO, FR, DK

The distributions are based on climate threats and are therefore represented in relation to EU territory, rather than to national boundaries. Some geographic regions cut across some Member States and for the purpose of our analysis we have made double allocations for those Member States where this is most evident. These Member States are Germany (both North-West and Central & Eastern regions), France (both North-West and Central & Eastern regions) and Denmark (both North-West and Central & Eastern regions). For all other Member States a potential overlap between geographic regions is not particularly relevant in terms of impacting on the results of our analysis.

2.2.2 The relative importance of direct and indirect expenditure

Identifying relevant categories of expenditure under CAP and Cohesion Policy is a first step towards assessing the needs and prospects for climate mainstreaming and proofing. The nature of expenditure under both policies varies significantly; hence, a uniform policy approach is not possible. At the same time some expenditure categories are in greater need of climate proofing than others as they require greater adaptation needs or have a larger impact on these. Hence it is important to identify the most relevant categories of expenditure under both policies and to ensure that the approach to climate proofing fits their specific needs and characteristics. In this respect, expenditure categories could be sub-divided into those that are not at all relevant from the perspective of climate change adaptation, those that directly target climate change adaptation, and those that could indirectly impact on climate change adaptation. Of these three categories, clearly the first is of no interest to this study, so below we discuss the second two.

Direct expenditure in climate change adaptation under Cohesion Policy and CAP

Under the 2007-2013 programming period, around €300 million of Cohesion Policy expenditure has been directly allocated to climate change mitigation and adaptation under a specific category targeting climate change. It is also possible that expenditure in a number of other categories – such as risk prevention – could be used for direct investment in adaptation even though the categories themselves are potentially broader. Expenditure directly targeting climate change is not in need of climate proofing.

The way in which CAP expenditure is reported means that it is not straightforward to identify precisely the types of expenditure that would be used directly to address climate adaptation, whether that is in relation to agriculture, forestry, biodiversity or other types of investments in rural areas. The Common Monitoring and Evaluation Framework (CMEF) indicators, which assess the outputs, results and impacts of Pillar 2 expenditure, are also not designed in a way to enable this type of assessment. Part of the reason for this is that investments and land management activities needed to achieve climate adaptation priorities are also delivering a range of other benefits simultaneously (e.g. reducing water use, improving soil management, improving the resilience of habitats etc.) and it is often these priorities that are the main objective of the expenditure.

The one exception to this is the reporting of the allocations of funds under the CAP Health Check in 2008. Of the €5 billion of additional funds made available for rural development policy under the Health Check, water management was allocated the second largest proportion by Member States

(€1,332 million or 27 per cent), with an additional 14 per cent (€704 million) allocated to the climate objective to reduce greenhouse gas emissions from agriculture and to climate-proof Community expenditure. However, as with Cohesion Policy expenditure, investment that directly targets climate change adaptation is not in need of climate proofing. Hence, from the perspective of this study, the investment that we are interested in is that which can be used indirectly to invest in climate change adaptation.

Indirect Cohesion Policy and CAP expenditure in climate change adaptation

Under both Cohesion Policy and CAP, many different categories of expenditure are likely to be sensitive to climate change related impacts. Without being climate proofed, it is these investments that risk being severely affected by the impacts of climate change. Under Cohesion Policy, these investments include specifically transport, energy and environmental infrastructure, public services, tourism and cultural infrastructures. This concerns both the renewal of existing infrastructure and the erection of new infrastructure under future expenditure programmes.

Priorities for the programming period 2014-20 should be considered in relation to the immediate exposure of investments to different threats (discussed in greater detail below) across their whole life-cycle, including the frequency and timing of replacement.

Threats cannot be assigned to categories of expenditure in a uniform way. The geographic location, of the expenditure is important and needs to be considered in designing climate proofing responses. Major threats over the coming years include flood risks (based on available studies of damage costs), for example, which will affect some Member States much more than others.

The life-cycles of different investments also differ. Some categories of expenditure (e.g. tourism or some road infrastructure) have a relatively short life (say less than 25 years) and are less at risk from climate change, given the relatively short period before they are renewed or replaced. Categories of infrastructure that have longer life-times, especially over 50 years (for example, port or rail infrastructure) are at a greater risk of damage from the impacts of unfolding climate change. For such investment, the urgency of getting the project design right is much higher.

2.3 Overview of climate change threats and impacts and associated damage costs

2.3.1 Most significant threats from climate change

There are a number of threats from climate change (out of a wider range of threats) that have the potential to impede or reverse regional development because of their sudden and destructive impacts on the region as a whole, rather than from localised impacts on specific sectors or types of infrastructure.

The most significant threats in this respect relate to coastal flooding as a consequence of sea level rise, river flooding as a consequence of extreme precipitation events and from more frequent, high intensity storms; and (possibly) prolonged periods of extreme weather conditions (heat waves and snow/ice). These threats have the potential to cause major damage affecting the full range of regional social, economic and environmental assets. This can generate significant direct costs to households and the economy, and damage eco-system services, with the potential to impede and disrupt regional development and the implementation of regional development programmes, which could be part funded by Cohesion Policy.

2.3.2 Regional variation of most significant threats from climate change

The significance of these threats varies across the EU.

Table 6 summarises our assessment of the relative threats across the four geographic regions of the EU used by the European Environment Agency (EEA) to describe climate change (see Figure 4). The inherent uncertainty in predicting the pace and scale of climate change means that any assessment of the relative significance of different threats over space and time is necessarily only indicative. However, in order to shape policy and to design precautionary measures the assessment, whilst recognising the uncertainties, has sought to provide a general indication of the distribution and scales of these impacts.

The assessment seeks to reflect the prevailing climatic predictions over the next decade and to indicate (High, Medium, Low) the risk of increased threats from the current time period due to climate change. Studies that have projected damage costs over longer periods, e.g. to 2050 or even to the end of the century, indicate an increasing scale of threats (depending on specific climate scenarios). However, these do not generally indicate any major variation in the relative significance of different threats or in the regional distribution of threats. This means that the assessment used for the period to the 2020s is likely to be indicative of the longer-term significance of different threats and their regional distribution. However, a major uncertainty is the extent to which autonomous adaptation in the absence of policy responses may vary by threat/receptor. For example, farmers may be better able to adapt than say energy utilities, in which case over time the relative risks to energy utilities might increase.

Table 6 Relative regional threats from flooding and storms, in the 2020s

Region	Relative regional risks of increased risks from climate change			
	Coastal flooding	River flooding	Storms	Extreme weather
Northern	Medium	High	High	Low
North-west	High	Medium	High	Medium
Mediterranean	Low	Low	Low	Medium
Central & eastern	Low	High	Low	High

Own Assessment

2.3.3 Damage costs of most significant climate change threats on regional development

The assessment of the impacts has examined the available literature describing the type and scale of the potential impact of these threats on regional development. Researchers have sought to translate climate predictions into possible impacts on society. The uncertainty of prediction requires reference to the possible range of climate scenarios reflecting different assumptions about the rate of greenhouse gas emissions and the influence of a given volume of emissions on the climate (and in particular on temperature and precipitation).

By reference to different scenarios, the related impacts of climate change on society can be approximated for different regions and for different time periods. The more specific the location and the further ahead in time the assessment period, the more uncertain the results become.

Studies have sought, using selected climate scenarios, to estimate the potential damage to life and property from events triggered by climate change, in the short (2020s), medium (2050s) and longer term (2080s). The assessment of the possible impacts is reflected in the annual costs of the damage caused, based on the value of assets at risk. These include the value of residential buildings, industrial and commercial buildings, and infrastructure.

In summary, the results of these studies suggest that the largest impacts, by some magnitude, are likely to be as a consequence of river flooding (Table 7), although it is important to recognise the difficulties of assessing, in particular, the incidence of storms and their impacts. Studies of EU impacts of prolonged periods of extreme weather events (e.g. heat waves and winter ice/snow) have only examined the impacts on individual receptors (such as heat waves on health or winter conditions on transport), rather than across the whole region.

In order to establish some measure of consistency and comparability in the damage cost estimates, the reported estimates are those relating to the scenario that appears most frequently in the various studies (what is known as climate scenario A1B). This excludes damage from prolonged extreme weather events.

Table 7. EU and regional impacts from flooding and storms, in the 2020s, € million per annum

Region	Estimated damage costs of threats expected to increase due to climate change					
	Coastal flooding (2005 prices)	River flooding (2010 prices)	Storms (2006 prices)	Approximate total for the specified threats	Cost (€) per capita	Cost as % GDP
Northern	200	1,600	300	2,000	95	0.4%
North-west	3,600	6,800	1,700	12,100	74	0.3%
Mediterranean	300	2,400	600	3,300	25	0.1%
Central & eastern	1,100	9,600	800	11,600	62	0.3%
Total EU	5,200	20,400	3,400	29,000	58	0.2%

Numbers may not sum due to rounding
Sources:
Coastal flooding: Brown et al, 2011, based on scenario A1B, and a mid-range estimate of sea level rise
River flooding: Feyen & Watkiss, 2011, based on scenario A1B and an average of results from different climate models
Storms: Wehrli et al (EEA), 2010 and Heck et al (Swiss Re), 2006
Note: The total does not include adjustment for the differences in the price base

2.3.4 The indicative impacts of threats on receptors

The range of impacts for each of the receptors has been reviewed on the basis of the reported evidence in the receptor reports, summaries of which can be found in Annex 1. Table 8 provides an overview of the relative significance of different EU impacts across the different threats and receptors in the 2020s. This assessment is designed to assist in identifying priorities across the different impacts, and especially the receptors, and the Cohesion Policy and CAP expenditure categories most at risk. The assessment is informed by the detailed assessments of individual receptors that can be found in the respective reports contained in the Supplementary Material Report.

The regional variation of these impacts shown in Table 9 indicates which of the four regions is likely to be most affected by these impacts on the receptors. Based on this assessment it seems as though the grouping of countries in the Mediterranean region and in the Central & Eastern region will be most affected.

The assessment should only be considered as broadly indicative since, with the exception of river flood risk assessment, most of the available evidence is provided for discrete impacts from particular threats on individual receptors, thus limiting the scope to make direct comparisons. The assessment is also focussed on the 2020s, where the estimated ranges in damage costs are less, reflecting the

relatively lower uncertainty in the shorter-term. Note also that the assessment is at the aggregate level, there may be cases of “high” local impacts even when overall it has been assessed as having “low” impacts, and vice versa.

Table 8. Overview of the main EU impacts from climate change, affecting receptors, 2020s

Region	Flooding - Coastal	Flooding - River	Water scarcity - continuous /drought	Water quality / salinity	Air quality	Disease	Soil erosion	Storms	Extreme snowfall / prolonged snow cover / snow ice	Temperature extremes inc fires	Temperature change over time
Population Health	Low	Low	Low	Low	Medium / High	Medium / High	N/A	Low	Low	Medium / High	Low
Population Property	Medium	High	N/A	N/A	N/A	N/A	N/A	Medium	Low	Low	Medium
Industry	Low	Medium	Low	N/A	N/A	N/A	N/A	Low	Low	Low	Medium
Tourism	Low	Low	Medium	N/A	N/A	N/A	N/A	Low	Low	Low	Low
Energy Supply	Medium	Medium	High	N/A	N/A	N/A	Medium	Medium	Low	Low	Low
Water Infrastructure	Low	Medium	Low	Medium	N/A	N/A	Low	Low	Low	Medium	Low
Transport	Low	Medium	N/A	N/A	N/A	N/A	Low	Low	Low	Low	Low
Biodiversity	Medium	Medium	Low	N/A	N/A	N/A	Low	Medium	Low	Low	Medium
Forestry	Medium	Medium	Medium	N/A	N/A	High	Medium	High	Medium	Medium	Low
Agriculture	Medium	Medium	Medium	N/A	Low	Medium	Medium	Medium	N/A	Medium	Medium

Source: Own assessment

N/A – significant impacts not expected, but may be subject to research in the future

Table 9. Likely level of regional variation in the impacts for the period to 2020

Region	Health	Buil-dings	Industry	Tourism	Energy supply	Water infra-structure	Tran-sport	Bio-diversity	Forestry	Agri
Northern	Low	High	Low	Low	Low	Low	Mediu m	Medium	Medium	Me-dium
North-West	Low	High	Low	Low	Low	Low	High	Medium	Medium	Me-dium
Mediterra nean	High	Low	High	High	High	High	Low	Medium	Medium	High
Central & Eastern	High	Medium	High	Medium	High	High	High	Low	Medium	Medi um

Source: Own assessment

2.3.5 Affected Cohesion Policy and CAP expenditures

The water, energy and transport sectors have a number of relevant Cohesion Policy expenditure categories that are potentially sensitive to the impact of climate change.

For energy these include electricity, natural gas, petroleum products and renewables (wind, solar, biomass, hydroelectric and geothermal). Expenditures in hydropower facilities, particularly installations at rivers and streams determined by glacial run-off regimes, may become sensitive to climate change and investments in power plants may also become sensitive to reduced productivity. Extreme events such as flooding and storms may also put these expenditures at risk.

Cohesion Policy in the water sector includes expenditure on the management and distribution of water (drinking water supply) and waste water treatment (waste water). Investments in new and existing infrastructure in these expenditure categories may be most sensitive to the threat of flooding as infrastructure is often located near to the coast or river areas. Additional investment needs and higher operating costs of abstraction, distribution and treatment as a result of climate change are likely to increase Cohesion Policy expenditure needs for water infrastructure.

Potentially sensitive Cohesion Policy expenditure in the transport sector includes motorways, national and regional roads, railways, airports, ports inland waterways, urban and multimodal transport and cycle tracks. Therefore all of these expenditures under Cohesion Policy have the potential to be sensitive to climate change impacts; however the scale of the impact will be very much dependent on the region and specific location of investments.

For forestry the CAP expenditure category for afforestation and other woodland planting is relevant to ensure that the locally appropriate species are chosen and that afforestation takes place in the most suitable location (for example to ensure that shallow rooting, water demanding species are not planted in areas where increased water scarcity is anticipated).

For tourism, biodiversity and agriculture the focus is mostly on increasing the resilience of the expenditure categories, rather than that these areas of expenditure are necessarily sensitive to climate change themselves. Hence future expenditure in these areas will need to ensure that the infrastructure being funded is able to withstand future climate impacts and ideally contribute to the adaptation needs of the sector.

For the health sector the nature of heat stress and related mortality effects, and the possible sensitivity of elderly populations, suggests that a number of adaptation measures might be considered related to cooling and early warning systems where these are required to implement cooling measures. The additional contribution of urban heat island effects might also be the subject of changes in urban design and the use of cohesion fund investments.

2.3.6 Summary of the main impacts and conclusions

These main impacts per receptor, and an example of the type of relevant expenditure section, are summarised in Table 10.

Table 10. Summary of the main impacts by receptor

Receptor	Types of impact associated with the threats from climate change
Population – Health	Mortality risks from a range of threats. The largest threat is from heat waves, especially in urban areas. Impacts from some threats, such as lower air quality and disease are less well understood.
Population – Buildings	Damage from floods and storms are the most significant. In addition households in the Mediterranean and Central/Eastern regions are likely to incur increased energy costs for cooling.
Industry	Industry and commerce is affected by floods and storms. Higher costs for energy and water are expected. Losses in labour productivity due to heat related stress may also occur (although offset by cooling systems).
Tourism	Higher temperatures and water shortages may cause reductions in summer tourism numbers in the Mediterranean and Central/Eastern regions, offset in part by increased offers in the beginning and end of the tourism season. Ski seasons are also likely be adversely affected.
Energy supply	Energy demand is likely to increase for cooling, especially in the shorter-term until building standards and designs adjust. Energy supply costs are also likely to increase as water for cooling, and for hydro and biomass energy production, is reduced. Damage from floods, storms and soil erosion are also likely to be significant. Costs will be passed onto users. In the longer-term new energy plant designs should adapt.
Water infrastructure	Water scarcity and sea water intrusion requiring water treatment will increase water supply costs (e.g. from increased distribution and pumping costs). Treatment costs may rise for waste-water treatment plants that discharge to rivers with reducing flows.
Transport	Transport infrastructure is at risk form floods, storms and temperature extremes. Indirect costs to users and the economy are significant. Significant damage already occurs. Increased risks include floods, soil erosion and fires, with particular impact on the railways.
Biodiversity	It is reasonably certain that biodiversity impacts will increase as a result of climate change. Impacts are expected to be minor for most habitats and species up to 2020, but are expected to increase considerably beyond 2050, leading to substantial changes in the location and extent of habitats and the distribution and population sizes of many associated species.
Agriculture	Water scarcity is already being experienced in some areas of Europe and longer and more frequent droughts are anticipated in large parts of Southern Central and Eastern Europe, as well as parts of Northern Europe, with significant risks to crop yields. More arid conditions are likely to exacerbate soil degradation as a result of wind erosion and will also cause heat stress for livestock. There is less clarity about the likely changes in precipitation that might be experienced. The higher incidence of these types of extreme weather events (e.g. droughts, storms) is likely to severely disrupt crop production and increase the unpredictability and variability of crop yields. These higher temperatures and increased rainfall are also likely to lead to a noticeable increase in the incidence of disease, pests and pathogens, including the spread of invasive alien species.
Forestry	There is ample evidence that temperature extremes (forest fire risk) is a threat to be considered as top priority for the EU adaptation strategy, whilst pest/disease, storms and soil erosion are likely to have a potentially high negative impacts as well.

Sources: Own assessment

The assessment suggests the following conclusions:

- Many of the most significant impacts are from threats which are most acute in the Mediterranean and/or the Central and Eastern regions, and hence indicate risks to Cohesion Policy expenditures in these regions.
- River flooding has the biggest impact of all threats, especially on residential, industrial and commercial property. The total EU damage cost per year has been estimated at €20 billion in the 2020s, three times current levels. The largest impacts are estimated to be on residential property.
- Health effects could also be very significant depending on how mortality risks are valued. Heat waves, for example, could result in loss of life valued at some €15 billion a year, even assuming some acclimatisation. These effects are most likely to be reflected in Cohesion Policy programmes through the increased demand for energy for cooling and lower labour productivity; but do not directly affect the resilience of assets receiving Cohesion Policy investment.
- Higher energy costs for cooling are in absolute terms substantial (some €7 billion per year), although the percentage increase on current levels is not dramatic (less than 1%). In the Northern and North-west regions energy savings from reduced winter demand accrue and offset higher costs. Depending on the speed of adaptation of energy plants, the reduced efficiency of thermal plants due to reduced cooling potential could be significant. Energy systems are also at significant risk from floods and storms, although EU damage costs have not been specifically estimated.
- Water infrastructure and related operating costs are likely to be significantly affected. Additional energy costs for example have been estimated at some €0.5 billion a year. Water sector investment is likely to become a more significant factor in regional development, and will need greater investment to improve resilience.
- Transport infrastructure is already subject to considerable damage from floods and storms. Provisional analyses suggest that higher risks may result in an approximate increase of 5% over the next decade, representing an additional cost in the order of €0.1 billion per year in the 2020s. Risks to the rail network are considered to be most likely to increase compared with other modes, especially given the length of the investment cycle in rail (c 50-100 years).
- In terms of the absolute future scale of damage costs, and the threats to regional assets funded under Cohesion Policy, the most significant impact from climate change is likely to be the impacts on the energy sector, directly as a result of increasing demand and high production costs, and indirectly from the pass through of higher costs to the rest of the economy. To the extent that climate change reduces the efficiency of certain renewable energy sources, such as hydro power, there are also implications for the effectiveness of mitigation plans and the longer term levels of emissions and related climate threats.
- The impacts on forestry and agriculture are much more diverse and difficult to predict with the regional variations of the impacts being much more local and the diversity of positive and negative impacts much greater than for the other receptors.

2.4 Assessing the adaptive capacities of Member States

2.4.1 Approach to assessing adaptive capacity

The adaptive capacity of a Member State is a key determinant of the overall climate vulnerability of a Member State and hence a determinant of the future damage costs of climate change (see Figure 2). EU funding through CAP and Cohesion Policy is a key influencing factor for adaptive capacity. However, as it will be explained in the remainder of this chapter, the assessment of adaptive capacity, and the appropriate role of EU policy support, is a complex undertaking. EU policy support should seek to target those areas of action that require support that would not materialise otherwise. It should not crowd-out action that would have been taken by private actors anyway and should not replace domestic support action which is often also legally required.

The IPCC's Fourth Assessment report outlines several determinants of adaptive capacity. Overall human capital, economic performance and the quality and stability of overall governance structures are regarded as crucial determinants of the overall adaptive capacity of a country. The availability of suitable technologies and a high potential for innovation are also important factors. Equally important are, however, soft capital factors such as the level of education or overall health of the population (IPCC 2007).

Several studies and reports provide a more in-depth analysis of adaptive capacity and develop factors and indicators to estimate the capacities of Member States to adapt to climate change and thus to avoid some of the estimated damage costs (e.g. Brooks, Adger and Kelly, 2005). The approach taken in this study is based on a review of selected studies that develop specific indicators for adaptive capacity in the EU.[11]

An overview of the approaches used within these selected studies can be found in Annex 2. This analysis makes it clear that different approaches have been used up to now to assess the adaptive capacity of a region or a Member State. Of the indicators developed within these various studies, some are more useful than others for the purpose of this study. Consequently, we have developed some key indicators that determine adaptive capacity (see Table 11). As each indicator should be assessed on a similar scale to allow a straightforward comparison later on, we have used either a scale with five values (either "1= very low", to "5= very high" or an illustration in the form of quintiles) or a scale of three values that can be merged with the 5-value scale. Additionally, an average of the different indicators has been evaluated for all EU countries, which has been formulated as very low (1), low (2), medium (3), high (4), very high (5). In our study, as in the ESPON climate study, the indicators are then weighted to take into account their different relevance.

[11] The ESPON climate study givesa good overview on different approaches and indicators developed in the literature.

Table 11. Key indicators for adaptive capacity

Indicator	Description	Values	Source	Weight
National information platform available (Awareness)	Illustrates the availability of an online information platform that informs of future climate change impacts, scenarios and need for action.	1= no overall platform available or difficult to access information 2= platform available but not with highest level of information (e.g. not comprehensive, outdated, etc.) 3= Platform with comprehensive information available	Own research	23%
Technological resources % of GDP for R&D and number of patents (Ability)	Ability of a Member State to develop the necessary technologies for adaptation	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	39%
GDP/capita as proxy for economic resources (Ability)	Ability of a Member State to provide the necessary funds for adaptation funding	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	
National Adaptation Strategy (Action) (specific per policy field)	This indicator illustrates the state of the National Adaptation Strategy. Is a strategy available? Does it include recommendations for adaptation options? Does it include a specific action and financing plan?	1 = NAS under development 2= NAS available, without specific proposals for options 3= NAS available, with action plan and further steps	Own research (based on EEA)	38%
Government effectiveness (Action)	This indicator illustrates the efficiency of government and national decision-making. If decision-making is effective, it is likely that that decisions related to adaptation are taken when necessary	Data from World Bank database where -2.5 = weak and 2.5 = strong. → Transformed into 0 = weak and 5 = strong	World Bank	

For agricultural, forestry and biodiversity (related to CAP) policy, further key indicators have been added to the generic indicators explained above. Adaptive capacities in these sectors differ from that in other sectors for a number of reasons. Hence, the indicators cover the three categories of awareness, ability and action and follow the same basic methodology. The selection of the indicators is based on different literature sources and expert opinions (see Reidsma et al 2007, Swanson et al 2007). The selected indicators and their evaluation scale are illustrated in Table 12. The average adaptive capacity for agriculture and forestry for each Member State is estimated on the basis of the general and the additional key indicators.

Table 12: Additional key indicator for agriculture sector

Indicator	Description	Values	Source	Category
Share of households with internet access in rural areas (Awareness)	Shows the possibility to inform farmers easily for knowledge transfer and raising awareness of future climate change impacts, scenarios and need for action.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	Included in Awareness
Farmers' training level (Awareness)	Illustrates the possibility to inform farmers via trainings of future climate change impacts, scenarios and need for action.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	
Research expenditures in agricultural sciences per GDP (Ability)	Ability of a Member State to develop the necessary technologies for adaptation in agricultural sector.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	Included in Ability
Amount of large area farms (over 100 ha) (Action)	It is more likely that larger farms can deal with adaptation in a more efficient way, because they have more resources for knowledge gathering and implementation.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	Included in Action
Share of RDP funding to agri-environment measures (Action)	Indicates experience with agri-environmental measures and economic resources for environmental measures	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	European Network for Rural Development (ENRD)	
Share of UAA under agri-environment measures (Action)	Indicates experience with agri-environmental measures and economic resources for environmental measures.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	European Network for Rural Development (ENRD)	

2.4.2 Results on adaptive capacity

Table 13 provides an overview of the scores for adaptive capacity as identified as part of the developed adaptive capacity indices. Detailed results on the different determinants of adaptive capacity (i.e. ability, action and awareness) are illustrated in Annex 3 and Annex 4 for the two different adaptive capacity assessments, i.e. for Cohesion Policy and CAP, respectively.

Table 13 : Adaptive capacity for Cohesion policy and for CAP – overall assessment and comparison with other studies (Member State ranking in brackets, 1 = best rating)

Member State	Overall score adaptive capacity index in the frame of climate proofing		Comparison with other adaptive capacity indicator systems*	
	Cohesion policy fields	CAP policy fields	ESPON Climate Project	RESPONSES Project
AT	4.5 (4)	4.3 (1)	4.3 (5)	4.2 (6)
BE	3.6 (9)	3.6 (9)	4.3 (5)	4.0 (7)
BG	1.0 (26)	1.8 (24)	1.2 (25)	1.0 (27)
CY	1.8 (19)	2.0 (21)	1.8 (20)	2.0 (18)
CZ	2.0 (16)	3.1 (12)	3.2 (12)	2.2 (16)
DE	4.7 (2)	4.3 (2)	4.0 (8)	4.0 (7)
DK	4.6 (3)	3.9 (6)	4.5 (3)	4.5 (3)
EE	2.0 (16)	2.8 (14)	3.0 (14)	3.0 (12)
EL	1.4 (21)	1.5 (27)	1.2 (25)	1.5 (23)
ES	2.4 (14)	2.7 (16)	1.5 (21)	2.5 (13)
FI	4.0 (7)	4.1 (5)	4.8 (2)	4.6 (2)
FR	4.0 (8)	3.7 (7)	3.5 (10)	3.3 (11)
HU	2.4 (13)	3.0 (13)	3.2 (12)	2.3 (14)
IE	3.0 (10)	3.4 (11)	4.0 (8)	3.5(19)
IT	1.8 (18)	2.3 (18)	1.4 (23)	2.0 (18)
LT	1.3 (23)	2.0 (23)	2.0 (17)	2.0 (18)
LU	2.7 (12)	3.5 (10)	5.0 (1)	5.0 (1)
LV	1.3 (23)	2.0 (22)	2.0 (17)	2.0 (18)
MT	1.4 (21)	1.7 (25)	2.0 (17)	2.0 (18)
NL	4.7 (1)	3.6 (8)	4.2 (7)	4.5 (3)
PL	1.3 (23)	2.1 (20)	1.4 (23)	1.2 (24)
PT	2.7 (11)	2.6 (17)	1.5 (21)	1.2 (24)
RO	1.0 (26)	1.6 (26)	1.2 (25)	1.2 (24)
SE	4.2 (6)	4.2 (4)	4.5 (3)	4.5 (3)
SI	2.3 (15)	2.8 (15)	2.5 (15)	2.3 (14)
SK	1.5 (20)	2.1 (19)	2.1 (16)	2.2 (16)
UK	4.4 (5)	4.2 (3)	3.5 (10)	3.8 (9)

* Please note: the ESPON climate project and the RESPONSES project provide information on the regional level. The information has been aggregated to the national level to allow a direct comparison

The analysis of adaptive capacity shows a clear split between Member States in Eastern and Southern Europe and Member States in Northern and Western Europe. Concerning overall adaptive capacities or relevance for Cohesion Policy the highest capacity appears to be in Germany, the Netherlands, Denmark and the UK, which all have a result close to the highest possible rating. The other Nordic countries, France, Belgium and Luxembourg have a comparatively high score as well. Hence, the need to increase EU Cohesion funding in these countries is lower, as a result of their capacity to deal with climate change adaptation at the national level.

On the other hand, Bulgaria, Romania, Poland and the two Baltic countries Latvia and Lithuania have a very low rating. Their overall adaptive capacity is considered to be limited due to a number of financial and administrative factors. Additional EU funding under Cohesion Policy is needed in these countries to support adaptation actions. Also, Italy and Greece are considered to have comparatively low adaptive capacities.

The split is similar concerning the more specific adaptive capacity of relevance to CAP. Member States, such as Germany, Austria, Finland, UK and Sweden, show the highest capacity to adapt to climate change. EU funding needs for adaptation via CAP are consequently lower for these countries. Low adaptive capacities characterise the Eastern and Southern European Member States. According to this assessment, Greece has the lowest adaptive capacity in the agriculture sector. Other Member

States with a low indicator are Romania, Bulgaria, Lithuania, Latvia, Malta and Cyprus. For these countries additional funding under CAP could help to deal with climate change and initiate adaptation activities in these countries.

Overall, this assessment is mostly in line with the more general assessments in the frame of the ESPON and the FP7-RESPONSES projects, although individual Member States scores differ. The adaptive capacity indicator developed under RESPONSES (Jung et al. 2011) provides a break-down at the regional level, whereas our approach is more focused on Cohesion Policy and CAP. Differences result from our approach of integrating qualitative information on the National Adaptation Strategies and information platforms. The value that is assigned as a result of such considerations is mainly "medium", which brings down the combined score of Member States that would otherwise score more highly, while increasing the combined score of Member States that would otherwise have a low score. For example, some countries that score highly on all other indicators score only moderately on national adaptation policy efforts (e.g. Luxembourg). An opposite case is Portugal. However, the approach towards assessing adaptive capacity indicators in this study is better targeted towards the needs of the CAP and Cohesion Policy and thus provides a better basis for the decision making process associated with these two funding instruments.

2.5 Baseline: Development and assessment

This chapter provides a baseline of climate change impacts and threats to CAP and Cohesion Policy investments, as well as of expenditure needs in Member States until 2020. This is based on the results of the assessments presented in Sections 2.3 and 2.4 assuming that Cohesion Policy and CAP continues to fund the same types of investment to 2020 without any action to climate proof these investments, while impacts and adaptive capacities remain unchanged. A summary of the approach is presented in Section 2.5.1, while an overview of the results is presented in Section 2.5.2. More detail on the methodology and the results for each Member State can be found in Annex 5.

2.5.1 Methodological approach

The baseline combines information on four main elements of the overall problem:

1. An illustration of the climate change impacts per policy field/main receptor in a qualitative way: each field / receptor is classified and colour-coded (low, medium, high) based on the assessment of regional threats (as presented in Section 2.3).
2. An assessment of current EU spending under the different categories of Cohesion Policy and CAP identified in Section 2.3 per Member State: the matrix allows the comparison of the assessment of impacts with the amount of EU investment spent in each policy field. Those fields that are characterised by large spending and that have been identified to face medium or high climate change impacts require particular action for climate proofing.
3. An assessment of domestic adaptive capacities: Information on adaptive capacity, based on the assessment reported in Section 2.4, is important to contextualise the needs for EU attention and climate proofing. Low or medium adaptive capacities imply risks that impacts and threats of climate change are potentially insufficiently addressed by national authorities.
4. Taken together, these three dimensions allow for an indicative estimate of which policy fields/receptors in Member States will be severely affected under a business as usual scenario and hence should be regarded as priority areas for a strategy of climate proofing CAP and Cohesion Policy. This information is then used to assess the value added of the different policy options discussed in chapter 3.

The evaluation criteria for each of these elements are presented in Table 14.

Table 14. Evaluation criteria for each of the four elements

Evaluation scheme for element 1: climate change impacts	Evaluation scheme for element 2: Significance of EU expenditures	Evaluation scheme for element 3: adaptive capacity	Evaluation scheme for element 4: Policy fields that require priority attention at EU level
Low (based on results from section 2.3)	Less than 5% of overall CP/CAP spending in the relevant category of expenditure is spent in relevant member state.	Adaptive capacity is high (based on a score in the project's adaptive capacity index above 3.5, see section 2.4)	Low need for action if maximum two classification "orange" or one "red"
Medium (based on results from section 2.3)	5-15% of overall CP/CAP spending in the relevant category of expenditure is spent in relevant member state.	Adaptive capacity is medium (with a score in the adaptive capacity index between 2.1 and 3.5, see section 2.4))	Medium need for action if: - 3 orange classifications, or - 2 orange and one red
High (based on results from section 2.3)	More than 10% of overall CP/CAP spending in the relevant category of expenditure is spent in relevant member state.	Adaptive capacity is low (with a score in the adaptive capacity index below 2, see section 2.4))	High need for action if: - 1 orange, two red classifications, or - 3 red classifications

Source: Own compilation

For agriculture-, biodiversity- and forestry-related CAP expenditures it needs to be recognised that the proposed categories could theoretically be used for adaptation to climate change in these sectors. Currently, only a small proportion of these expenditure categories are however channelled into activities which have a positive influence on adaptation to climate change. Unfortunately, a more focused assessment is not possible at the moment because we know only the funding amount of the categories and not the types and outcomes of the funded activities.

2.5.2 Summary of baselines

Depending on the perspective, baselines can be interpreted in different ways. In what follows, we first present an overview of the needs arising from an overall EU perspective assessment, followed by an assessment from the perspective of each individual Member State.

Summary from an overall EU perspective

Table 15 summarizes the results of the baseline assessment from an overall EU perspective. It provides a snapshot of the topics that may warrant particular attention in terms of climate proofing EU expenditure, leading to the following conclusions:

- Expenditures foreseen in Member States in Central and Eastern Europe as well as in the Mediterranean region require priority in terms of climate proofing efforts.
- A strong need for climate proofing related to Cohesion Policy occurs for health, transport, tourism, energy and water. Climate proofing needs are less pronounced but still relevant for sectors of relevance to the CAP as well as for industry and commerce under Cohesion Policy.

Table 15. Summary table of baseline assessment from EU viewpoint

	Member States where CAP and Cohesion Policy expenditure are at high risk from climate change for specific sectors	Member States where CAP and Cohesion Policy are at relevant risk from climate change for specific sectors
Health related expenditures	Italy, Greece, Poland, Hungary, Slovakia	Spain, Portugal, Czech Republic
Housing infrastructure	Poland, Lithuania	Hungary, Romania
Biodiversity (CP)		Spain, Greece, Poland, Hungary, Czech Republic
Biodiversity (CAP)		Spain, Italy, Poland, Ireland
Agriculture		Spain, Italy, Poland, Romania
Forestry (CAP)		Spain, Portugal, Italy, Greece, Poland, Romania
Forestry (CP)		Spain, Portugal, Italy, Greece, Poland, Hungary, Czech Republic
Industry/Commerce		Spain, Portugal, Italy, Greece, Poland, Czech Republic
Tourism	Italy, Poland	Spain, Hungary, Czech Republic, Romania
Transport Rail	Poland, Slovakia, Romania	Hungary, Czech Republic
Transport Road	Poland, Romania	Hungary, Czech Republic
Transport Aviation	Poland	Czech Republic
Transport other	Poland	Hungary, Czech Republic
Energy conversion	Poland, Romania	Spain, Greece
Energy renewables	Italy, Poland, Romania	Czech Republic
Drinking water	Spain, Poland, Romania	Portugal, Greece, Hungary, Czech Republic
Waste water	Poland, Slovakia, Romania	Spain, Portugal, Greece, Hungary, Czech Republic, Bulgaria

A Member State perspective

Table 16 identifies the top three priorities per Member State in relation to Cohesion Policy. This summary leads to similar priorities as for the assessment from an EU-level perspective:

- In most Member States, the policy fields related to essential infrastructure are identified as priority areas for climate proofing as they currently receive large amounts of funding: transport infrastructure (especially road and rail), water infrastructure (especially waste water) as well as energy infrastructure (especially regarding CP funding for renewables).
- More developed Member States (with regions classified as "Competitiveness and Employment Regions") receive no or only very limited funding for infrastructure development. In these Member States, the policy field "Industry & Commerce" is identified as priority area (see e.g. Austria, Belgium, Denmark, etc.). Especially in Denmark and Luxembourg, which receive no or very low amounts of funding in other categories of expenditures, the "industry and commerce" policy field should become the focus of climate proofing activities.
- In the Southern Member States (Mediterranean region), the transport sector will be less affected by climate change impacts and is thus not identified as a priority area (even though it receives large amounts of Cohesion Policy funding). In these Member States, the focus lies on water infrastructure, as well as health related expenditure, to meet the challenges from increasing droughts and heat waves.
- Policy fields which generally receive lower amounts of funding are only identified in some specific cases, e.g. tourism in Italy and Denmark or biodiversity in France.
- For those Member States that are divided into two climatic regions, the priorities do not differ considerably between the two regions. Whereas in the North-Western parts of the three relevant countries all threats are identified as "medium", the priority partially shifts to "high" in the Central & Eastern parts.

Table 16. Summary of major threats on EU investments per country[12]

Summary table from Member State viewpoint*		
	With medium climate threats	**With high climate threats**
Austria	Industry & Commerce (53% of CP funding) Tourism (11.5% of CP funding)	Energy renewables (27.5% of CP funding)
Belgium	Industry & Commerce (38% of CP funding) Transport other (23% of CP funding Transport road (7% of CP funding)	
Bulgaria		Transport Road (28% of CP funding) Waste water infrastructure (20% of CP funding) Transport other (13% of CP funding)
Cyprus	Industry & Commerce (9% of CP funding)	Waste water infrastructure (7% of CP funding) Health related expenditures (6% of CP funding)
Czech Republic		Transport Road (28% of CP funding) Transport Rail (21% of CP funding) Waste water infrastructure (10% of CP funding)
Germany (N-W)	Transport Road (36% of CP funding) Transport Rail (14% of CP funding) Industry & Commerce (13% of CP funding)	
Germany (C & E)	Industry & Commerce (13% of CP funding)	Transport Road (36% of CP funding) Transport Rail (14% of CP funding)
Denmark (N-W)	Industry & Commerce (83% of CP funding)	
Denmark (C &E)	Industry & Commerce (83% of CP funding) Tourism (17% of CP funding)	
Estonia	Transport Road (19% of CP funding) Transport other (14% of CP funding) Transport Rail (12% of CP funding)	
Greece	Industry & Commerce (8% of CP funding)	Waste water infrastructure (9% of CP funding) Health related expenditures (9% of CP funding)
Spain	Industry & Commerce (6% of CP funding)	Waste water infrastructure (13% of CP funding) Drinking water infrastructure (13% of CP funding)
Finland	Industry & Commerce (40% of CP funding) Transport other (5% of CP funding) Transport Road (4% of CP funding)	
France	Industry & Commerce (16% of CP funding) Transport Rail (10% of CP funding) Biodiversity (6% of CP funding)	
Hungary		Transport Road (27% of CP funding) Transport Other (17% of CP funding) Health related expenditures (14% of CP funding)
Ireland	Transport Road (36% of CP funding) Transport Rail (23% of CP funding) Transport other (8% of CP funding)	
Italy	Industry & Commerce (15% of CP funding)	Energy renewables (19% of CP funding) Tourism (9% of CP funding)
Lithuania	Transport Road (19% of CP funding) Transport Rail (16% of CP funding) Industry & Commerce (12% of CP funding)	
Luxembourg	Industry & Commerce (47% of CP funding)	Energy renewables (53% of CP funding)
Latvia	Transport Road (20% of CP funding) Transport other (17% of CP funding) Transport Rail (11% of CP funding)	
Malta		Waste water infrastructure (16% of CP funding) Health related expenditures (14% of CP funding)

[12] The share of CP funding refers to the relevant categories of expenditure considered in the frame of the baseline assessment

		Energy renewables (5% of CP funding)
Netherlands	Industry & Commerce (41% of CP funding) Transport other (17% of CP funding) Transport road (2% of CP funding)	
Poland		Transport Road (42% of CP funding) Transport Rail (15% of CP funding) Transport other (12% of CP funding)
Portugal		Waste water infrastructure (13% of CP funding) Drinking water infrastructure (11% of CP funding) Health related expenditures (9% of CP funding)
Romania		Transport Road (28% of CP funding) Transport Rail (18% of CP funding) Waste water and drinking water infrastructure (each 14% of CP funding)
Sweden	Industry & Commerce (46% of CP funding) Transport other (18% of CP funding) Transport Rail (5% of CP funding)	
Slovenia		Transport Rail (22% of CP funding) Transport Road (20% of CP funding) Drinking water infrastructure (11% of CP funding)
Slovakia		Transport Road (36% of CP funding) Transport Rail (23% of CP funding) Waste water infrastructure (15% of CP funding)
United Kingdom	Industry & Commerce (48% of CP funding) Transport other (14% of CP funding) Transport Road (5% of CP funding	

* Germany, France and Denmark are divided into two climatic regions (according to EEA classification), facing different climate threats. For those three countries the analysis is differentiated into those two regions (N-W = North-Western Europe, C & E = Central & Eastern Europe)

For funding under CAP, the picture is less diverse. The policy field “Agriculture” itself receives the largest amounts of funding in all Member States. The specific objectives need to be fine-tuned on the national or regional level to meet the different threats from climate change. Biodiversity and forestry have a lower priority as they receive lower shares of funding but should also remain a focus as they will face considerable threats from climate change as well.

3 Options and instruments for climate mainstreaming and proofing of CAP and Cohesion Policy

3.1 Introduction

This chapter appraises the potential adaptation options and instruments that might be used to climate proof CAP and Cohesion Policy. Section 3.2 begins by developing a typology of adaptation options followed by an overview of the potential options assessed. On the basis of a high level assessment, a short-list of options was identified for which the costs and benefits were assessed and presented. The short-list of options is identified on the basis of their potential to prevent significant climate threats and their urgency, and thus relevance, for implementation within the 2014-2020 programming period. The typology reflects a number of issues that will help Member States prioritise options to climate proof CAP and Cohesion Policy. Section 3.3 presents the appraisal of the potential of existing EU policies and measures that might be used to climate proof expenditure under Cohesion Policy and CAP. The most promising instruments and measures and assessed in more detail for their potential to climate proof the CAP and Cohesion Policy in the 2014-2020 programming period. Possible modifications and/or adjustments of these instruments are proposed where these are needed, followed by a suggestion as to additional action to be undertaken in the course of the project that might be taken to climate proof relevant expenditure.

3.2 Appraisal of adaptation options

3.2.1 Typology of adaptation options

This chapter presents a typology of potential options to climate proof CAP and Cohesion Policy. The initial selection of options has been based on the available information from relevant EU strategies and documents, such as the White Paper on Climate Change Adaptation, the related Impact Assessment[13], and the Commission staff working documents accompanying the White Paper for agriculture and rural areas[14], health[15] and water, coasts and marine issues[16] and took into account existing databases and lists of adaptation options that have been compiled for specific sectors (e.g. in the frame of the ClimWatAdapt project for water, the FP7 project "WEATHER" for transport) or Member States (included in adaptation strategies or action plans).

The evaluation and prioritisation of options in the frame of this project is based on these data sources. Furthermore, additional expert opinions have been incorporated in order to justify the selection of the different criteria as well as to gain information on the evaluation of options.

A large array of potential options exists, some of which are more suitable for public funding than others. In order to prioritise options, we have developed a so called 'decision-tree' (see Figure 5). Our

[13] EC (2009): Adapting to climate change: Towards a European framework for action: Impact Assessment. SEC(2009)0387, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2009:0387:FIN:EN:PDF

[14] EC (2009): Adapting to climate change: the challenge for European agriculture and rural areas. SEC/2009/417, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009SC0417:en:NOT

[15] EC (2009): Adapting to climate change: Towards a European framework for action: Human, Animal and Plant Health Impacts of Climate Change. SEC/2009/416, http://ec.europa.eu/health/ph_threats/climate/docs/com_2009-147_en.pdf.

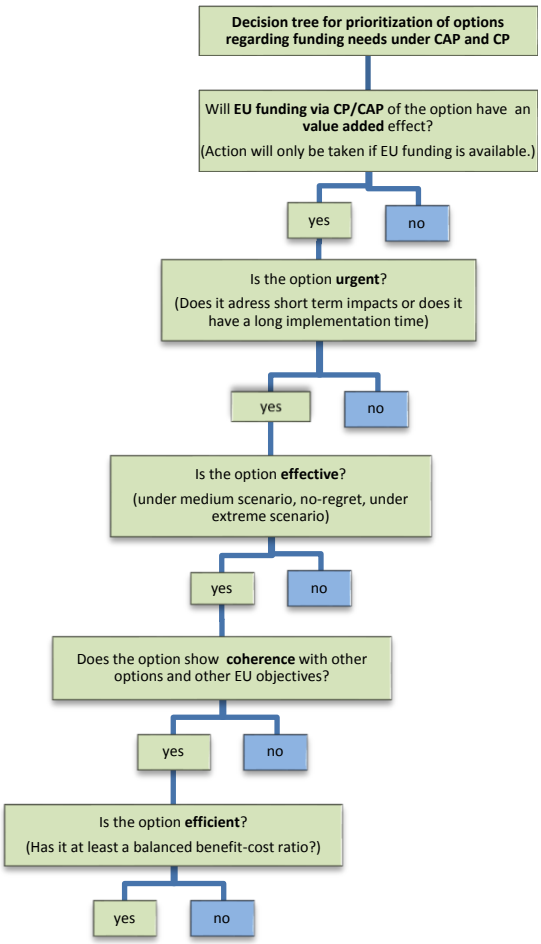
[16] EC (2009): Adapting to climate change : towards a European framework for action Climate Change and Water, Coasts and Marine Issues. SEC(2009)386, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2009:0386:FIN:EN:PDF.

approach reflects the approach chosen in the Commission's White Paper on Climate Change Adaptation[17]:

- "Grey" options relate to infrastructure;
- "Green" options relate to the environment/ecosystems/green infrastructure); and
- "Soft" options relate to human capital and adaptive capacities.

Options have been categorised accordingly. The final list of options presented in this report constitutes of 75 policy options, which has been derived from a much longer list of initial options and supports the technical guidance material developed in this project (Annex 7). All of these 75 options have been analysed along the "decision-tree" for judging the suitability of options to be brought forward as part of a strategy to climate proof CAP and Cohesion Policy (see Figure 5). The last criterion of the decision tree could, however, only be analysed for about one third of the options given the lack of available data. For some of the options, we prepared a cost-benefit analysis in the frame of this study. Further information for options in the energy and transport sector, as well as for urban areas, is available in other publications (e.g. Altvater et al. 2012). For some of the options, information for selected Member States is included as an initial estimate.

Figure 5. Decision tree for prioritization of options



[17] Commission of the European Communities (2009): Commission staff working document accompanying the White paper - Adapting to climate change: towards a European framework for action - Impact assessment. {SEC(2009) 387}, Brussels.

The decision tree consists of five subsequent steps. The criteria are closely linked to the criteria set out in the EU Impact Assessment (IA) Guidelines for the comparison of options. The first two steps of our decision tree aim to identify the scope of potential action on EU level and the urgency regarding the next MFF; the remaining steps are consistent with the main criteria for the comparison of policy options contained in the EU IA guidelines (i.e. effectiveness, efficiency, coherence).[18] The five steps are as follows (more detail can be found in Annex 6):

1. **EU relevance:** Options which are not delivered by voluntary/market action and which will benefit from support from Cohesion Policy and CAP, as domestic funding is unlikely to deliver these and private autonomous implementation is not probable.
2. **Urgency**: Identification of options that need to be implemented or at least initiated during the next MFF, based on the temporal characteristics of the respective options.
3. **Effectiveness:** Identification of the degree to which adaptation options effectively reach their intended objective in terms of preventing climate change damage. As effectiveness related to climate change adaptation depends crucially on any assumptions related to projected climate change, the uncertainty around climate change scenarios needs to be considered. An assessment of options under different climate scenarios (including the extremes) is required to determine their robustness. The lower and upper-bound of scenarios include a business-as-usual scenario without climate change (i.e. a "no regret" scenario) as well as an extreme climate change scenario (where temperature increases beyond 4°C).
4. **Coherence:** To what extent does the implementation of options result in synergies or conflicts with other adaptation options? At the same time, to what extent does the implementation of options result in co-benefits or undermine other EU policy objectives (especially those with environmental and socio-economic objectives).
5. **Efficiency**: Identification of those adaptation options that are considered to reach their objectives in the most efficient way (i.e. they achieve objectives at least cost). As climate change threats and impacts will differ across the EU, it needs to be assessed whether efficiency is given for the total EU or only for specific regions or Member States.

3.2.2 Overview of relevant options

In addition to the distinction between soft, grey and green options, our analysis is based on two layers of adaptation options that have to be clearly differentiated:

- Layer 1: A concrete adaptation option itself that responds directly to climate threats requiring investment, maintenance and other implementation costs.
- Layer 2: The establishment of a policy framework that sets the right incentives for the implementation of these options, i.e. via standards and regulations, capacity building, guidelines or direct financial support (EU financing schemes). These policy measures themselves have much lower costs (mostly administrative costs) and their impact on adaptation is less direct.

Layer 1 options seem more relevant for the detailed cost-benefit and impact assessment analysis of further funding needs under CAP and Cohesion Policy.[19] The analysis associated with the layer 2 options is a subsequent step required to determine the most effective policy implementation framework.

[18] See chapter 9.2. in the Impact Assessment Guidelines (European Commission, 2009).

[19] In this respect, the methodology differs from the approach of the previous Climate proofing study (Ecologic et al. 2011, task 2 report). In this study, the options have been grouped under the following headings: A. Technical measures, B. Standards and Regulation, C. Capacity Building, D. Communication and Awareness raising, E. Guidelines, F. EU Financing Schemes.

Overview of potential adaptation options per policy field

The following paragraphs give a short overview of potential adaptation options by policy field/ receptor, their illustration in the form of an electronic database, as well as any potential co-benefits between options.

Health /population: Most health-related options can be categorised as soft options. They include warning, monitoring and information systems. Furthermore, additional support for vulnerable groups of persons and options for civil protection, such as the provision of cool spaces, are potential recipients of public funding. Grey and green options can be used to help enhance the resilience of health infrastructure to extreme heat and precipitation, e.g. through passive cooling of hospitals or green roofs. Many no-regret or low-regret options are included in the health sector, that means options already show benefits under current climate conditions, e.g. energy efficient cooling or further green spaces in cities. Some options have synergies with the EU Strategy on public health, thereby yielding potential co-benefits as part of a cost-benefit analysis.

Relevant health/population options		
Grey	Green	Soft
○ Energy-efficient cooling of hospitals ○ Green roofs	○ Green and blue spaces	○ Warning, information, monitoring systems for heat, diseases ○ Additional care for vulnerable people, e.g. providing cool space in urban areas ○ Training for disaster protection organisations and adaptation of disaster management plans.

Buildings: Options in the buildings sector comprise predominantly grey options, such as robust construction and design options involving better insulation or passive cooling systems, as well as options designed to protect from storms and precipitation, like securing roof tiles with special clips. Some of these grey options can be replaced by green options, e.g. green roofs[20] as these can insulate against heat and absorb higher precipitation. Most options related to the adaptation of buildings could be considered as urgent, as their implementation should be included in the regular maintenance cycle or included in the design of new buildings.

Relevant buildings options
Grey
○ Energy efficient adaptation of homes against heat ○ Protection of buildings to storms, extreme precipitation ○ More water-efficient building constructions

Biodiversity: Biodiversity-related options are primarily green options, supplemented by several soft options. Soft options relate to the monitoring of biological diversity, especially trends in animal and plant composition. The options involve the preservation and expansion of protected areas, especially in terms of improving the connectivity of networks of different protected areas, as well as individual activities, such as the restoration of rivers and wetlands, or integrated water, coastal and forest management as well as monitoring of biological diversity. The options demonstrate the potential to deliver a lot of co-benefits in tandem with the implementation of other adaptation measures, for example, the expansion of green spaces in cities, buffer strips or floodplain management. Given the

[20] Included in the previous study on cliamte change adaptation by Ecologic (Ecologic, 2011) and hence not assessed in detail as part of this study,

coherence of these options with the EU Biodiversity Strategy, these options are classified as no-regret and should be implemented in the short-term.

Relevant biodiversity options	
Green	Soft
○ Maintaining and improving habitat management and habitat connections (including new protected areas, green corridors)	Better monitoring and evaluation of ecosystems and services, biodiversity, habitats

Agriculture (including soil) and forestry: For agriculture and forestry advice/training (soft), infrastructure (grey) and land management (green) options are relevant. Advice and training options focus on the provision of information to farmers regarding climate change impacts and adaptation measures, including information and monitoring systems and insurance tools. Infrastructure options focus mainly on water management (i.e. flood protection or improvement of irrigation efficiency), and the adaptation of buildings and animal shelters. The effectiveness of water management and flooding options can be optimised when combined with green options. Land management options include many crop and soil management options that aim to mitigate soil erosion, e.g. plant winter cover. Agricultural options can include those that are implemented in the short-term, mostly on an annual basis, such as used crops or intercropping. Other options such as buffer strips and floodplain management are implemented over a longer timeframe, and there is often a time-lag between implementation and their ability to respond to impacts. Many options in agriculture are no-regret options in that they address existing problems such as soil erosion, water quality and water scarcity. At the same time, their implementation, particularly when combined with similar options, is mutually reinforcing in terms of responding to climate change impacts, thus increasing the overall resilience of the land use sector while also addressing the objectives of the Water Framework Directive and the Biodiversity Strategy.

Relevant Agriculture and Forestry options		
Grey (Infrastructure)	Green (land management)	Soft (advice/training)
○ Irrigation efficiency ○ On farm harvesting and storage of rainwater ○ Adaptation of agricultural infrastructures ○ Setting up of hail nets ○ Improvement of animal rearing conditions ○ Livestock diversification	○ Maintenance / reintroduction of terraces ○ Reduce grazing pressure to reduce risk of erosion ○ Conservation soil tillage ○ Enhance floodplain management ○ Maintenance of permanent grassland ○ Buffer strips ○ Organic farming ○ Use of adapted crops ○ Plant winter cover, Intercropping, crop rotation ○ Residue management ○ Use of native breeds to promote genetic diversity ○ Afforestation, Establishment of agroforestry systems ○ Improved forest management	○ Water metering ○ Farm Advice ○ Insurance schemes ○ Pest/disease monitoring and integrated pest management

Industries (excluding tourism and utilities): Both soft and grey options are relevant for the adaptation of industry. Soft options could include specific awareness raising campaigns, or training to support companies in developing their own adaptation strategies. Grey options include those focussing on the adaptation of buildings and general infrastructure (e.g. roads on company premises,

own energy production facilities, etc.). Awareness raising options and improved energy efficiency should be implemented in the short-term. Other options such as the installation of energy efficient cooling systems should also be initiated in the short-term but combined with standard maintenance procedures.

Relevant Industry options	
Grey	Soft
○ Energy efficient adaptation of offices, and industrial plants to extreme heat events	○ Awareness raising to companies regarding adaptation to climate change

Tourism: The adaptation of travel destinations depends on specific regional threats from climate change and will require new infrastructure (grey). Soft options are limited to marketing campaigns for diversified travel destinations. The proposed option under tourism is a no-regret option because diversification of tourism infrastructure already has benefits today. The options are short- to medium-term, but should be implemented in mountainous regions as soon as possible in order to initiate the necessary structural changes. Synergies with other options and policies are low.

Relevant Tourism options	
Grey	Soft
○ Infrastructure development and changes to support diversification of tourism offers in different regions (winter and summer tourism)	○ Marketing and information campaigns

Water utilities/water management: Many options for this receptor are grey options, especially waste water infrastructure. A very important green option is river restoration to provide buffer zones for flooding. Some soft options exist, including monitoring systems and information campaigns to adapt to droughts. Most options under water utilities are urgent, as adjustments of the complex water infrastructures have a long implementation time. No-regret options, such as demand management, as well as regret options, e.g. desalination or adaptation of sewage systems, are included. Almost all options show synergies with the Water Framework Directive and/or Floods Directive.

Relevant Water utilities / water management options		
Grey	Green	Soft
○ Additional rain overflow basins ○ Adaptation to sewage systems against droughts ○ Desalination of water	○ River restoration	○ Leakage control in water distribution system ○ Demand management

Energy: Most energy-related options focus on infrastructure and power generation, as well as demand side management as this relates to the use of major appliances. Options related to power generation ensure that generation is able to cope with changing climatic conditions, and that transmission is maintained through the enhancement of electricity grids. Soft options include the adjustment of design standards and awareness raising measures. The implementation of energy options is somewhat urgent, given the implementation lifetime of the relevant options, and the need to consider them as part of standard operations and maintenance procedures. The co-benefits associated with the enhancement are largely attributed to the rehabilitation of electricity supply

grids and the potential for new and enhanced grids to cope with increased generation from renewable energy.

Relevant Energy options	
Grey	Soft
○ Increase robustness of transmission grids to storm damages ○ Installation of additional network capacity ○ Cooling of thermal power plants ○ Retrofitting to increase robustness of thermal power plants in coastal areas ○ Adapt hydropower reservoir power stations to cope with higher water levels ○ Installation of additional storage facilities to adapt to higher volatility in base load energy supply ○ Energy-efficient ventilation systems	○ Adjustments in design standards for wind turbine generators ○ Awareness raising and information sources

Transport: Most options related to the transport sector are classified as grey options as they relate to the climate proofing of infrastructure and vehicles. This includes adjusting road asphalt to cope with heat and extreme precipitation or installing air-conditioning in trains. Green options include vegetation management. Soft options relate to proving real-time information on travel and logistic information and weather forecasts to allow for effective early warning. The implementation of options is relatively urgent, given their long implementation time and the costs associated with adjustments of the transport infrastructure (which should be included in the regular maintenance cycle). They show mostly a high effectiveness because technological possibilities to deal with the problems exist. Synergies with other options and policies are limited; these concern mainly the EU Transport White Paper and TEN-T.

Relevant Transport options		
Grey	Green	Soft
○ Retrofitting existing road infrastructure and airports to cope with increased precipitation ○ Adaptation of rail infrastructure, road and airports to heat and temperature change ○ Shifting of road alignments beyond areas at risk ○ Adjustments of the maintenance of rail infrastructures ○ Retrofitting air-conditioning in trains to changing temperatures ○ Retrofitting of existing shipping infrastructure to cope with extreme weather events ○ Improvement of water flow management, including creation of water storage facilities ○ Adequate design and maintenance of bridges and tunnels	○ Vegetation management along roads and rails	○ Real-time early warning systems

Crosscutting options: Several adaptation options do not focus on a specific sector and are considered "crosscutting" options. They have the potential to either address more than one impact either within one sector or within a number of sectors. This includes a broad range of soft and grey options, supplemented by green options. Examples of soft options could include information sharing platforms that are currently provided at the Member State level (e.g. the UKCIP or the German KOMPASS website). Some of the options, such as early warning systems for example, are able to provide data related to a range of impacts including forest fires, extreme heat or storms. Crosscutting options also include all grey options related to sea-level rise and river flooding, e.g. dike reinforcement and heightening, and beach nourishment, as they have benefits for several policy fields.

Options that are implemented in urban areas and contained geographic regions (such as mountainous regions) are also crosscutting, such as urban and regional planning. These strategic options have a close link to green options that improve overall resilience. Crosscutting options possess unique characteristics and it is difficult to summarise their respective evaluation. Those that address impacts in a number of sectors have a no-regret potential, others that require significant up-front investment such as dikes and other flood related options run the risk of maladaptation.

Relevant Crosscutting options		
Grey	Green	Soft
○ Flood gates, dike reinforcement and heightening ○ Installation and retrofitting of environmental infrastructures to prevent natural disasters ○ Sustainable urban drainage systems ○ Protection from forest fires	○ Sustainable urban drainage systems ○ Soft coastal defences[21] ○ Protection from forest fires	○ Strategic urban and regional planning to prevent further accumulation of assets in vulnerable areas ○ Protection from forest fires ○ Remote sensing and satellite imagery for early warning systems: for extreme weather events

The medium list of options is also made available with a more comprehensive explanation for the different criteria of the decision tree in an electronic database (see below).

[21] Giving space to water and using natural landscapes to aid coastal defense infrastructure is emerging, e.g. allowing the sea to invade former dune slacks in certain sections of the coast, the strategic construction of reefs along a coastline is likely to reduce the strength of waves, and thus the erosion of the coastline by the sea.

Electronic database of adaptation options

An electronic database was prepared for the medium list of options, including some general information on the adaptation options, as well as all the information that is necessary to evaluate the options along the decision tree proposed in this project:

- General information on each option: which climate threat does the option address? Is it relevant for all EU Member States or only for specific climate regions?
- Urgency: How does the option relate to the next programming period for CP and CAP?
- Effectiveness: How effective is the option under a medium climate change scenario? Is the evaluation robust under a scenario without climate change (no-regret) and an extreme climate scenario?
- Coherence: Does the option lead to synergies with other adaptation options and/or with other EU policies?

Regarding efficiency, the database includes the detailed information on costs and benefits for those options that have been analysed in detail in the frame of this study (see next chapter). For further options, an initial estimate is included.

The database is available via: www.evaluation-adaptation-options.eu and will be integrated into the Climate Adapt Platform.

Co-benefits: Optimising the effectiveness of adaptation options with smart sets of options

Policy options will seldom be implemented in isolation but are normally part of a broader options mix that can generate important co-benefits across a range of areas. Quite a few options depend also on the effective interplay with other options to become fully effective.

In many cases, the effectiveness of either grey or green options can be optimised through a smart combination. In the case of urban flooding, for example, sustainable urban drainage systems as well as improved retention reservoirs can improve the resilience against extreme precipitation. The degree in which these grey and green options are combined depends on the local circumstances and potentials. Another example is improving of animal rearing conditions, where tree planting and animal shelters against heat should ideally be combined. Utilising the full benefits of the smart combination of options requires careful planning of the interplay of various adaptation options.

In some cases, potential threats and risks can only be averted if several options are combined. This is especially true in the case of coastal and river flooding where a whole set of options will be necessary (dikes, river restoration, buffer zones and wetland management in the case of river flooding). For these large scale climate impacts, it might also be necessary to combine sector specific options with cross-cutting ones, especially improved spatial planning.

Other options depend on the interplay with other options to become fully effective. For example, heat warning systems in themselves do not have any impact if people do not respond to the recommendations, like for example avoiding (extreme) outdoor activities during heat waves. Installing such early-warning systems will need to be complemented by related information events, easy access channels to information, training of administrative personnel, availability of hot-desks to answer to questions etc.

Further, some options need to be implemented in parallel as they overlap and reinforce each other. This can be seen for some of the agriculture options, e.g. enhance floodplain management, which is a part of habitat renaturation and habitat management or on-farm water harvesting and storage should be effectively combined with water saving measures such as the increased efficiency of irrigation systems.

For some options, the co-benefits under a business-as-usual scenario can determine the time-frame and respectively the urgency of different options. For a set of options, the implementation can be started with no-regret options, where possible. For example in the case of animal shelters: in regions with lower heat stress under current circumstances trees could be planted, which have a longer implementation time but are a no-regret option. In regions, where today the heat stress is already high or if later a short-term option is needed, shelters should be built, which is a regret-option.

Annex 7 provides further detailed information on co-benefits of options combination.

3.2.3 Adaptation options: Cost and benefits (including analysis of impacts) and their role for mainstreaming and climate-proofing CP and CAP

Selection of options for detailed analysis

Annex 7 provides the results of the cost-benefit analyses as well as a broader analysis of the impacts of specific adaptation options that could address the identified threats. Given that very little cost benefit analysis has been completed for adaptation options to date, the analysis undertaken for this project was not able to provide a full picture of additional expenditure needs under Cohesion Policy and CAP necessary to fund adaptation. However, the options were selected in a way that provides a first indication of the magnitude of additional expenditure needs by choosing high-impact options (which have the potential to avoid a large share of climate change damage for the specific receptor) and by clustering several related options together.

Furthermore, the options are chosen to focus on short-term options that need to be implemented, or at least prepared for implementation, in the 2014-2020 programming period. As defined in the typology in Table 51 (in Annex 6), this relates mostly to adaptation options types I and III.

In addition, the case studies aim at further validating and developing the methodologies around bottom-up cost-benefit analysis and impact assessment, in addition to gaining a better understanding of the challenges involved in analysing different types of measures. Given the uncertainty range associated with the presentation of cost data for adaptation options, this study focuses to a large degree on the feasibility of implementing options under different scenarios. Based on the need to consider the impact of options and their relative implementation urgency, example options were selected to cover the following typologies:

- Grey, green and soft options should be analysed in order to better understand the different approaches involved in assessing costs as well as benefits.
- Both regret and no-regret options should be covered to get a sense of the magnitude of benefit-cost ratios for these two types of options, and how implementation could be prioritised in light of ongoing budgetary constraints.
- High- and low-sensitive options with respect to different climate scenarios should be covered to get a better understanding of how to handle uncertainties related to climate-scenarios.

Based on these criteria, 14 options were selected for detailed cost-benefit and impact analysis. They were chosen to prevent overlaps with the previous climate proofing study (Altvater et al. 2012) and other ongoing activities at the EU level (e.g. the ClimateCost project). Table 17 provides an overview of the different typologies as they relate to the selected options based on the professional judgement of the analysts completing this section of the report.

While the options listed are relevant they are by no means generally more relevant than other options presented as part of the longer list including 75 options.

Table 17: Overview of selected adaptation options and their typology

Option	Grey, green or soft option			Regret or no-regret		Robustness under different scenarios	
	Grey	Green	Soft	Regret	No-regret	Relevant under all scenarios	Relevant only under specific scenario
Remote sensing and satellite imagery for early warning	X		X		X	X	
Cooling in hospitals (passive cooling concepts)	X			X			
Setting up of hail nets	X			X		X	
On-farm harvesting and storage of rainwater (e.g. small-scale reservoirs and methods for water collection)	X			X			X
Enhance floodplain management (re-creation of water meadows)		X		X			X
Plant winter cover		X			X	X	
Improvement of animal rearing conditions	X			X			X
Planting of buffer strips		X			X	X	
Improved forest management		X		X			X
Awareness raising for companies regarding adaptation			X	X		X	
Additional rain overflow basins, enhancing water storage reservoirs	X			X			X
Sustainable Urban Drainage Systems and water sensitive urban design	X	X			X	X	
Tourism (Diversification of tourism infrastructures), geographical case study	X	X			X	X	
Hydropower reservoir power stations: increase in dam height	X			X			X

Methodology for the cost-benefit analysis

The "decision rule" underlying the economic assessment of adaptation options in this report, is based on a cost-benefit approach that produces a benefit-to-cost ratio for each option. **Costs** are assessed using a bottom-up approach based on specific adaptation needs per Member State and the underlying unit costs for these adaptation options. **Benefits** are assessed by applying two different methods:

- For the assessment of individual grey and green options that focus on infrastructure or that involve the implementation of technical options, the benefits are assessed using a bottom-up approach, by analysing their specific potential to reduce damage costs.[22]

[22] This approach has also been considered in the previous study on climate proofing (Altvater et al. 2012),, by other studies on national level (see e.g. Tröltzsch et al, forthcoming) as well as in major research projects like the ClimateCost project. However, the approach undertaken by the ClimateCost project also realized the boundaries of this approach if adaptation options highly depend on specific local frameworks and thus can not be defined in a "generic" way. Thus, for river flooding, ClimateCost assesses the costs and benefits of a more integrated adaptation strategy within a defined water catchment area using a top down approach.

- For soft options (i.e. early warning or other information systems, awareness raising campaigns, etc.) the undertaking of a bottom-up analysis is however more complex as the benefits associated with their implementation are both direct and indirect. Given the complexity of the interrelationships between the various direct and indirect benefits, it is difficult to limit the scope of damage costs. The benefits are therefore assessed not in terms of avoided damage, but based on both a willingness to pay and benefits transfer approach.

While an effort has been made to streamline approaches taken for each cost assessment, the methodologies and data variables used differ based on the type of option analysed. To allow a quick first estimate, the summaries in Annex 7 show results for the overall EU as a first indication; the detailed results for each member state are included in the Supplementary Material report.

All cost-benefit estimates have been assessed under the logic of using conservative values to avoid an overestimation of specific options. Thus, the ranges of cost and benefits are interpreted in a transparent way, showing the major uncertainties around the average results. The following methodological elements require specific consideration when interpreting the results:

- **Uncertainties around climate scenarios:** assumptions regarding climate change scenarios drive the quantification of benefit-to-cost ratios for different adaptation options. Thus, we aim to derive ranges of costs and benefits, while considering different climate scenarios. In some cases, data was however only available for one specific climate scenario, mostly relating to the most common climate change scenario (e.g. the SRES A1B scenario).[23] In a few cases, the analysis uses a more generic approach independent of specific assumptions on climate change (e.g. for the options based on willingness to pay approaches).
- **Discounting:** The incorporation of price adjustments and discounting (equivalent annual values vs. net present values) in applied methodologies has a considerable impact on the benefit-to-cost ratio. The previous Climate Proofing I study (Ecologic et al. 2011), on which our methodology is built, did not consider price adjustments or discounting; instead it presented equivalent annual costs and benefits. The same approach has been considered in the frame of the ClimateCost project (see the explanation in Brown et al. 2011 and Feyen & Watkiss 2011). There may however be some scope to discuss whether the approach to price adjustments and discounting could differ according to the option type. We would consider the following factors in adopting a net present value approach:
  - Deriving conservative estimations for benefits: If benefits are not discounted, the benefit-to-cost ratio may be overestimated. For options with very high benefits, it might be necessary to check if the benefit-to-cost ratio is sensitive to discounting (e.g. for soft options like “early warning systems”).
  - The time lag between the timing of expenditure, and the ability of options to deliver benefits: If there is a significant gap between the timing of initial investment in the option and the delivery of benefits, it will be necessary to calculate the benefit-to-cost ratio using a net present value approach, e. g. for Early Warning Systems, urban and spatial planning options. As the analysis focuses on short-term options, benefits and costs occur in the same timeframe for most of the 14 analysed options, so that discounting is not necessary.
- **Economic lifetime of adaptation options and the relevant analytical time-frame for the analysis:** The analysis is aimed at providing information for the next MFF period (2014-2020). All selected options should be implemented, or at least initiated, in this timeframe. However,

[23] Different climate change and socio-economic scenarios as used by the IPCC and other sources are summarized in the Supplementary Material report.

the lifetime of some options extends well beyond the 2020 timeframe. The cost-benefit analysis thus needs to consider the potential for accelerating climate change impacts beyond 2020 and the accumulation of benefits over time. The following table provides an overview on the lifetime of our selected options. For the options with a short economic lifetime, the analysis focuses on climate change impacts in the 2020s. For options with a longer lifetime, we also considered the increasing benefits up to the 2050s.

Options with short economic lifetime (< 20 years)	**Options with long economic lifetime (> 20 years)**
• Early warning system • Awareness raising for companies • Soft options related to tourism • Anti-hail nets • Planting of winter cover • Improvement of animal rearing conditions • Forest management/forest thinning	• Cooling of hospitals • Hydropower: increase of dam height • Sustainable urban drainage systems • Storm retention reservoirs • Grey and green options related to tourism • Buffer strips • On farm harvesting and storage of water • Floodplain management

For the options analysed, both costs and benefits are presented at current price levels (2012 prices) to allow for a straightforward comparison with the baseline later on. Also, the costs and benefits are illustrated in annual values to allow for a direct comparison between the options.[24] The methodology builds on the previous climate proofing study (Altvater et al. 2012). Although the ClimateCost project has used a slightly different approach with consideration of integrated sets of adaptation options (see Annex 8), the results related to river flooding and sea-level rise have been integrated into the synthesis table in order to provide a broader overview of potential adaptation options (see Table 18)

Assessment Results and Benefit to Cost Ratios

Numbers are provided to reflect average annualized values based on 2012 prices. There are a number of issues to consider in interpreting the results of the cost benefit analysis. The differences in benefit to cost ratios could be explained by:

- The variability in damage costs and vulnerability of the sector: the divergence in benefit-to-cost ratios is also a function of the range of damage costs. The buffer strip example indicates how costs and benefits are likely to vary given the vulnerability of the agricultural sector to impacts across the EU. The divergence in minimum and maximum benefit-to-cost ratios illustrates how benefits are likely to be far higher under certain scenarios. To derive a more decisive result, it will thus be important to consider estimates at the national, or even regional level, which will deliver a much lower range of results.
- The limited scope of the quantitative approach: not all benefits and co-benefits could be analysed quantitatively within this project. In these cases, the initial estimate needs to be seen as lower bound. In this respect, it is also necessary to consider the scope of the options: while some options respond to more local impacts, other options, especially those related to flooding, have broader far-reaching effects. The cost of implementing individual adaptation options may be lower in cases where options address isolated impacts that are unable to account for downstream impacts.

[24] For two of the options, a detailed cost-benefit calculation has not been possible. For the option "Hydropower: increase of dam height", the existing data base was not sufficient and expert interviews were not helpful enough to fill the missing information. For the option "Adaptation of tourism services and infrastructures" the aggregated analysis on EU level was not possible, as different tourism regions will face completely different challenges and thus adaptation needs. Those two case studies are analysed in a qualitative way with some estimations on costs and benefits at the end of this chapter.

- The inability of cost-benefit assessments to integrate benefits associated with non-use values, for biodiversity for example: some benefits can be estimated via ecosystem services but an overall benefit estimation is difficult due to the nature of estimating benefits of non-use values, that cannot be quantified using price differentials.
- Differences in the scope of Member State coverage at the EU level: With respect to the assessment of absolute costs and benefits, it is necessary to consider the coverage of the options. If the costs and benefits have not been analysed for all 27 EU countries, the summary tables state which countries have not been covered.

The summary Table 18 illustrates that cost-benefit ratios have been calculated for 20 options at the EU level (including the results of Altvater et al. 2012), i.e. about one third of the options included in the medium list. Furthermore, the summary table includes information on the effectiveness and coherence of each option as assessed in the frame of the decision tree (see section 3.2.1)[25]:

- The effectiveness criterion summarises the potential of adaptation options to effectively prevent climate change damages. For agriculture and biodiversity options, the approach concentrates on their likely effect on the provision of public goods (i.e. improving water quality, soil functionality, biodiversity, etc.) due to their relevance for CAP funding. As uncertainty around climate change scenarios is still rather high, the robustness of the option to different scenarios has been analysed: a medium climate change scenario as well as the extremes ("no-regret" indicating the effectiveness even under existing climate variability, "extreme scenario" referring to a high climate change scenario).
- The coherence criterion indicates whether the implementation of the specific option leads to synergies with other adaptation options or if it results in co-benefits with other EU policy objectives.

[25] More detailed information on the different criteria of the decision tree and their link to the EU Impact Assessment Guidelines can be found in Annex 6

Table 18. Overview of costs and benefits (efficiency) and comparison with the criteria effectiveness and coherence

Policy field/ Adaptation option	Average Costs (bn. € per year)	Average Benefits (bn. € per year)	Benefit-cost ratio, average and variability (= Efficiency)	Reliability of results	Effectiveness under different scenarios			Coherence With other…	
					Medium scenario	No-regret	Extreme scenario	adaptation options	EU policies
Health related adaptation options									
Early warning system	6 – 12 (new MS only)	1 - 96 (new MS only)	5 (0.2 – 8)	High	High	Low regret	High	++	0
Cooling of hospitals	1.0 – 3.2	0.6 – 1.4	0.5 (0.2 – 1.5)	High	Medium	Low regret	Medium	+	+
Agricultural and forestry related adaptation options									
Improved forest management	3.5	1.3 – 2.6	0.5 (0.4 – 0.8)	Costs: med Benefits: low	High	No regret	Medium	++	++
Setting-up anti-hail nets	6.9 - 9.7	1.0 - 1.6	0.16 (0.1 - 0.2)	Medium	High	Low regret	Medium	0	0
Additional farm advisory service (CC proof I[26])	0.053 – 0.198				High	No regret	High	++	++
Irrigation efficiency (CC proof I)	0.331				Medium	No regret	Low	+	++
Buffer strips	0.04 – 0.16	0.3 – 3.7	20.1 (1.9 - 97)	Medium	High	No regret	High	++	++
On-farm harvesting and storage of water	0.33 – 5.27	14.58 – 44.57	10.9 (2.8 – 136)	Medium	Medium	Regret	Medium	+	++
Enhance floodplain management	73.9 – 79.3	86.1 – 124.7	1.4 (1.1 – 1.7)	Medium	High	No regret	High	++	++
Plant winter cover	0.95 – 1.21	0.87 – 1.31	1.0 (0.7 – 1.4)	Medium	Medium	No regret	High	++	++

[26] Results from the previous project: 'Climate proofing' of key EU policies – short term action. See Altvater et al. (2012): Adaptation Measures in the EU: Policies, Costs, and Economic Assessment. Funded by European Commission, DG Climate Action.

Policy field/ Adaptation option	Average Costs (bn. € per year)	Average Benefits (bn. € per year)	Benefit-cost ratio, average and variability (= Efficiency)	Reliability of results	Effectiveness under different scenarios			Coherence With other…	
					Medium scenario	No-regret	Extreme scenario	adaptation options	EU policies
Improvement animal rearing conditions	0.76	0.99	1.3	Medium	Medium	Regret	Medium	+	0
Water management related adaptation options									
Storm retention reservoirs	0.32 – 0.65	0.33 – 3.04	3.5 (0.5 -9.4)	Medium	Medium	Regret	Medium	+	++
Sustainable urban drainage systems	4.1	0.33 – 3.04	0.31 (0.1 - 0.6)	Medium	High	No regret	Low	++	++
Industry and tourism related adaptation options									
Awareness raising for companies	0.26	1.37	5.3 (1.0 – 9.7)	Medium	Medium	Regret	Medium	+	+
Diversification of tourism services and infrastructures	Depends on specific option	Depends on specific option	High for soft and strategic options Medium/low for infrastructure options		Medium	No regret	Medium	Depends on specific option	
Energy related adaptation options									
Hydropower reservoir stations: increase in dam height	Roughly 16.0 for six MS	Bottom-up analysis not possible		Very low	Medium	Regret	Low	+	+
Adaptation of electricity grids (CC proof I)	0.64-0.65 (EU26, without MT)	0.13 – 6.50 (EU26, without Malta)	5.1 (0.2 -10)	High	High	Regret	Medium	0	++
Additional cooling of thermal power Plants (CC proof I)	0.64	Benefits not estimated		Medium	Medium	Regret	Medium	0	+
High efficiency ventilation in 2025 (CC proof I)	0.1 – 41.8	8.5 – 66	1.8 (0.2 -660)	Low	Medium	No Regret	Medium	+	++
Cross-cutting adaptation options									

Policy field/ Adaptation option	Average Costs (bn. € per year)	Average Benefits (bn. € per year)	Benefit-cost ratio, average and variability (= Efficiency)	Reliability of results	Effectiveness under different scenarios			Coherence With other…	
					Medium scenario	No-regret	Extreme scenario	adaptation options	EU policies
Options to prevent river flooding (top-down approach))	1.9	7.2	3.8	High (based on LISFLOOD model)	High	Low regret	High	++	++
Options to prevent coastal flooding (dikes, beach nourishment)	1.2	3.92	3.3	High (based on DIVA model)	High	Regret	Medium	+	++
Transport related adaptation options									
Adapting tracks to higher temperatures in the EU (CC proof I)	0.06 – 0.26	0.09 – 0.54	2.0 (0.34 - 9)	Medium	Medium	Regret	Low	0	+
Adapting roads to higher temperatures in the EU (CC proof I)	2.9 - 8.9	2.1 - 2.7	0.41 (0.2 - 0.9)	Medium	High	Regret	Medium	0	+
Adapting roads to increase in precipitation in the EU (CC proof I)	0.03 – 0.14	0.019 – 0.057	0.45 (0.1 - 1.9)	Medium	High	Regret	Medium	0	+
Better surface asphalt for European runways (CC proof I)	0.14 – 0.43	Benefits not estimated		Low	High	Regret	Medium	0	+
Retrofitting existing infrastructure of airports' drainage system (CC proof I)	0.04 – 0.18	Benefits not estimated		Low	High	Regret	Medium	0	+

Findings on efficiency of options

The synthesis table above shows a broad bandwidth of average benefit-to-cost ratios. The following table gives an overview of options with high benefit-to-cost ratios (with benefits at least twice as high as costs), medium benefit-to-cost ratios (with balanced benefits to costs or slightly profitable results) and low benefit-to-cost ratios below 1 (inefficient).

High B-C-ratio (> 2)	Evidence 1 Medium B-C ratio (1< x ≤ 2)	Low B-C-ratio (< 1)
• Early warning system • Buffer strips • Storm retention reservoirs • On-farm water harvesting • Awareness raising SMEs • Options to adapt to river flooding (ClimateCost) • Options to adapt to coastal flooding (ClimateCost) • Adapting rail tracks to higher temperatures (Climate proofing I) • Adapting electricity grids (Climate proofing I)	• Floodplain management • Planting of winter cover • Improvement of animal rearing conditions • High-efficiency ventilation (Climate proofing I)	• Cooling of hospitals • Improved forest management • Anti-hail nets • Sustainable urban drainage systems • Adapting roads to higher temperatures (Climate proofing I) • Adapting roads to increasing precipitation (Climate proofing I)

Source: Own calculations.

High or medium efficiency can be seen for the following types of options:

- Soft options such as early warning systems or awareness raising measures for SMEs require rather low upfront investment and lead to high benefits. The effectiveness of the option however depends on the availability of complementary options.
- For similar reasons, green options seem to have good benefit-to-cost ratios. In comparison to grey infrastructure options, upfront investment costs are rather low. This is however not the case for options with high opportunity costs, particularly if implemented in urban areas with competing uses for green space. Green options often include co-benefits particularly in terms of supporting biodiversity, which can make implementation of the option more environmentally beneficial if perhaps less profitable from a commercial perspective.
- Options which focus on maintaining the operation of critical infrastructure also have high or medium benefit-to-cost ratios. This is especially true in cases of infrastructure where the entire network needs to function, e.g. electricity networks and to a lesser extent rail infrastructure. Options focusing on road infrastructure are less profitable (at least at the EU scale) as selected disruptions can be avoided with a detour, so that the disruptions have lower effects in their operations. Especially, for the adaptation of electricity grids the avoided economic impacts for industries and the population are a major part of the benefits.
- Regarding the climate change impacts underlying the options, no specific patterns can be identified. There are options triggered by increasing temperatures with low to high benefit-to-cost ratios. The same is true for precipitation. However, options related to flooding seem to have a rather high efficiency given that they address the highest level of damages.
- For some of the options, the analysis at the EU level leads to a low benefit-to-cost ratio, indicating that these options might be inefficient. However, a more detailed analysis at the Member State level, where the relevant threats from climate change are especially high,

leads to more favourable results. This is for example the case for both road transport related options, which will have to be targeted at regions and Member States with high vulnerabilities.

Conclusions regarding cost benefit assessment

In most of the cases, calculations are based on a bottom-up approach so that specific results are available for each Member State. In some cases, it has become clear that the average benefit-to-cost ratio for the EU as a whole considerably underestimates the efficiency of the option in specific circumstances, e.g.:

- Where climate impacts differ considerably between Member States and where some Member States will face low impacts up to 2020, the inclusion of the less affected countries reduces the average benefit-to-cost ratio. This is especially true for options that reduce the vulnerability to heat. For all these options, the benefit-to-cost ratios in the Southern Member States (Mediterranean and Southern parts of Central and Eastern Europe) lies considerably above the average ratio;
- The average scenarios for some climate change impacts are not able to capture the cross-cutting impact of urban development. For example, storms leading to intra-urban flooding have much intense impacts in very dense cities with a low share of green space. The same is true for heat where some cities will suffer from the heat-island effect way above the average for their country.

This shows the need to develop more detailed assessments at the national, regional or even local level. The EU level estimates provide a first indication of benefit-to-cost ratios; the variability of underlying impacts needs to be considered when interpreting the benefit-to-cost ratios.

Findings on the role of co-benefits

For some options, it has become clear that not all benefits can be quantified. Thus, some of the estimates of benefits refer only to a lower bound and a qualitative assessment (as included in the long versions in the Annex report) needs to be considered. Environmental and social co-benefits are difficult to estimate, i.e. the value of increased biodiversity for the agricultural options.

The benefit-to-cost ratio for most of the options would also improve if synergies with other options are considered (see earlier discussion in chapter 3.2.2). The benefits of storm retention reservoirs and sustainable urban drainage systems are amplified when they are implemented jointly. Positive effects can also be seen when flood plain meadows and buffer strips are implemented jointly. The combination of the two options could increase the benefits, especially for river water quality.

3.2.4 Overall conclusions and success factors and barriers for the implementation of options

The detailed analysis of options indicates some major success factors and barriers that affect the optimal implementation of options. While a successful implementation process will always depend on the specific local, regional or national framework conditions and might, for example, be addressed in the frame of a regional SWOT analysis, some general findings can be summarized.

Factors influencing overall success of implementing options

Some options require a coordinated approach between public authorities and private stakeholders. In most cases, it might be necessary that public authorities initiate the implementation process, e.g.

making use of financial incentives or information campaigns, in the absence of a clearly defined climate change adaptation policy framework.

For each option, the relevance of Cohesion Policy or CAP funding has been analysed, indicating the potential market failures. If market failures exist and if Cohesion Policy or CAP funding should support the implementation of options, it will however be necessary that the relevant authorities identify those market failures. This provision of easily accessible and targeted information material, capacity building and training for the relevant authorities will be a crucial corner stone in the implementation process.

Information and guidance material is also essential in enabling both authorities and project developers or farmers to fully exploit the opportunities of using CAP and Cohesion Funding to foster climate change adaptation. Awareness raising and information needs to be targeted and take into account specific local and regional conditions (as, for example, illustrated for SMEs in the frame of this study).

Some adaptation options have positive synergies with other policy objectives, are relatively easy to implement or promise a clear outcome. They will thus face higher acceptance. However, some adaptation options lead to negative trade-offs with other policy objectives, imply higher upfront costs, require specific technical expertise or are less certain with regard to immediate outcomes. Hence they will be regarded unattractive, although they might be highly relevant. For example, dike constructions might reduce the attractiveness of urban settlements or the installation of additional green urban spaces and might face a trade-off with local objectives to prevent urban sprawl. In such cases, it will be important to carefully evaluate the adaptation options against other policy objectives and to develop a hierarchy of objectives within an overall comprehensive planning framework. Risk and vulnerability assessments need to be more firmly integrated into overall urban planning and development frameworks.

When evaluating the urgency of options, potential delays due to prolonged discussions with the affected public need to be taken into account. It is hence important to start as early as possible with the planning, and consider transparent and balanced public consultations in addition to technical implementation. Options need to be linked to existing cycles of infrastructure planning and renewal, which offer specific “windows of opportunities” for influencing investment decisions that might be difficult to revise once taken.

Data gaps and uncertainties

Our overall analysis and particularly the in-depth analysis of the 14 selected options has provided further insights into how to deal with uncertainties and data gaps. The overall data situation appears imbalanced – in some areas such as energy production a relatively good body of information is available whereas in other areas, such as agriculture, the data availability is less well-developed. Data sources are rather thin when it comes to concrete investment decisions on a local level (for local water infrastructure for example). Where data is available, the main uncertainties relate to:

- For several options, cost or benefit assessments are based on transfers, i.e. transferring the estimates of one country from available data sources to other European countries on the basis of some key indicators. Although we tried to fine-tune these transfer approaches as far as possible, this approach always entails a certain level of uncertainty.
- In cases where a top-down approach has been used for the benefit assessment, it is always based on an expert estimate for which a share of damage costs can be avoided by the

relevant option. To further refine the assessment for these options, it will be necessary to check if there is a possibility to estimate benefits using a bottom-up approach. However, this might only be possible for more regional assessments.

- As all of the options analysed in the frame of this study relate to short-term threats, the time-lag between initiation and realisation of benefits is rather short but there will be a long flow of benefits into the future for a number of the measures. In some cases, benefits are even realised immediately after the implementation. Thus, our approach based on equivalent annual costs and benefits seems to be appropriate – and compared to the other elements discussed above – leads to a low level of uncertainty.
- Further uncertainties manifest themselves in relation to the assumptions related to climate change scenarios. The projections are already highly uncertain. Given the lack of information corresponding to the project lifetime of various options, it has been necessary to break down projection information from 2100 to the analysing horizon of 2020 or 2030.
- Further uncertainties lie in socio-economic developments occurring up until 2020 and even for more relevant longer time-horizons. Data available for ageing populations has been included in socio-economic analysis where possible. For options in the agricultural sector, data related to other exogenous factors such as changing demand for crop types, or market price fluctuations, would have both direct and indirect effects on benefits. This information was however not factored into our final results given the scope of work and limited project timeframe.

Further research needs to reduce uncertainties around cost-benefit analysis

These findings on uncertainties indicate some further research needs and provide some information on how to deal with uncertainties in the frame of further cost-benefit analysis of options:

- One important research need relates to minimising the uncertainties around climate change scenarios. This especially includes the provision of relevant climate change indicators on national or even regional level as well as the provision of more specific indicators, especially on extreme weather events.
- Where the aggregated approach on EU level includes several levels of uncertainty, it will be important to fine-tune the analysis on national or regional level. In many cases, regional authorities can provide more detailed data than the aggregated approach used in this study was able to capture. Better harmonisation of indicators and data sets will help to achieve more consistent and comparable assessments.
- The fine-tuning of cost-benefit analysis or the assessment on regional level can also integrate more specific information on socio-economic developments as well as other policy trends. Especially regarding demographic change, a more regional assessment will provide more accurate results – as the population in some EU countries will still be growing while it will decline in others.
- For several socio-economic developments only short-term data is available. However, cost-benefit analyses for adaptation options require a mid- to long-term perspective and would thus require relevant input data on socio-economic developments as well. Long term projections on socio-economic developments would of course include further uncertainties, but a common database would at least prevent that each analysis draws back on own assumptions and projections.
- To derive more detailed information on efficiency of adaptation options, it will also be necessary to quantify co-benefits of options as well as synergies between options. In many

cases, this however requires more research on the physical impacts and interactions of specific options (e.g. how sustainable urban drainage systems do not only reduce threats from urban flooding but also reduce the heat island effect).

3.3 Appraisal of instruments to better integrate climate-proofing concerns into funds programming

3.3.1 Introduction

This chapter focuses on existing EU policies and measures and identifies which of these policies and measures are most relevant for ensuring that expenditure under Cohesion Policy and CAP is 'climate proofed'. The aim is to assess to what extent existing regulatory, voluntary and strategic instruments already envision measures that can help climate proof the future CAP and Cohesion Policy and determine possible modifications/adjustments of instruments where these are needed. Additionally, any further measures that might be taken within CAP or Cohesion Policy to achieve a similar objective will be identified.

The following analysis has two steps. First, Section 3.3.2 presents a high level assessment of a wide range of EU policies, or instruments contained with these, focusing on their potential to be used to climate proof the Cohesion Policy and CAP from the perspective of adaptation. An earlier version of this high level assessment was discussed with internal experts, as well as the Commission at the Interim Meeting, after which a short list of instruments was identified.

The short-listed instruments that have the potential to enhance the climate proofing of the CAP and CP from the perspective of adaptation are assessed in more detail in Section 3.3.3. In this respect, the instrument itself was analysed to identify how it might be modified to climate-proof Cohesion Policy and CAP investments from the perspective of adaptation. In order that such climate-proofing be achieved more generally, clearly it would be important to amend the actual legislation in a similar way to that suggested. However, in the context of this project, we are also concerned with climate proofing under CAP and Cohesion Policy. Hence, it was also assessed how within the framework of CAP and Cohesion Policy, action could be taken to climate-proof these two budget areas.

3.3.2 High level assessment of EU policies and instruments

The table in Annex 9 presents the high level assessment of the instruments that could potentially be used to aid the process of ensuring that CAP and Cohesion Policy expenditure is climate proofed from the perspective of adaptation. The approach taken was to identify as wide a list as possible of existing EU policies and measures that have the potential to improve the approach taken towards adaptation to climate change. In this respect, the instruments in the first column were identified on the basis that they could potentially have some relevance to improving adaptation to climate change generally – not just in relation to Cohesion Policy and the CAP. The list was identified on the basis of a review of the EU environmental acquis and developed on the basis of suggestions from sectoral experts within the project team. Legislation focusing on climate change mitigation, e.g. that aims to reduce GHG emissions, or legislation that aims at reducing the emissions of non-GHG pollutants, was excluded, as it was not considered that these would not have an obvious potential to be used for the purpose of climate change adaptation.

The assessment as to whether the instruments were relevant for proofing Cohesion Policy and the CAP from the perspective of climate change adaptation is undertaken in the fifth and sixth columns of the table and aims to identify whether the requirements of the instruments can be used, or should be modified, to climate proof expenditure under the Cohesion Policy and CAP from the perspective

of adaptation. An earlier version of the assessment that was discussed with the Commission at the Interim Meeting was checked with team members with expertise in the CAP and Cohesion Policy.

Of the instruments assessed, the following were considered to be of potential relevance for both Cohesion Policy and the CAP, and which were subsequently assessed in more detail in step 2:

- Environmental Impact Assessment (as required by Directive 85/337/EEC)
- Strategic Environmental Assessment (as required by Directive 2001/42/EC)
- Public procurement, as covered by Directives 2004/17/EC and 2004/18/EC
- Assessment in accordance with Article 6(3) of the Habitats Directive (92/43/EEC)

EIA (i.e. certain projects) and SEA (i.e. certain plans and programmes) are both required by both Cohesion Policy and the CAP and, as both are environmental assessments, clearly have the potential in the context of climate proofing associated investments and measures from the perspective of adaptation. All contracts let that are of relevance to the both Cohesion Policy and the CAP will also have to be subject to the public procurement Directives, which covers a variety of potential works contracts. Hence, there would appear to be an opportunity to proof the infrastructure funded by such works contracts in the context of climate change adaptation. Activities under both the CAP and Cohesion Policy have the potential to adversely affect habitats, so the assessment under Article 6 of the Habitats Directive is of potential relevance.

Some instruments were considered to be of potential relevance for Cohesion Policy, but not the CAP, e.g.:

- Union guidelines for the development of the trans-European transport network (TEN-T), as proposed in COM(2011) 650/2
- Union guidelines for the development of the trans-European energy network (TEN-E), as proposed in COM(2011) 658
- Union guidelines for the development of the trans-European telecommunications network, as proposed in COM(2011) 657

All of the TEN guidelines are of potential relevance to climate change adaptation in Cohesion Policy, as Cohesion Policy could potentially fund projects that contribute to the development of the various TENs. In this respect, it is worth noting that both the proposed transport and energy guidelines already require that consideration be given to adaptation measures with a view to improving the resilience of infrastructure to climate change. In this respect, TEN projects funded under Cohesion Policy would already be subject to reasonably strong requirements with respect to adaptation. However, Cohesion Policy can fund non-TEN infrastructures that would not be covered by the guidelines, so there would probably be added value in further assessment of these guidelines.

3.3.3 Detailed assessment of short-listed policies and instruments

Table 19 contains an overview of the more detailed assessment of the short-listed instruments. For some of the instruments, such as EIA, SEA and Appropriate Assessment (an Article 6(3) assessment under the Habitats Directive), an amendment to the respective legislation would be the best way of ensuring that all relevant projects, plans and programmes (not just those funded by Cohesion Policy or CAP) consider climate change adaptation in an appropriate manner. However, within CAP and Cohesion Policy, it is possible to develop, and require the application of, additional requirements for such investments beyond that which is required in EU legislation. From the perspective of these three instruments, the development of guidelines for the consideration of climate change adaptation in relevant projects, plans and programmes could be considered.

The role of climate change in SEA is currently underdeveloped. According to the Commission's *Report on the application and effectiveness of the Directive on Strategic Environmental Assessment (Directive 2001/42/EC[27])* the lack of a well established methodology to determine climate change impacts is one of the key problems reported by many MS. The report therefore calls for the development of specific guidelines to provide guidance on consideration of climate change issues in SEA. They point to a lack of an overarching policy on climate change and SEA, and the fact that the impacts of development on climate change has been considered on a case by case bases, particularly in relation to plans and programmes for energy and transport. However, it is worth noting that the TEN-T is already considered to be in compliance with the SEA Directive. Each Member State has had already provided documentation to the Commission to either i) confirm that an SEA is not required, e.g. as the plans that contain the comprehensive TEN-T network on their territory pre-date the requirement for an SEA; ii) if an SEA has been undertaken, provide a summary of the procedure, including alternatives considered, consultations and results; or iii) if an SEA is ongoing or yet to be undertaken, provide an explanation of how the application of SEA will be ensured[28]. Additionally, there is no explicit reference to the need to undertake an SEA analysis of the collective impacts of the individual Projects of Community Interest (PoCIs) that are to be developed and co-funded under the Connecting Europe Facility (Energy)/TEN-E[29].

The Commission's 2009 Report on the application and effectiveness of the EIA Directive[30] reports that most Member States recognise that climate change issues are not adequately identified and assessed within the EIA process. According to the report, reviews of the impacts of climate change appear to be frequently limited to CO_2 and other GHG emissions from industry and from increases in transport as part of air quality studies or as indirect impacts. All too often, the effects on global climate, the cumulative effects of an additional project and adaptation to climate change are not sufficiently considered within EIA. In the review[31] of the EIA Directive many Member States called for assessment tools to be developed in order to better integrate climate change considerations into the EIA process.

[27] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0469:FIN:EN:PDF

[28] See Annex IV of European Commission (2011) Impact Assessment accompanying the Proposal for a Regulation on Union Guidelines for the development of the trans-European transport network, Commission Staff Working Paper, SEC(2011) 1212/2, 19.12.2011 (revised version; original from 19.10.2011 replaced), Brussels.

[29] IEEP, GHK and TEPR (2012) Background study towards biodiversity proofing of the EU budget, Report for European Commission, DG Environment.

[30] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0378:FIN:EN:PDF

[31] CEC (2009), Study Concerning the report on the application and effectiveness of the EIA Directive, June 2009

The Appropriate Assessment under Article 6(3) of the Habitats Directive applies to any "plan or project" likely to have a significant effect on a Natura 2000 site. It requires an 'appropriate' site-specific conservation assessment when a plan is likely to have an adverse effect on the conservation status of a Natura 2000 designated site. Given that SEAs also apply to relevant plans and that EIAs apply to relevant projects, there is a clear link between these three instruments. SEA should be able to help screen whether the plan or programme is likely to have significant adverse effects on a Natura 2000 site, by helping to identify the probability or risk of such effects (but also opportunities based on ecosystem services etc.), and whether an Article 6 assessment is also required. In relation to EIA where Natura 2000 sites might be affected, has there already been an Appropriate Assessment undertaken under Article 6 (3) of the Habitats Directive can be used to inform the EIA.

With respect to public procurement, it is less clear how increased consideration of climate change adaptation might be included in the public procurement Directives. However, as with the assessments discussed above, within CAP and Cohesion Policy it is possible to develop additional guidance for procurement for investments from these funds. Given that procurement occurs within specific investment interventions, the environmental impacts of procurement should be considered in the assessment of the overall environmental impacts of the project. Hence, these could be assessed as part of the respective EIA. Consequently, within the EIA guidelines that have been developed within this project, we have included a section on climate change adaptation considerations in the context of procurement.

The inclusion of considerations relating to climate change adaptation risks associated with the development of infrastructure is addressed reasonably well in the respective draft TEN Guidelines. For transport infrastructure and selected energy infrastructure, references are made to the need to consider the potential impacts on the infrastructure of climate-related risks, but there is no consideration required of the potential impacts of infrastructure on adaptation capacity. However, all relevant projects would be subject to an EIA in this respect, while relevant plans and programmes have already been subject to an SEA, so the inclusion of considerations relating to climate change adaptation in the respective guidelines, could be sufficient in terms of climate proofing CAP and Cohesion Policy projects from the perspective of adaptation.

Table 19. Detailed assessment of how short-listed instruments could be applied in the context of proofing the CP and CAP from the context of climate change adaptation

Instrument	Problem with instrument as it stands	Changes required to the instrument	Other means of delivering same result without need to change the instrument in the context of CP and CAP
Environmental Impact Assessment (as required by Directive 2011/92/EU)	Article 3 lists the environmental factors on which the effects of the project need to be assessed, including climate. There is no wording that requires the consideration of climate change on the project.	Perhaps the most appropriate place to include climate change adaptation would be in Article 3. This could be done by adding a separate sub-article (i.e. 3(2)) that states that the EIA should identify, describe and assess the potential impacts of climate change **on** the project.	Further guidance could be developed on the treatment of climate change mitigation in the context of CP and CAP investments.

Instrument	Problem with instrument as it stands	Changes required to the instrument	Other means of delivering same result without need to change the instrument in the context of CP and CAP
Strategic Environmental Assessment (as required by Directive 2001/42/EC)	Annex I of the Directive sets out the information to be provided in the environmental report (required by Article 5(1)) where an environmental assessment is required by the Directive. Point f) of this Annex states that the likely significant effects on *inter alia* "climatic factors" should be provided in the environmental report.	An additional point in Annex I, e.g. after point f), might be the most appropriate place in the legislation to include a reference to the need to provide information on the impact **of** climate change in the respective environmental reports.	Further guidance could be developed on the treatment of climate change adaptation in the context of CP and CAP investments.
Public procurement, as covered by Directives 2004/17/EC and 2004/18/EC	Article 23(3)(b) of Directive 2004/18 allows for environmental characteristics to be taken into account in relation to the functional requirements in the technical specifications of the contract information. In such cases, detailed specifications or (parts of) eco-labels might be used (Article 23(6). Conditions for the performance of the contract may include environmental considerations (Article 26). Contracting authorities may ask for evidence of a contractors environmental management measures (Article 48(2)(f), which should refer to EMAS or an equivalent standard (Article 50). There are similar provisions in Directive 2004/17.	The inclusion of climate proofing in the public procurement Directives would not be straightforward. The references to the environment often refer to other legislation, e.g. ecolabels and EMAS, which would therefore need to take account of climate change adaptation, which they often do not). In terms of the possibility of taking account of environmental characteristics in the functioning requirements, the legislation focuses on environmental impacts of contracts procured, rather than the potential impacts of the environment (e.g. climate change) on what is being procured.	In the context of CAP and CP, many contracts will be procured that could potentially benefit from insights on climate change adaptation. Such insights could be included in project related guidance.
Appropriate Assessment (Assessment in accordance with Article 6(3) of the Habitats Directive (92/43/EEC))	The assessment required by Article 6(3) simply states that relevant plans or projects need to be assessed for their implications on the site in the context of its conservation objectives. Hence, the quality of the assessment relies on the quality of the definition of the site's conservation objectives, e.g. whether these have taken account of adaptation.	It could be made explicit within the Directive that a site's conservation objectives should *inter alia* consider the future impacts of climate change on the site.	Further guidance could be developed on the treatment of climate change adaptation in the context of CP and CAP investments that affect sites designated under the Habitats Directive.

Instrument	Problem with instrument as it stands	Changes required to the instrument	Other means of delivering same result without need to change the instrument in the context of CP and CAP
Union guidelines for the development of the trans-European transport network (TEN-T), as proposed in COM(2011) 650/2	The draft Guidelines state that project promoters should give consideration to risk assessments and adaptation measures in order to improve the climate resilience of infrastructure. However, this does not mention the consideration of the wider interaction of infrastructure with climate change adaptation, e.g. its positioning and location could adversely affect the resilience of ecosystems.	From the perspective of both a project and a plan/programme, if the required EIA and SEA were sufficient in relation to climate change adaptation and if these assessments were undertaken properly, then there would be significantly less of an issue in this respect. However, as noted in Annex 9, these are not sufficient with respect to adaptation.	The development of further guidance on the inclusion of climate adaptation in EIA (as the relevant SEAs have already been undertaken), could address some of these concerns. Additionally, such guidance would also apply to non-TEN-T transport infrastructure, so would have wider impacts.
Union guidelines for the development of the trans-European energy network (TEN-E), as proposed in COM(2011) 658	As with TEN-T, the focus of the guidelines with respect to adaptation is the potential risk to the infrastructure concerned from climate-related risks, rather than **on** the potential impact of the infrastructure on climate change adaptation.	From the perspective of both a project and a plan/programme, if the required EIA (and SEA, if one is undertaken) were sufficient in relation to climate change adaptation and if these assessments were undertaken properly, then there would be significantly less of an issue in this respect. However, as noted in Annex 9 , these are not sufficient with respect to adaptation.	As with TEN-T, the development of further guidance on the inclusion of climate adaptation in EIA and SEA.
Union guidelines for the development of the trans-European telecommunications network, as proposed in COM(2011) 657	The requirement to take account of climate change adaptation when developing telecommunications infrastructure is not as strong as with either transport or energy infrastructure, but then telecommunications infrastructure is less likely to be affected as significantly as this other infrastructure.	From the perspective of both a project and a plan/programme, if the required environmental assessments were sufficient in relation to climate change adaptation and if these assessments were undertaken properly, then there would be significantly less of an issue in this respect.	As with the other infrastructure guidelines, the development of further guidance on the inclusion of climate adaptation in EIA and SEA, could address some of these concerns.

4 Policy assessment of 2014-2020 Cohesion Policy

4.1 Background and policy context

It has been increasingly acknowledged that the context and drivers for regional development are changing and therefore the relevant policies need to evolve accordingly. In 2007, the EU's Cohesion Policy embarked on a comprehensive policy review that sought to reflect on its investment patterns and to adapt the policy to newly emerging challenges and needs. Climate change has been identified as one of the main long-term drivers of economic, social and environmental change.[32] Impacts of climate change are projected to be asymmetric across European regions, depending on the scale of impacts, the exposure and sensitivity of ecological and socio-economic systems, and the ability of communities to adapt to these changes. More than one third of the EU population (approximately 170 million) lives in the regions which are likely to be most affected by climate change. Climate change mitigation and adaptation considerations feature prominently in the Fifth Cohesion Report, which makes the case for Cohesion Policy to support regions vulnerable to climate change.[33]

In the meantime, the Europe 2020 Strategy, adopted in 2010, establishes the EU's strategy for smart, green and inclusive growth, thereby making the transition towards a low carbon and climate resilient economy one of the high level priorities of the EU.[34] Climate change has also been a central theme in another high level process - the on-going EU Budget Review.[35] In June 2011, the Commission unveiled its proposals on the 2014-2020 EU MFF. Climate change is among the key priorities and the Commission proposes that at least 20 per cent of the 2014-2020 EU budget should be allocated to climate change actions through contributions from different funding instruments, e.g. cohesion, agriculture, research and innovation and development cooperation. Climate change mainstreaming is envisioned to be implemented both through an increase in the direct support for climate change investment[36] but also through 'climate proofing' all Cohesion Policy investments.[37]

On 6 October 2011, the European Commission unveiled a legislative package on the 2014-2020 EU Cohesion Policy.[38] The total proposed budget for the 2014-2020 EU Cohesion Policy is €336 billion[39]

[32] European Commission, DG Regional Policy (2009) Regions 2020: the climate change challenges for European regions. Brussels.

[33] European Commission. Fifth Cohesion report. November 2010.

[34] European Commission (2010) Europe 2020: A strategy for smart, sustainable and inclusive growth, Communication from the Commission, COM(2010)2020, 3.3.2010, Brussels

[35] EC (2010) The EU Budget Review. Communication from the Commission. COM(2010)700, 19.10.2010, Brussels

[36] European Commission (2011) A Budget for Europe 2020 – Parts I and II, Communication from the Commission, COM(2011)500, 29.06.2011, Brussels

[37] European Commission (2012) Elements for a Common Strategic Framework 2014-2020, Part I and II, Commission staff working document, SWD(2012)61, 14.3.2012, Brussels

[38] A Regulation laying down provisions governing all five funds under shared management which fall under a Common Strategic Framework (CSF). These include the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund, the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF). The second part of the proposed Regulation lays down general provisions for the European ERDF, the ESF and the Cohesion Fund (i.e. replacing the current General Regulation 1083/2006/EC); Three specific Regulations for the ERDF, the ESF and the Cohesion Fund; and Two Regulations dealing with the European territorial cooperation goal and the European grouping of territorial cooperation (EGTC).

[39] European Commission (EC) (2011) *A budget for Europe 2020*, Commission Communication, COM(2011)500, 29.6.2011, Brussels

(or €11 billion less than the 2007-2013 budget). Funds will underpin two new goals: 1) '*Investment in growth and jobs'* and (2) '*European territorial cooperation'* with the majority of funds concentrated in poorer regions. The Commission proposed a number of important changes to the way EU Cohesion Policy is designed and implemented, namely:

- concentrating on the objectives and targets of the Europe 2020 Strategy (including the objective for sustainable growth and the 20-20-20 climate and energy targets);
- improving the coordination and strategic orientation of funds under shared management through the introduction of a Common Strategic Framework (CSF);
- reinforcing integrated programming and territorial cohesion;
- focusing on improving the overall performance of the policy and result-orientation; and
- simplifying delivery.

A more detailed overview of the Commission proposals on the overall principles, objectives, architecture and funding instruments of the future Cohesion Policy is presented in Annex 10.

4.2 Ex-ante appraisal: Analysis of the relevance of EU Cohesion Policy to climate change adaptation and scope for integration of climate change adaptation

This section analyses the Commission proposals on the 2014-2020 EU Cohesion Policy and their relevance for climate change adaptation. We carry out the ex-ante appraisal in two steps:

1) Identifying the needs for climate proofing future Cohesion Policy expenditure. This appraisal looks at both the allocated expenditure with relevance for climate change adaptation and risk prevention in the current 2007-2013 programming period and identified gaps and potential for improvements. Based on the Commission proposals on the future Cohesion Policy, it also identifies generic types of expenditure that are likely to be most vulnerable to anticipated climate change impacts and establishes areas where more action on improving the resilience of these types of expenditure needs to be considered in the next programming period; and
2) Identifying opportunities for integrating climate change adaptation options (both in terms of investment priorities and procedural requirements) in the preparation and implementation of future Partnership Agreements (PA), Operational Programmes (OPs) and investment projects.

4.2.1 Needs for climate proofing future expenditure under Cohesion Policy

Climate change adaptation considerations and actions have not traditionally been amongst the main priorities of EU Cohesion Policy. In the 2007-2013 programming period, there was no separate objective or priority action for climate change adaptation. An analysis of Member States' National Strategic Referential Frameworks (NSRFs) showed that climate change adaptation received little attention across most of the NSRFs.[40] Ten plans did not cover this issue at all, whereas most of the others addressed it implicitly, mainly in the context of a broader description of environmental risks. The notion of vulnerability to climate change features explicitly in four NSRFs (France, the Netherlands, Portugal and Slovenia). Six plans explicitly stress the need to adapt to climate change

[40] Hanger, S., Lung, T., Haug, C. and Bouwer, L.M. (2011) Catalogue of programmes and policies related to regional development and infrastructure ('Baseline assessment'). RESPONSES project: Deliverable D6.1.IVM, JRC and IIASA.

(France, Greece, Hungary, Malta, Portugal, Romania and Slovenia).[41] A certain share of the total allocations has targeted risk prevention activities, particularly in relation to protection from floods, forest fires and landslides. For example, approximately €6 billion in the 2007-2013 programming period (or some 1.8 per cent of the total Cohesion Policy budget) has been allocated for risk prevention activities with the majority of these funds being allocated to convergence regions (approximately €5 billion).[42] These activities are eligible under expenditure category 53 Risk Prevention.[43] Climate change adaptation related actions are also eligible under another expenditure category (49 Mitigation and adaptation to climate change) however its share of the total EU funds allocations is fairly low (€325 million in total for a seven-year period). Furthermore, it is difficult to establish the split between adaptation and mitigation activities and the exact type of actions that have been promoted.

Overall, the opportunities for addressing climate change adaptation in the current 2007-2013 programming period appear to be fairly limited. It has been estimated that at NUTS-2 level regions, approximately €13 per capita is allocated to activities under the two adaptation-related expenditure categories.[44] The spatial distribution of these allocations also shows considerable differences across Member States, reflecting Member State priorities and not necessarily the spatial distribution of climate change risks. Hungary has the highest allocation (primarily in large scale flood protection projects), followed by eastern Germany, several Portuguese regions and Andalusia while the lowest allocations are found in Bulgaria and Lithuania.[45] A number of projects were financed under the territorial cooperation objective of Cohesion Policy, designed to address cross-border climate change related risks and explore possible adaptation solutions (e.g. INTERREG and URBACT projects see Boxes 1, 2 and 3 in Annex 12). Although these are relatively small scale projects, they are considered to be a good example of cross-border cooperation on adaptation and risk prevention issues, particularly in relation to the development of management tools or monitoring systems as well as the elaboration of planning schemes, studies, databases and awareness-raising campaigns.[46] .

At the same time, currently a large proportion of Cohesion Policy expenditure targets infrastructure and sectoral developments that could hinder adaptation and even lead to maladaptation practices. This could be the result of systematic failure to modify the planning and design of infrastructure expenditure to take into account potential climate change risks and associated impacts. Interviews conducted in the frame of this project reveal that using Cohesion Policy expenditure to retrofit and/or adjust existing and new infrastructure has not been a common practice so far.

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[41] Hanger, S., Lung, T., Haug, C. and Bouwer, L.M. (2011) Catalogue of programmes and policies related to regional development and infrastructure ('Baseline assessment'). RESPONSES project: Deliverable D6.1.IVM, JRC and IIASA.

[42] EC (2008) EU Cohesion Policy 2007-2013: Environment and climate change. Thematic pages.

[43] Expenditure categories (codes per priority theme) are set out in Commission Regulation (EC) 1828/2006 of 8 December 2006 setting out rules for the implementation of Council Regulation (EC) No 1083/2006 laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and of Regulation (EC) No 1080/2006 of the European Parliament and of the Council on the European Regional Development Fund, Official Journal of the European Union, L 371/1, 27.12.2006

[44] Lung, T., Lavalle, C. and Bouwer, L. (2011) Digital map of investment in the EU. European responses to climate change: deep emissions reductions and mainstreaming of mitigation and adaptation. RESPONSE project. Deliverable D6.2. December 2011

[45] Lung, T., Lavalle, C. and Bouwer, L. (2011) Digital map of investment in the EU. European responses to climate change: deep emissions reductions and mainstreaming of mitigation and adaptation. RESPONSE project. Deliverable D6.2. December 2011

[46] Panteia and Partners (2010) INTERREG III Community Initiative (2000-2006) Ex-Post Evaluation (No. 2008.CE.16.0.AT.016) Final Report.

With the increasing risks associated with expected climate change impacts on key economic sectors and related investments, the need to factor risks and vulnerability into future Cohesion Policy investments becomes acute. Based on the Commission proposals on the 2014-2020 EU Cohesion Policy and drawing on the analysis from the respective receptors reports (see Supplementary Material Report or summaries in Annex 1), we have reviewed the types of expenditure that are likely to be mostly affected by climate change impacts and therefore would need to be climate-proofed in the future.

The Commission proposals on the ERDF, Cohesion Fund, ESF and territorial cooperation outline specific 'priority actions' under the eleven thematic objectives in each of the fund-specific draft Regulations (see Annex 1 for a list of thematic objectives). Some of the investment opportunities for the most relevant thematic objectives are shown in Table 20.. Given that Cohesion Policy is implemented under shared management by national and regional authorities, a detailed account of the types and scale of activities at risk from climate change impacts occurring on the ground is not possible at this point. Identifying a generic set of activities in relation to thematic objectives and priority actions however is still helpful. It will indicate where the focus should be placed and the actions that would be required in the respective PA, OPs and investment projects in order to climate proofing future expenditure at the national/regional level.

Table 20. Opportunities for investment in climate change adaptation

Thematic objective / Priority & key actions per fund	**(4) Supporting the shift towards a low-carbon economy in all sectors**	**(6) Protecting the environment and promoting resource efficiency**	**(7) Promoting sustainable transport and removing bottlenecks in key network infrastructures**	**(9) Promoting social inclusion and combating poverty**
Priority actions (ERDF)	(a) promoting the production and distribution of RES; (b) promoting EE and RES in SMEs; (c) supporting EE and RES in public infrastructures and in the housing sector; (d) developing smart distribution systems at low voltage levels;	(a) waste investment; (b) water investment; (c) cultural heritage; (d) protecting biodiversity, soil protection and promoting ecosystem services including NATURA 2000 and green infrastructures; (e) action to improve the urban environment, including regeneration of brownfield sites and reduction of air pollution;	(a) supporting a multimodal TEN-T network; (b) connecting secondary and tertiary nodes; (c) developing environment-friendly and low-carbon transport systems and promoting sustainable urban mobility; (d) developing comprehensive, high quality and interoperable railway system;	(a) investing in health and social infrastructure; (b) support for physical and economic regeneration of deprived urban and rural communities; (c) support for social enterprises;

Priority actions (CF)	(a) promoting the production and distribution of RES; (b) promoting EE and RES use in SMEs; (c) supporting EE and RES in public infrastructures; (d) developing smart distribution systems at low voltage levels ;	(a) waste investment; (b) water investment; (c) protecting and restoring biodiversity; (d) improving the urban environment, including regeneration of brownfield sites and reduction of air pollution.	(a) supporting a multi-modal TEN-T network; (b) developing environment-friendly and low-carbon transport systems including promoting sustainable urban mobility; (c) developing comprehensive, high quality and interoperable railway systems;	n/a
Key actions (CSF)	(i) Innovative renewable energy technologies, in particular technologies mentioned in the Strategic Energy Technology Plan and in the Energy Roadmap 2050, along with second- and third-generation biofuels; (ii) Cross-border development of electricity networks to enable a larger take-up of electricity produced with RES	(i) investment in efficient water supply, waste-water treatment and water reuse, including new investment in the reduction of leakage and the implementation of River Basin Management Plans; (ii) investment in waste management in line with the waste management hierarchy, in particular re-use, recycling and, for non-recyclable materials, recovery;	(i) core TEN-T infrastructure covering road, rail and sea transport, as well as multimodal and interoperable modes; (ii) core TEN-T railway infrastructure, secondary connectivity, upgrading of dense railway networks; (iii) the removal of bottlenecks in inland waterways while minimising substantial modifications to riverbeds	n/a

Source: IEEP compilation

The screening of proposed priority and key actions indicates that the expenditure that is most exposed to climate change risks comes under 4 thematic objectives notably: supporting the shift towards a low-carbon economy in all sectors; protecting the environment and promoting resource efficiency; promoting sustainable transport and removing bottlenecks in key network infrastructure; and promoting social inclusion and combating poverty. These include expenditure eligible under both the ERDF and the Cohesion Fund. Some actions have explicit cross-border character.

Activities under the future Cohesion Policy most at risk can be classified in the following way:

- Basic infrastructure in four sectors:
  - energy (including both production and distribution);
  - transport (all modes, but especially rail);
  - environment (water and waste in cases where these entail both technology- and ecosystem based solutions); and
  - public buildings (including health infrastructure) and housing.
- Nature, ecosystem services and natural/cultural assets in relation to tourism; and
- Urban development, especially from heat waves (exacerbated by heat island effects) and flood risk.

The magnitude of the expected climate change impacts on these future expenditure types however varies across European regions implying different scales and scope for climate proofing actions that would be required under the 2014-2020 programming period. As shown in the regional assessments in Chapter 2, climate change impacts on infrastructural developments in all four sectors identified above are expected to be the highest in the Mediterranean and Central and Eastern European regions. These are also the regions where Member States have relatively lower adaptive capacities to tackle climate change risks. At the same time, the majority of Cohesion Policy funding allocations are likely to be concentrated in less developed regions which are also in the Mediterranean and Central and Eastern Europe. This implies that those regions will need to factor climate change adaptation considerations in their sectoral programming processes and ensure that sufficient share of the projects' budget is dedicated to enable the incorporation of proper prevention and adaptation measures in the project design.

Tourism related activities are most at risk in the Mediterranean region. Although these types of expenditure do not account for a big proportion of the overall Cohesion Policy portfolio, expected impacts indicate the need to place more emphasis on climate proofing expenditure for protecting, restoring and enhancing natural and cultural assets in this region.

Climate change impacts on buildings are expected to be high in the North and North-West regions (due in large part to flood risks) and medium in the Mediterranean region. Buildings therefore constitute another area where more emphasis needs to be placed when preparing OPs and projects. The significance of Cohesion Policy funds for retrofitting and adapting existing and new building infrastructure in likely to be higher in less developed regions in the Mediterranean.

Although climate change impacts are likely to have some impacts on industry (e.g. higher energy costs, lower labour productivity) (especially in Mediterranean and Central and Eastern European regions), in the case of Cohesion Policy, the link to the proposed priority actions is not straightforward as a majority of actions envisioned under thematic objective 'Enhancing the competitiveness of SMEs' include 'soft' measures such as promoting entrepreneurship, the creation of new firms and of new business models for SMEs. Furthermore, any adaptation measures that might be needed in the industry sector are expected to occur as autonomous adaptation where the cost is borne by the private operators themselves. Some exceptions to this rule are possible for example where autonomous adaptation may not be the preferred response (e.g. higher energy use for cooling), and in the case of less developed regions, where support under the ERDF could be granted to aid the adaptation of the most vulnerable small- and medium sized enterprises and to raise the awareness of workers and personnel about working conditions and labour productivity under a changing climate.

A regional distribution and the exact scale of these risk-prone activities under the future Cohesion Policy is difficult to establish at this point as the allocation of funds for specific activities under the different thematic objectives will be determined by national and regional authorities in their respective PA and OPs by the end of 2013. Nevertheless, some assumptions can be made. For example, transition and less developed regions are allowed to choose from a wider range of objectives and priority actions, which means that a greater share of their expenditure portfolio is likely to be exposed to climate change risks. This indicates that the needs to climate proof future expenditure under Cohesion Policy will be greater in transition and less developed regions.

Commission proposals also foresee that basic infrastructure will not be eligible for financing in more developed regions. Article 3(1) stipulates that the ERDF shall not support investments in infrastructure providing basic services to citizens in the areas of environment, transport and ICT. If this provision is retained in the final legislative framework, it will mean that under the future

Cohesion Policy developed regions will have a more limited set of actions that are at risk from climate change (e.g. mainly energy, nature/cultural assets and urban development). It is also proposed that these regions concentrate 80 per cent of their ERDF resources on innovation, R&D and low-carbon development actions. This implies that the majority of funds will be allocated to actions, which, as indicated above, are not necessarily the most vulnerable to climate change risks. At the same time, however, it should be highlighted that investing in the resilience of SMEs, using research funds for improving the knowledge base for climate change adaptation and encouraging integrated mitigation-adaptation actions are very likely to bring additional resilience benefits to the entire economy and therefore should be promoted in more developed regions as well (see next section).

4.2.2 Opportunities and constraints for climate change proofing future expenditure

The new cycle of post-2013 Cohesion Policy marks a step-change in addressing climate change. In fact, according to Commission proposals the mainstreaming of climate change is among the key priorities of the future Cohesion Policy. In this regard, the draft Regulations published by the Commission contain a number of legal provisions which set out the rules and principles which will govern the integration of climate change adaptation in future PA, OPs and project development. These include both possibilities for dedicated investment for climate change adaptation options but also procedural requirements and safeguards for the horizontal integration of climate change adaptation concerns at different stages of the policy process. The proposed legal provisions as well as the opportunities and constraints for ensuring the resilience of future Cohesion Policy expenditure are discussed in this section.

Strengthening the resilience of future expenditure and promoting adaptation

Strengthening the effectiveness of Cohesion Policy requires the concentration of funds on fewer objectives. The Commission's proposals on the 2014-2020 EU Cohesion Policy aim to reinforce thematic concentration by setting out eleven thematic objectives in a 'choose-and-pick' menu (see Annex 9), which should guide Member States during the preparation of their PA and OPs. One of these objectives is of strong relevance for climate change adaptation. i.e. 'Promoting climate change adaptation and risk prevention and management'. The introduction of a **specific thematic objective for climate change adaptation** is an important step to guarantee that funds in all regions can be dedicated to climate change adaptation options and improve the resilience of economic sectors, natural systems and communities. Such a stand-alone objective for climate adaptation would appear for the first time in EU Cohesion Policy.

The draft ERDF and Cohesion Fund Regulations present a list of possible **priority actions** which will be eligible for financing under this thematic objective. These include:

1) Supporting dedicated investment for adaptation to climate change;
2) Promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems.

The proposed elements for the 2014-2020 **Common Strategic Framework** (CSF)[47] further elaborate key actions which can be promoted under this thematic objective. These include:

- Development of *strategies and action plans* for adaptation to climate change and risk prevention and management plans at national, regional and local level and for building up a

[47] European Commission (2012) Elements for a Common Strategic Framework 2014-2020, Part I and II, Commission staff working document, SWD(2012)61, 14.3.2012, Brussels

knowledge base and data observation capacities, and mechanisms for the exchange of information;

- Increased investment in *adaptation to climate change and risk prevention* and management, including:
  - avoiding damage and increasing resilience to the built environment and other infrastructure;
  - protecting human health;
  - decreasing future pressure on water resources;
  - investing in flood and coastal defences; and
  - decreasing the vulnerability of ecosystems in order to increase ecosystem resilience and enable ecosystem-based adaptation;
- *Development of tools* (e.g. detection, early warning and alert systems, risk mapping and assessment); and
- Increased investment in *disaster management systems* to facilitate disaster resilience and risk prevention and management of natural risks, including weather-related risks (such as storms, extreme temperature events, forest fires, droughts, floods) and geophysical risks (such as avalanches, landslides, earthquakes, volcanoes), and to support societal responses to industrial risks (early warning systems, risk mapping).

It should be noted that even though it is not explicitly specified in the draft Regulations and the CSF, **investment for climate change adaptation could be promoted under other thematic objectives as well**. This is particularly relevant for actions aimed at increasing the resilience of the built environment and other infrastructure to climate change impacts. The majority of Cohesion Policy expenditure which is prone to climate change risks fall under other thematic objectives.

An important opportunity for promoting bottom-up climate change adaptation actions could be implemented under the new initiative for **community-led development** schemes based on the LEADER experience (carried out with the support of the EAFRD in the past). Currently, the draft Common Provisions Regulation defines community-led development in relatively broad terms but the underlying idea is to promote integrated and multi-sectoral area-based developments and actions. This certainly provides scope for promoting climate change adaptation activities/options. As climate change impacts and adaptation needs are inherently local in nature, bottom-up initiatives designed directly by local actors may have greater potential to directly address and/or integrate climate adaptation than traditional spending priorities designed at a national level by sectoral authorities. Longer-term planning of investment decisions for climate change adaptation, however, will still require national level policy-making.

The Commission proposals also introduce several novelties concerning the use of **financial instruments** in EU Structural and Cohesion Funds. Building on the experience with financial engineering schemes such as JEREMIE/JESSICA, the draft Common Provisions Regulation introduces new ways of using financial instruments in order to alleviate the pressures on public expenditure and to mobilise private finance.[48] The current 2007-2013 legislative framework for example limits their

[48] According to the Commission proposals, Member States can continue creating tailor-made instruments under the shared management principle, based on experiences with JESSICA/JEREMIE; second option will be to create 'off-the-shelf instruments' where Member States/regions could use standardised templates for the use of financial instruments (developed by the Commission based on past experience) thereby establishing the financial instrument more easily/speedily; and the third option entails Member States investing part of their Structural Funds in EU level instruments (e.g. the EEEF).

use to specific types of projects, e.g. SMEs and sustainable urban development.[49] The proposals for the post-2013 period remove this limitation, thereby expanding the scope of financial instruments to all types of projects, which could include climate change adaptation. The choice of the exact instrument (loan, equity or guarantee) however would depend on the type, development stage and the risk profile of a project as well as its ability to generate income. For example, JESSICA has so far been used mainly for the provision of loans to energy efficiency projects, which are considered low-risk projects that can generate periodic cash inflows.[50] However, there is generally little experience with using financial instruments for climate change adaptation projects. Their potential to promote climate change adaptation under the Cohesion Policy 2014-2020 would therefore depend on ensuring a return on the investment, making better use of public-private partnerships and building institutional capacity of the managing authorities to work with the banking sector.[51] . One option where financial instruments could be deployed is in the case of integrated mitigation-adaptation projects where the energy savings component could ensure a higher internal rate of return and therefore make the project more attractive to private finance. Another option would be if the adaptation action (e.g. flood protection) is made an integral part of a larger investment project itself (e.g. a new road construction) instead of being financed separately.[52] However, it is likely that many climate change adaptation projects would rely on traditional grant schemes and/or a mixture of grants, financial instruments and technical assistance.

In addition, some opportunities exist under the **European Social Fund** (ESF). In line with the proposed thematic objective for low carbon transformations, the ESF would support projects promoting the reform of education and training systems, adaptation of skills and qualifications, the up-skilling of the labour force, and the creation of new jobs in sectors related to the environment and energy.[53]

Based on the list of adaptation options developed in the framework of this project (see chapter 3.2), we have analysed the opportunities for financing these specific options under the draft ERDF and CF Regulations. The table below outlines opportunities for financing these options in relation to the proposed **priority actions, category of expenditure, funding instruments and thematic objectives**. The Table is important as it points to the opportunities for promoting climate change adaptation and risk prevention not only under the dedicated thematic objective on climate change adaptation and risk prevention but also under other thematic objectives concerning actions either at risk from climate change impacts or of relevance for adaptation. It also shows that some options could be pursued under more than one thematic objective indicating potential for maximising synergies and for 'win-win' solutions, particularly for integrated mitigation-adaptation projects, adaptation action in the urban areas, and raising awareness and institutional capacity building.

[49] Article 44 on financial engineering instruments of Council Regulation (EC) 1083/2006 of 11 July 2006 laying down provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and repealing Regulation 1260/1999

[50] European Investment Bank and European Commission (2010) JESSICA work 2014-2020, Part I and II, Commission staff worontext of JESSICA implementation

[51] Withana, S., Nunez Ferrer, J., Medarova-Bergstrom, K., Volkery, A., and Gantioler, S. (2011) Mobilising private investment for climate change action in the EU: The role of new financial instruments, IEEP, London/Brussels.

[52] GEF and UNEP. Assessing international funding for climate change adaptation: A guidebook for developing countries. UNEP Risø Centre on Energy, Climate and Sustainable Development, Denmark

[53] Proposal for a Regulation on the European Social Fund and repealing Regulation (EC) No 1081/2006, COM(2011)607, 6.10.2011, Brussels

Thematic objective	Prevention and adaptation option	Category of expenditure	Relevance under draft Regulations	Comment
2) Enhancing access to and use and quality of ICT	Information and Monitoring system on spread and relevance of vector-borne, food-borne diseases	067 Civil protection and disaster management systems and infrastructures	ERDF - art. 5(5) b ERDF - art. 5(2) c	
4) Supporting the shift towards a low-carbon economy in all sector	Energy efficient adaptation of offices, industrial plants to heat (e.g. passive cooling systems)	060 EE in SMEs	ERDF - art. 5(4) b	Only less developed regions and where the polluter pays principle cannot be applied
	Awareness raising to companies regarding adaptation to climate change	060 EE in SMEs	ERDF - art. 5(4) b	Only less developed regions and where the polluter pays principle cannot be applied
	Increase robustness of transmission grids to storm damages	02 Energy infrastructure 061 Smart grids	ERDF - art. 5(4) d CF - art. 3(a) iv	
	Installation of additional network capacities (smart grids)	02 Energy infrastructure 061 Smart grids	ERDF - art. 5(4) d CF - art. 3(a) iv	
	Hydropower reservoir power stations: Increase dam height to allow for higher variability in water availability	057 RES: Hydro, geothermal and marine energy	ERDF - art. 5(4) a CF - art. 3(a) i	
	Adjustments in design standards for wind turbine generators (consideration of extreme storm)	054 RES: wind	ERDF - art. 5(4) a CF - art. 3(a) i	
	Installation of additional storage facilities to adapt to higher volatility in base load.	054 RES: wind 955 RES: solar	ERDF - art. 5(4) a CF - art. 3(a) i	
	Higher energy efficiency of ventilation systems	02 Energy infrastructure 060 EE in SMEs	ERDF - art. 5(11) a	
	Energy efficient adaptation of homes against heat (e.g. passive cooling systems)	059 EE in existing housing	ERDF - art. 5(4) c ERDF - art. 5(9) b	Social housing Synergies between adaptation and mitigation
	Protection of buildings to storms, extreme precipitation	058 EE renovation in public infrastructure	ERDF - art. 5(4) c ERDF - art. 5(9) b CF - art. 3(a) iii	Social housing Synergies between adaptation and mitigation

5) Promoting climate change adaptation, risk prevention and management	Protection from forest fires	65 Adaptation to climate change and natural risk prevention	ERDF - art. 5(5) a CF - art. 3(b) i	
	Soft coastal defenses	65 Adaptation to climate change and natural risk prevention	ERDF - art. 5(5) a CF - art. 3(b) i	
	Flood gates (with impacts for several policy fields)	65 Adaptation to climate change and natural risk prevention	ERDF - art. 5(5) a CF - art. 3(b) i	
	Dike reinforcement and heightening	65 Adaptation to climate change and natural risk prevention	ERDF - art. 5(5) a CF - art. 3(b) i	
	Installation and retrofitting of environmental infrastructures to prevent natural disasters (e.g. protection against snowslips)	03 Management and distribution of water (drinking water) 05 Water treatment (waste water)	ERDF - art. 5(5) a CF - art. 3(b) i	
	Cooling of thermal power plants	02 Energy infrastructure		Not possible for installation under ETS; Only in less developed regions and when the polluter pays principle cannot be applied
	Targeted retrofitting to increase robustness of thermal power plants in coastal areas	02 Energy infrastructure		Not possible for installation under ETS; Only in less developed regions and when the polluter pays principle cannot be applied
	Heat Warning System	067 Civil protection and disaster management systems and infrastructures	ERDF - art. 5(5) b ERDF - art. 5(2) c CF - art. 3(b) ii	–
	Remote sensing and satellite imagery for early warning systems: for extreme weather events	067 Civil protection and disaster management systems and infrastructures	ERDF - art. 5(5) b CF - art. 3(b) ii	–
	Strategic urban and regional planning to prevent further accumulation of assets in vulnerable areas	65 Adaptation to climate change and natural risk prevention 075 Integrated schemes for urban and rural development 076 Community led local development initiatives in urban/rural areas	ERDF - art. 5(5) a ERDF - art. 5(4) e CF - art. 3(b) i	

5) Promoting climate change adaptation, risk prevention and management **11) Enhancing institutional capacity and an efficient public administration**	Awareness raising and information sources, especially for small-scale project developers	077 Improving the delivery of policies and programmes	ERDF - art. 5(11) a ERDF - art. 5(4) e	Synergies
–	Further conservation areas and habitat renaturation	064 Protection and enhancement biodiversity, nature protection and green infrastructure	ERDF - art. 5(6) c,d,e CF - art. 3(c) iii	–
	Maintaining and improving habitat management (conservation management, green corridors, etc.)	064 Protection and enhancement biodiversity, nature protection and green infrastructure	ERDF - art. 5(6) c,d,e CF - art. 3(c) iii	–
6) Protecting the environment and promoting resource efficiency	Diversification of tourist offers in different regions (winter + summer tourism)	069 Development and promotion of the tourism potential of natural areas	ERDF - art. 5(6) c	
	Additional rain overflow basins to adapt sewage system against flooding, enhancing water storage capacity of reservoirs	05 Waste water	ERDF - art. 5(6) b CF - art. 3(c) ii	–
–	Adaptation to sewage systems against droughts and low-water level	05 Waste water	ERDF - art. 5(6) b CF - art. 3(c) ii	–
–	River restoration (buffer zone), restoration of wetlands	05 Waste water	ERDF - art. 5(6) b CF - art. 3(c) ii	–
–	Leakage control in water distribution system	04 Drinking water	ERDF - art. 5(6) b CF - art. 3(c) ii	–
–	Demand management (rationale water use, restriction of groundwater consumption, etc.)	04 Drinking water	ERDF - art. 5(6) b CF - art. 3(c) ii	–
–	Desalination of water	04 Drinking water	ERDF - art. 5(6) b CF - art. 3(c) ii	–
6) Protecting the environment and promoting resource efficiency **9) Promoting social inclusion and combating poverty**	Green and blue Spaces, incl. green roofs	075 Integrated schemes for urban and rural development	ERDF - art. 5(6) e ERDF - art. 5(9) a,b CF - art. 3(c) iii	Synergies

	Sustainable urban drainage systems	05 Waste water 075 Integrated schemes for urban and rural development	ERDF - art. 5(6) b ERDF - art. 5(9) b CF - art. 3(c) ii	–
–	Heat-resistant asphalt and adjustment of maintenance	010, 011, 012, 013 and 014	ERDF - art. 5(7)a, b CF - art. 3(d) i	
	Shifting of road alignments beyond areas at risk	010, 011, 012, 013 and 014	ERDF - art. 5(7)a, b CF - art. 3(d) i	
	Retrofitting existing road infrastructure concerning increased precipitation	010, 011, 012, 013 and 014	ERDF - art. 5(7)a, b CF - art. 3(d) i	
	Adjustments of maintenance of rail infrastructures	06, 07 and 08	ERDF - art. 5(7)d CF - art. 3(d) iii	
	Adaptation of rail infrastructure to heat and temperature change	06, 07 and 08	ERDF - art. 5(7)d CF - art. 3(d) iii	
7) Developing sustainable transport and removing bottlenecks in key network infrastructures	Retrofitting trains concerning increased temperatures on Air Conditioning	09 Mobile rail assets	ERDF - art. 5(7)d CF - art. 3(d) iii	Only in less developed regions
	Retrofitting airports against heat	017 and 018	ERDF - art. 5(7) a, b CF - art. 3(d) i	
	Retrofitting airports against higher precipitation	017 and 018	ERDF - art. 5(7) a, b	
	Retrofitting existing infrastructure of shipping concerning extreme events	021 and 022	ERDF - art. 5(7) a, b, d	
	Improvement of waterflow management, including creation of water storage facilities	021 and 022	ERDF - art. 5(7) a, b, d	
	Adequate design and maintenance of bridges and tunnels	From 06 to 014	ERDF - art. 5(7) a, b, d	
	Vegetation management along roads and rails	From 06 to 014	ERDF - art. 5(7) a, b, d	
9) Promoting social inclusion and combating poverty	Energy efficient cooling of hospitals	028 Health infrastructure	ERDF - art. 5(9) a	
	More water-efficient building constructions	075 Integrated schemes for urban and rural development	ERDF - art. 5(9) a	

	Additional care and support of vulnerable citizens through health infrastructure (workers, buildings)	028 Health infrastructure	ERDF - art. 5(9) a	
9) Promoting social inclusion and combating poverty **10) Investing in education, skills and lifelong learning by developing education and training infrastructure**	Further adaptation in disaster protection organisations (e.g. education, disaster plans)	076 Community-led local development in urban/rural areas 089 and 090 - Investing in education, skills and life-long learning	ERDF - art. 5(9) a ERDF - art. 5(10)	Synergies

It should be noted that the list of options is not exhaustive and should be regarded as a menu of possible thematic options that would need to be further developed and tailored according to the national/regional needs in terms of expected climate change impacts and sectoral priorities. Based on the analysis in chapter 2, however, it can be argued that climate proofing expenditure in the areas of health, transport, tourism, energy and water should be made a priority particularly in the Mediterranean and Central and Eastern European regions given the magnitude of expected impacts and relatively low adaptive capacity of most countries in these regions.

Some of the options are **cross-cutting and concern mostly soft measures** (e.g. developing the knowledge base and tools for risk assessment / reduction as well as awareness-raising of public administrations). Such measures should be given a priority in all regions under the 2014-2020 EU Cohesion Policy for three reasons. Firstly, they could improve the overall planning processes at the national/regional level by linking forecasts on climate change impacts/costs to investment planning. Secondly, they could lead to more autonomous adaptation in the long-term and reduce the need for an intervention from the EU. Thirdly, they could enhance the ability and skills of national/regional authorities to develop bottom-up options that are better suited to their local circumstances.

At the same time, there are provisions in the draft Regulations which can also pose certain constraints on increasing financing for climate change adaptation. In general, there is a much stronger focus on mitigation than adaptation to climate change. For example, specific **earmarking** of funding is proposed with regard to the thematic objective supporting the *shift towards the low-carbon economy* [54] in the following way:

- at least **20 per cent** of the total ERDF resources in more developed and transition regions, shall be allocated to low carbon measures, particularly energy efficiency and renewable energy; and
- at least **6 per cent** of the total ERDF allocations in less developed regions shall target low carbon measures, particularly energy efficiency and renewable energy.

No such earmarking is set out for climate change adaptation. The draft Regulations stipulate that five per cent of the ERDF shall be earmarked for actions promoting sustainable urban development, which could potentially include actions aimed to tackle and adapt to climate change but this is not explicitly specified. This can create a certain **competition amongst different climate** objectives especially in the more developed and transition regions where the Commission proposals assume a stronger thematic concentration with the majority of the funds targeting mitigation activities (20 per cent). One interviewee, for example, stated that the Member State is most likely to allocate 20 per cent of its Structural Funds to low carbon measures and no funds for climate adaptation stressing that it 'cannot afford'[55] to have two climate related priorities – one on mitigation and another one on adaptation. However, not all interviewees necessarily shared this view. Others stressed that the existence of a separate thematic objective on climate change adaptation gives a sufficiently strong signal to national authorities and that they are likely to allocate more funds in the next period for adaptation measures. How exactly funds will be allocated to the various objectives and priority investments remains to be seen in the OPs that will be developed by managing authorities in 2013.

[54] Proposal for a Regulation on specific provisions concerning the European Regional Development Fund and the Investment for growth and jobs goal and repealing Regulation (EC) No 1080/2006, COM(2011)614,6.10.2011, Brussels

[55] Interview with a representative of a Member States

Another particular challenge flagged up during the interviews and the stakeholder workshop held as part of this study regards the opportunities and possible barriers for climate proofing the future Cohesion Policy. There is a considerable gap among the different countries in their efforts to address climate change – some countries are quite advanced and have national climate change adaptation strategies and/or some practice with dealing with extreme events (Austria, the Netherlands, etc.) while others are only beginning to carry out risk assessments and develop national policy frameworks (Spain, Romania, Bulgaria, etc.). Member States in northern Europe which are likely to experience beneficial effects due to climate change impacts tend to have analysed the potential opportunities within relevant studies and/or assessments.[56] However, even in countries where there is a more developed knowledge base, awareness, knowledge and skills is mostly limited to specialised climate change administrations. Managing authorities responsible for EU funds are not necessarily familiar with the issues and know how to address adaptation in the context of the planning, implementation and monitoring of expenditure programmes and projects.

There is particularly little awareness among authorities on the integration of climate adaptation measures in relation to making infrastructure developments more resilient to climate change impacts.[57] **Investing in sector specific options** in order to improve the resilience of different sectors and assets is strongly linked to a country's/region's vulnerability and preparedness to tackle climate change impacts. Interviews with representatives of various Member States however indicate that there is no priority for enhancing such investments in the post-2013 period. Importantly, all new infrastructural developments should foresee adjustments to their design and financial plans in relation to projected climate change risk and impacts. In order to optimise the use of EU funds, managing authorities should further seek to enhance potential 'win-win' solutions especially for the energy and water sectors. Such solutions for example should promote options that enhance synergies between adaptation and mitigation to climate change, e.g. integrated energy efficiency/adaptation measures in public buildings, SMEs, etc. See Box 4 in Annex 12 for an example.

At this point of time, given the different levels of preparedness of managing authorities to deal with climate proofing expenditure, **more operational guidelines** are needed from the Commission in relation to the type of specific measures that could be promoted under future Cohesion Policy. Depending on the knowledge base, different Member States have different preferences on the need for instruction from the Commission. Countries which have more advanced knowledge base and national strategies tend to prefer a more flexible approach where priorities and funding allocations are based on risk assessment according to regional circumstances and needs. In other countries, where the knowledge base and policy frameworks are less developed, there is a tendency to prefer more top-down instructive guidance from the Commission in terms of potential investments. The options developed in the framework of this project could be considered as a 'shopping list' of potential options that can guide national and regional authorities. Additional case studies which can exemplify in more depth some of these options and how they can be implemented in practice with EU funds would also be helpful.[58]

More clarity is also needed in terms of specifying concrete adaptation measures/options, which is also related to how to **classify and report** on expenditure for climate change adaptation. Interviewees stressed that a number of projects in the field of risk prevention, water management and eco-system services are already being promoted under Cohesion Policy but are not necessarily

[56] Interview with a representative of the European Environment Agency
[57] Interview with a representative of the European Environment Agency
[58] Interview with a representative of a Member State

considered and therefore reported as 'adaptation'. A clear system for classifying and counting categories of interventions under the future Cohesion Policy therefore would be needed.

At the same time, operational guidelines should also introduce **sustainability criteria** for investments which would ensure that certain types of adaptation measures (e.g. dams and dikes) do not impose unintended negative impacts on the natural environment.[59] There is often a tendency to perpetuate 'known' solutions usually related to grey technology-based options and avoid innovative solutions under Cohesion Policy.[60] The criteria should also determine how to avoid the promotion of maladaptation practices. For example, the provision of artificial snow in mountain regions, which is sometimes promoted as adaptation but in fact, could have rebound effects on water and electricity consumption. Another example is the construction of desalination plants to cope with water scarcity or shortages which however tend to be energy intensive and/or could cause chemical contamination.

The technical guidance developed as part of this project, accompanied by the capacity-building materials, provide a first step in this direction. This guidance aims at supporting adaptation experts within Member States and regions to promote the mainstreaming of climate change adaptation across all Cohesion Policy sectors, through communication and information gathering at each stage of the Cohesion Policy programme cycle including *inter alia* PA, OPs and project preparation and appraisal. The guidance is accompanied by descriptions of the adaptation options identified in the table above. These may then be furthered specified through more detailed technical and/or procedural guidelines within Member States.

Procedural requirements for climate proofing

The Commission proposals on the 2014-2020 Cohesion Policy introduce a number of legal provisions and novel mechanisms aimed at mainstreaming climate change concerns into the entire process of expenditure planning, implementation, reporting and evaluation. These include various procedural and institutional mechanisms which are likely to help the effective climate proofing of future expenditure. **This is a considerable improvement in comparison to the current programming period.** This chapter therefore explores both opportunities and potential constraints stemming from the new provisions and discusses their implications for integrating further climate change considerations in the development and implementation of PA, OPs and project development.

Article 8 of the draft Common Provisions Regulation prescribes that the objectives of the CSF Funds shall be pursued in the framework of sustainable development and the Union's promotion of the aim of protecting and improving the environment, as set out in Articles 11 and 19 of the Treaty, taking into account the polluter pays principle. It also specifies that Member States shall ensure that environmental protection requirements, resource efficiency, climate change mitigation and adaptation, disaster resilience and risk prevention and management are promoted in the preparation and implementation of PA and programmes. The inclusion of **climate change adaptation, disaster resilience and risk prevention** in the definition of the horizontal principle of sustainable development marks a considerable advancement, as for the first time an explicit requirement for climate change integration is included, embodying also instructions for its operationalisation at different stages of the policy cycle (namely programming and implementation). In fact, Articles 24 (4) and (5) regulating the content of the future expenditure programmes prescribe that each programme shall include a description of actions to take into account the principles set out in Article 8 and shall set out an indicative amount of support to be used for climate change objectives. Article 87 (3) further requires that each OP, except for technical assistance ones, shall provide a description

[59] Interview with a NGO representative
[60] Interview with a NGO representative

of specific actions to take into account *inter alia* climate change adaptation, disaster resilience and risk prevention and management in the selection of operations. Importantly, this will have an effect on the whole portfolio of EU Cohesion Policy expenditure, not only on funds earmarked for climate objectives. Depending on how it is further operationalised, it could have a positive effect for climate proofing sectoral expenditure programmes and the selection of investment projects.

Integrating climate change adaptation horizontally - understood as making non-climate expenditure more resilient to climate change impacts - was recognised by many of the interviewees as an important element of the mainstreaming concept. Based on past experience, however, a number of respondents commented that integrating horizontally 'cross-cutting' issues such as climate change can easily become a mere 'tick-of-the-box' exercise with no real impact of the decision-making unless they are properly operationalised in the programme/project development stages. A number of interviewees also indicated the need for additional guidance in terms of specific mechanisms and tools making it work in practice, e.g. project selection criteria, assessment procedures, etc.

Elements of the 2014-2020 **Common Strategic Framework**, proposed by the Commission, are potentially a very helpful tool not only to strengthen the strategic orientation of expenditure programmes and improve their links to the Europe 2020 Strategy but also because they put forward important implementation principles, some of which are linked to climate change adaptation. The proposed CSF includes specific language on climate proofing investments by stating that future expenditure should be made resilient to the impact of climate change and natural disasters. It further specifies that cross-border cooperation actions should be enhanced particularly in relation to flood prevention, forest fires and coastal protection; the promotion of ecosystem-based adaptation in comparison to technology based solutions is encouraged; and synergies with climate mitigation, environmental protection and resource efficiency should be exploited.

Commission proposals in the draft Common Provisions Regulations would also make improvements to the **partnership principle**. It is explicitly stated that partners include regional and local authorities, social and economic partners as well as 'bodies representing civil society, including environmental partners'. Importantly, the draft Regulation spells out the requirement that 'partners' should be involved at each stage of the programme cycle and shall be members of the Monitoring Committees. An interesting novelty compared to previous programming periods is the proposed 'Code of Conduct' (Article 5(3)) which should specify the objectives and criteria for the implementation of the partnership principle. At the same time, an omission is that there is no explicit reference made to the participation of environmental/climate public authorities, which is an important pre-requisite for policy coordination and climate mainstreaming.

The Commission's proposals also include provisions which require that sustainable development and climate change is taken into account in **assessment procedures,** such as the ex-ante evaluation for OPs as well as in the environmental analysis, part of the application form prepared for large scale projects. A specific article in the proposed Common Provisions Regulations (CPR) prescribes that ex-ante evaluations of each programme shall assess the adequacy of planned measures to promote sustainable development. Explicit reference to climate change adaptation is not made. Further reference is made to the implementation of the EU SEA Directive in relation to carrying out SEAs as part of the ex-ante evaluation process. Indeed, climate change mitigation and adaptation needs and impacts could be covered in the scope of the SEA as much as this is possible (see Box 5 in Annex 12). For major projects, the draft CPR Regulation further specifies that the analysis of the environmental impact of projects should take into account climate adaptation needs and disaster resilience while the CBA should include a risk assessment. Assessing climate change risks and adaptation options could therefore be provided by the EIA or the CBA of projects but at this point it is unclear how it would be carried out in practice.

The way in which SEA and EIA are traditionally carried out may not necessarily be suited to accommodate climate change adaptation needs in practice[61]. In fact, research has shown that SEAs carried out across the EU have so far struggled to effectively integrate climate change issues into practice.[62] Part of reason for this is that the assessment of climate change impacts on the plan/programme/project is not formally required by the SEA and EIA Directives. Methodologically, it could also be challenging given that the logic of SEA/EIA is the other way around. In other words, these aim to assess the impacts of the plan/programme/project on the different environmental components and not the other way around. There are innovative practices in some Member States which indicate how existing SEA/EIA procedures could integrate climate change adaptation (see Box 6 in Annex 12). The Netherlands for example has fairly developed SEA/EIA systems which incorporate compulsory elements of a risk assessment that take climate change impacts into account.[63] In Spain, there are several attempts to include climate change assessment in the SEA of proposed regulations governing different sectoral policies but not in the context of EU Cohesion Policy programmes/projects.[64] The EIB has also recognised the need to assess the risks from natural hazards to its investment portfolio, for instance flooding.[65] Other international banks apply tools such as 'portfolio screening' which requires the modification of already existing instruments such as the EIA as well as the introduction of complementary tools such as risk assessment and vulnerability assessments.[66] The application of these however remains fairly limited.

Forthcoming guidance from the Commission on the integration of climate change and biodiversity into SEA does advocate the use of these instruments to assess the impacts of climate change on plans, programmes and projects. One rationale behind this is that climate change impacts are intricately related to other environmental impacts – biodiversity in particular but also water and energy – and therefore need to be taken into consideration in any robust environmental assessment. Another reason given for doing this is that it makes good practical sense to build climate resilience into plans, programmes and projects from the start and SEA brings together the information and expertise to facilitate this.

A new system of **ex-ante conditionality** is also proposed by the Commission (Article 17). The fulfilment of ex-ante conditionalities will be reviewed by the Commission before approving the Partnership Agreements / Operational Programmes and may lead to the suspension of interim payments pending the satisfactory completion of actions to fulfil these conditionalities (ex-post). The Annex to the draft Common Provisions Regulation makes reference to national adaptation strategies which should be taken into account where appropriate. While this could offer an opportunity for linking expenditure programme to existing adaptation strategies, more clarity needs to be provided as to how this would be implemented in practice.

The Commission proposals also aim to improve the performance of EU spending, including in relation to climate change. The Commission foresees two consecutive **performance** reviews, in 2017 and 2019 respectively, which would assess performance against the preliminary established milestones for *inter alia* climate change among others in a performance framework (Article 19). The latter shall

[61] Practical guidance for integrating climate change and biodiversity into EIA and SEA procedures, DG ENV (forthcoming)

[62] COWI (2009) Study on the application and effectiveness of the SEA Directive (2001/42/EC)

[63] Interview with a representative of a Member State

[64] Interview with a representative of a Member State

[65] Lung, T., Lavalle, C., Hiederer, R. and Bouwer, L (2011) Report on potential impacts of climatic change on regional development and infrastructure. RESPONSES project. Deliverable D6.3, December 2011

[66] Klein, R. et al (2007) Portfolio screening to support the mainstreaming of adaptation to climate change into development assistance. Working paper 102, Tyndall Centre for climate change research, February 2007.

be determined in each Operational Programme. Based on the 2019 review, a **performance reserve** (5 per cent of the resources allocated to each CSF Fund and Member States) will be awarded to the best performing Member States or funds may be suspended in the case of failing to achieve the established milestones (Article 20). A set of 'common **indicators'**, proposed by the Commission in the Annexes of the fund-specific Regulations, should be accompanied by programme-specific indicators and used in the context of the performance framework. An attempt is made to move away from output-based to more result-based indicators. These include a number of indicators for greenhouse gas emissions, energy, environmental infrastructure, risk prevention, biodiversity and soil.[67]

The lack of proper indicators in relation to climate change adaptation in general and in the context of Cohesion Policy in particular however was stressed by a number of interviewees. Additional issues were raised were in relation to the nature of climate change impacts and adaptation measures which can be characterised to some extent by the uncertainty of the results and also depend on geographic, social and environmental particularities. This means that it would be easier to measure the appropriateness of measures and the level of compliance with policy/strategies but it would be more difficult to measure the effectiveness of the results.[68] Another interviewee also stressed the fact that under the current knowledge base, there are no criteria as to what forms good practice or a bad practice in relation to climate change adaptation,[69] which is another challenge to measuring the effectiveness of spending in this regard.

Using **differentiated co-financing rates** is another potential opportunity to boost climate related activities under the future Cohesion Policy. Article 111 of the proposed Common Provisions Regulation stipulates that the co-financing rate from Structural and Cohesion Funds to a priority axis may be modulated to take into account of the following *inter alia*: 'protection and improvement of the environment, principally through the application of the precautionary principle, the principle of preventive action and the polluter pays principle'. While there is no explicit mentioning of climate change, taking into account the principle of preventive action could be broadly interpreted as providing higher co-financing rates for projects that have included risk assessment in relation to climate change impacts and have integrated adaptation option to increase their resilience.

A summary assessment of the draft provisions for climate proofing of the 2014-2020 EU Cohesion Policy is presented in Table 21. It points to the relevant articles in the Commission's proposals and identifies the opportunities, gaps and additional improvements that are needed to ensure that future expenditure would be effectively climate proofed.

[67] See Annexes to proposed Regulation on ERDF and Cohesion Fund

[68] Interview with a representative of a Member State

[69] Interview with a representative of the European Environment Agency

Table 21. Summary assessment of provisions for climate proofing Cohesion Policy

Provision	Relevant article	Assessment[70]	Explanation
Sustainable Development as a horizontal principle, including the integration of climate change adaptation, disaster resilience and risk prevention and management	Art. 8 CPR Art. 24 (4) and (5) Art.114 (3) ii	+	The provisions provide requirements for the horizontal integration of climate change adaptation, disaster resilience and risk prevention and management in the Operational programmes and project selection
Thematic objective for climate adaptation, disaster resilience and risk prevention and management	Art. 9(5) CPR	+	The provision provides an opportunity for mobilising dedicated investment in climate adaptation, disaster resilience and risk prevention and management
Earmarking	Art. 4 (a) ii ERDF Art. 4 (b) ii ERDF	-	Provisions give clear priority to mitigation which could lead to competition between climate objectives and insufficient mobilisation of funding for climate change adaptation. The provision needs to be strengthened by promoting synergies between mitigation and adaptation under thematic objective 4 and/or including references to financing adaptation options and making sectoral investments climate resilient under other thematic objectives
CSF	Art. 10 CPR EC proposal on CSF (Annex to the CPR)	+/-	Important novelty to Cohesion Policy and other funds under shared management. Provisions set out specific key actions and implementation principles for climate change adaptation under thematic objective 5. At the same time, the status and content of the CSF is still unclear, undergoing political negotiations between the Council and the European Parliament.
Principle of partnership	Art. 5 CPR Art. 42 CPR	+	Provisions allow for the engagement of partners among which non-governmental stakeholders in the programming, implementation, monitoring and reporting of EU programmes and projects. No reference is made to environmental authorities though.

[70] '+' provisions are sufficient, '+/-' some gaps exist, '-' provision(s) needs significant improvement

Assessment procedures (ex-ante evaluation, analysis of environmental impact, CBA)	– Art. 48 (3) m CPR Art. 48 (4) CPR Art. 91 (e) CPR Art. 91 (f) CPR	+/-	Provisions include references for taking into account sustainable development in the ex-ante evaluation of OPs and climate adaptation needs and disaster resilience in the analysis of environmental impact for major projects. This analysis could potentially be provided by the SEA and EIA but there is no common practice integrating the assessment of risks in these procedures. The provisions are limited only to major projects, i.e. projects with a total cost above €50 million. Provisions need to be clarified how they would be implemented in practice. While risk assessment is required as part of the CBA, no specific reference is made to climate change risks. The provisions are limited only to major projects, i.e. projects with a total cost above €50 million. Provisions could be strengthened.
Community-led development	Art. 28 CPR	-	Provisions encourage bottom up initiatives. There is no explicit reference to integrating climate change adaptation, resilience and risk prevention which is an omission. The provision could be strengthened in this regard.
Ex-ante conditionality	Art. 17 CPR	+/-	Establishes a link to existing adaptation programmes where appropriate but it is unclear how this will be taken forward. Provisions could be clarified.
Project selection	Art. 87(3) l CPR Art 114 (3) ii CPR	+	The provisions indicate that climate adaptation, disaster resilience and risk prevention and management should be taken into account in the selection of projects, which means that project selection procedures at national/regional levels should integrate criteria to ensure climate proofing of projects.
Modulation of co-financing rates	Art. 111(2) CPR	-	There is not explicit reference to risk prevention/climate change adaptation but the principle of preventive action could be interpreted as a possibility to provide higher co-financing rates for promoting climate resilient projects. The provision could be strengthened in this regard.
Common indicators	Art. 6 ERDF + Annex Art. 4 CF + Annex	+/-	The list of common indicators includes indicators on risk prevention and management but they could be assessed only as a starting point for the development of comprehensive indicators. The provisions could be strengthened.

Performance framework	Art. 19 CPR	-	Provision provides an opportunity for measuring and improving the performance of Cohesion policy. However, there is no explicit reference to climate change adaptation and risk prevention. The provision could be strengthened.
Performance incentives – performance reserve/financial penalties	Art. 20 CPR	-	Provision provides an opportunity for rewarding/penalising achievements of Cohesion policy. However, there is no explicit reference to climate change adaptation and risk prevention. The provision could be strengthened.
Annual implementation reporting	Art. 44(3) CPR	+	Provision indicates that in 2017 and 2019, annual implementation reports should take stock of actions undertaken to integrate sustainable development (including climate change) and a report on support provided for climate change targets.
Institutional capacity building (training, networking, cooperation and exchange of experiences)	– Art. 3 (2) a ESF Art. 3 (d) iv ERDF Art. 5 (11) ERDF	+/-	Provisions provide opportunities under both ESF (explicit) and the ERDF (implicit). The provisions in the ERDF Regulation could be strengthened.
Technical assistance	Art. 51 CPR	-	Provisions indicate that technical assistance under the ERDF could be used in relation to preparatory, monitoring, administrative, technical, evaluation activities. There is no explicit reference to climate change adaptation. The provision could be strengthened.

Source: IEEP compilation

4.2.3 Barriers and success factors for climate proofing future Cohesion Policy

This chapter discusses different barriers, success factors and enabling conditions for promoting and integrating climate change in Cohesion Policy. There is a growing body of literature on barriers to adaptation but much less information available in relation to barriers for climate proofing Cohesion Policy. Therefore, we draw on a number of interviews and the web-survey conducted in the context of this project. The identification of barriers is critical for the final chapter on policy recommendations as well as the technical guidance developed under this project as they offer solutions how barriers can be overcome. A summary overview of barriers, success factors and enabling conditions is presented in Annex 11.

Political will

Political will is a key factor for initiating, driving and coordinating adaptation to climate change at a strategic level, including proper budgeting. In practice, however, risk prevention and adaptation to climate change impacts have not been considered as a political priority, not least in the context of Cohesion Policy. An exception to this is some geographic regions in Europe which have in the past been exposed to some forms of extreme weather events (e.g. landslides, floods) or where the effects of a changing climate have caused tangible negative impacts on key economic sectors (e.g. coastal and mountain areas). Even here actions/policies have generally been motivated by the effects of extreme events or natural hazards[71] while the willingness to start adapting has been limited.[72]

Furthermore, only 12 EU Member States have adopted a national climate change adaptation strategies.[73] This means that more than half of the EU Member States still do not have overarching strategy frameworks that set out objectives, priorities and measures for climate change adaptation. The lack of political will to act on climate change adaptation is also sometimes coupled with a certain level of scepticism about the scientific knowledge. Therefore, stepping up action to tackle climate change is not always treated on par with other economic and social issues, which form first order priorities.

Gaps in planning frameworks and tools

A number of interviewees identified the lack of planning frameworks and tools as a serious barrier that impedes the climate proofing of Cohesion Policy expenditure. In some countries this is due to the lack of a national or regional climate change adaptation strategy. In other countries, even if adaptation strategies are in place, there are no explicit links established to expenditure programmes related to Cohesion Policy. This means that it is fairly difficult to inform the programming of EU spending in relation to potential climate change threats, sensitive geographic areas and/or economic sectors or investment options for adaptation and disaster resilience. This is evident from the types of expenditure promoted so far under Cohesion Policy, which have been mainly focused on the prevention of flood and fires. Integrating adaptation options for climate proofing traditional investments have not been a common practice.

Another planning barrier is linked to the very nature of Cohesion Policy. Its primary goal is to promote social, economic and territorial cohesion, which means that all expenditure needs to be

[71] EEA (2009) Regional climate change and adaptation: the Alps facing the challenge of changing water resources. EEA report 8/2009. Copenhagen.

[72] Biesbroek, G.R. *et al* Institutional governance barriers for the development and implementation of climate adaptation strategies Working paper for the International Human Dimensions Programme (IHDP) conference "Earth System Governance: People, Places, and the Planet", December 2-4, Amsterdam, the Netherlands

[73] CLIMATE-ADAPT, Adaptation strategies

justified on the basis of its contribution to these objectives. Although climate change impacts can have both negative and positive impacts on these objectives, the links between these are not easy to determine for managing authorities. Furthermore, Cohesion Policy involves a wide range of interventions across different sectors. Sectoral administrations tend to think in narrow sectoral frameworks and therefore have had difficulties in tackling cross-cutting issues such as climate change. A lack of proper cross-sectoral communication and collaboration during programming has been raised as an important issue. It has also been found that cross-cutting issues such as 'sustainable development' have been difficult to operationalise and therefore did not have much impact on the content of OPs and the design of projects.[74]

Past experience in some Member States indicate barriers to the planning of small scale projects based on an ecosystem approach to climate change adaptation as they are generally seen as more difficult and time consuming to implement. This includes setting the call for proposals, conducting EIAs for a higher number of smaller projects, the issuing of various permits, etc. In addition, if the available institutional capacities are relatively low, the expected administrative costs of such projects are perceived as high.[75] For some of these reasons, national authorities often tend to favour the promotion of larger scale, grey infrastructure.

Gaps in knowledge and institutional factors

Awareness about climate change adaptation not least in the context of Cohesion Policy appears to be among the biggest challenges and a barrier for climate proofing future expenditure.[76] 44 per cent of the survey respondents assert that stakeholders preparing OPs have little knowledge of climate change impacts; and that there is little knowledge available of practical ways to take climate change adaptation into account in OPs. 58 per cent of the survey respondents see the lack of awareness and knowledge of practical ways to take climate change into account, as a major barrier to integrate climate change adaptation into Cohesion Policy projects.

Awareness is usually lacking also with regards to understanding what adaptation measures could consist of and what specific interventions can be financed under Cohesion Policy. It is often unclear how these are linked to the strategic objectives, priority actions and categories of expenditure in Cohesion Policy. For example, in one Member State, under OP Environment, priority axes 3 on 'Biodiversity' there has been envisioned the financing of projects on biodiversity and climate change. However, so far a call for proposals has not been launched as the managing authorities are struggling to prepare the terms of references and specify the eligibility of actions.[77] In addition, public authorities often face the problem of dealing with uncertainty related to climate forecasts and

[74] Nordregio (2009) The Potential for regional Policy Instruments, 2007-2013, to contribute to the Lisbon and Göteborg objectives for growth, jobs and sustainable development, Final Report to the European Commission, Directorate-General for Regional Policy, Evaluation Unit, Nordregio: Stockholm.

[75] These insights are based on two projects financed under Cohesion Policy in Poland – 'Increasing the retentive potential of forest ecosystems and counteracting the causes of flood and drought on forest ecosystem in lowland' and 'Counteracting the effects of rainwater runoff in mountainous areas. Increasing retention and maintaining streams and associated infrastructure in good condition'

[76] Kazmierczak, A. and Carter, J (2010) Adaptation to climate change using green and blue infrastructure: A database of case studies. GRABS, INTERREG IV.

[77] Interview with a representative of the managing authorities in a Member States

scenarios[78] and/or experience difficulties with estimating the costs associated with adaptation measures, which in turn affects the programming and implementation processes.[79]

Potential beneficiaries also lack an understanding of the opportunities and awareness how to prepare sensible and climate proofed projects. This has often has hindered their ability to make use of the allocated funds. In France, for example, funds have been earmarked for adaptation but no applications were received.[80] In Greece, funds were also allocated to risk prevention but were not utilised even though Greece was hit by natural disasters (e.g. forest fires).[81] Low absorption levels mean that allocated funds remain unused which in turn could make it difficult to justify the same or a higher budget line for the next programming period.

Monitoring gaps

A major gap is the lack of understanding and knowledge of how to monitor and measure progress towards climate change adaptation. This can be discussed from three different perspectives notably the lack of a common definition for the 'success' of integrating adaptation, the lack of indicators for measuring progress and the availability/accessibility of data., Progress towards a successful climate proofing of expenditure could be perceived differently from the perspective of different sectors, for example, or from the perspective of a different level of governance (EU, Member States, region and/or even community). This process could be further complicated by the fact that many adaptation measures require a long period of time to deliver the desired effects and the lack of immediate results does not necessarily mean a less 'successful' adaptation. Monitoring and measuring progress towards adaptation therefore requires a commonly agreed and determined definition of its meaning in relation to expenditure programmes and investment projects.

Regarding indicators, there are considerably more indicators measuring the impacts of climate change. However, these are considered to be insufficient to measure the progress towards adaptation not least in the context of expenditure programmes and projects. Some experience in this regard is being recently developed in Germany, Finland and the UK[82]. At EU level, the European Environment Agency (EEA) has mainly been using two indicators in the past 1) existence of a national climate change adaptation strategy and 2) expenditure on climate adaptation. The EEA is now looking into developing new adaptation related indicators. In the context of Cohesion Policy, indicators are developed by national and regional managing authorities as part of their OPs. These however have usually focused on economic and social indicators. The most commonly used climate change related indicators include output-based indicators such as 'the number of projects promoting risk prevention' or 'the number of people benefiting from flood protection measures'.[83]

Another issue is the availability and accessibility of data related to climate change impacts and vulnerability to/by managing authorities. In general, there is relatively more information and data

[78] Ecologic, AEA, ICLEI and REC (2012) Adaptation to Climate Change - Policy instruments for adaptation to climate change in big European cities and metropolitan areas. *Berlin/Vienna*

[79] Pfenninger, S., Hanger, S., Dreyfus, M., Dubel, A., Hernández-Mora, N., Esteve, P., Varela-Ortega, C., Watkiss, P. and Patt, A. (2010) Report on perceived policy needs and decision contexts. Report deliverable for the MEDIATION FP7 research project; IIASA, SEI and UPM.

[80] Interview with Ruslan Zhechkov, Regional Environmental Centre for CEE

[81] Interview with a representative of DG Regio, European Commission

[82] EEA (2012) Urban adaptation to climate change in Europe. Challenges and opportunities for cities together with supportive national and European policies, EEA Report 2/2012, Copenhagen.

[83] EC (2006) Working Document No 2: Indicative Guidelines on Evaluation Methods: Monitoring and Evaluation Indicators, DG Regional Policy

available and accessible at the national level; however, there is less data available downstream, especially at the regional level. In some countries, even if data is available, it is often not properly analysed and systematically presented which makes it less accessible. In other countries, existing data sets and indicators on water and biodiversity could be used in relation to climate adaptation but only to some extent.

With increasing efforts to move to a more performance-based and result-oriented EU Cohesion Policy, the need to develop transparent indicators and reliable data sets concerning climate change adaptation may pose a considerable barrier for climate proofing future Cohesion Policy expenditure.

Maximising synergies and win-wins

Since the available Cohesion Policy funding is limited, and it is likely to decrease in the 2014-2020 period, there will be competition among different objectives. Therefore, one factor that could foster climate proofing is to promote climate change expenditure in a smart way, for example by prioritising actions that maximise synergies for climate change adaptation and mitigation. Examples[84] of such actions include; waste to energy facilities, multi-modal transportation, mass rapid transit systems resilient to risk of floods, storms and heat waves, energy efficiency or demand-side management projects, water efficiency and storage, 'space for water' land use and urban greenery.

Similarly, an assessment of possible co-benefits between climate adaptation and biodiversity and ecosystem services needs to identify actions with a high synergy potential. In addition, many measures for improving energy efficiency and resilience to climate impacts have positive economic, fiscal and social effects, for example improving competitiveness, creating new employment opportunities or reducing energy bills and thus freeing resources for other investments. Such 'win-win' solutions should be identified and promoted in future funding programmes.

Involving all stakeholders

Effective adaptation to climate change requires not only tools but a structured and inclusive process of evolving and working with all interested/affected stakeholders – from decision-makers, planners, environmental groups, communities, local businesses, insurance companies, project developers, etc. This process builds a common understanding about potential impacts and vulnerabilities as well as the costs and benefits of adaptation options.

4.3 Solutions and policy recommendations

This section sets out policy recommendations to ensure that climate proofing of EU expenditure is delivered through the 2014-2020 Cohesion Policy. Building on the ex-ante appraisal and the analysis of barriers in the preceding sections it provides suggestions of how to improve the integration of climate adaptation needs within the Partnership Agreements, Operational Programmes and investment projects so that the performance and quality of EU expenditure is improved from the perspective of climate change resilience. These recommendations provide one of the inputs for the technical guidance for climate proofing Cohesion Policy, set out in a separate document accompanying this report.

The ex-ante appraisal and the analysis of barriers show that Commission proposals on the 2014-2020 EU MFF and the draft Regulations underpinning the future Cohesion Policy put forward a number of novel provisions which are likely to encourage better consideration of climate change risks and the

[84] Corfee-Morlot, Jan. and Less, C.T. (2012) Towards a green investment policy framework: the case of low-carbon, resilient infrastructure. OECD: Paris.

promotion of adaptation activities in the next round of expenditure programmes and projects. These include:

- Introducing separate thematic objective for risk prevention and climate change adaptation;
- Integrating climate change in the definition of sustainable development as a horizontal principle;
- Maintaining the principle of partnership;
- Requiring that climate adaptation, disaster resilience and risk prevention and management are taken into account in the selection of projects; and
- Requiring that 2017 and 2019 annual implementation reports should take stock of actions undertaken to integrate sustainable development (including climate change) and a report on support provided for climate change targets.

At the same time, how climate proofing of the future Cohesion Policy expenditure is delivered in practice will very much depend on the way Member States and regions prepare their Partnership Agreements, Operational Programmes and set out rules for project development and selection. To ensure that future Cohesion Policy expenditure is climate-proofed for the 2014-2020 period and beyond, a range of improvements are needed in the legislative and implementation frameworks for Cohesion Policy both at EU and national/regional levels:

At **EU level** these include:

- Clarifying and strengthening provisions in the draft Regulations for 2014-2020 EU Cohesion Policy;
- Adopting Implementing Regulations which include specific provisions on climate proofing Cohesion Policy;
- Providing additional guidance for managing authorities on how to implement climate proofing in practice; and
- Expanding the role of JASPERS.

At **national/regional level** these include:

- Setting out implementation framework for integrating climate change adaptation considerations at all stages of the policy cycle including strategic planning (Partnership Agreements), programming (OPs), implementation (project development), monitoring and reporting and evaluation

Cross-cutting issues that could enable the successful climate proofing of Cohesion Policy expenditure at all governance levels include:

- Raising awareness and strengthen institutional capacity;
- Improving considerably the knowledge base and availability of data; and
- Strengthening networking and the dissemination of good practice.

The Commission proposals on the **legislative package for 2014-2020 Cohesion Policy** are currently undergoing political negotiations, which could allow for further clarification and strengthening of the provisions that enable effective climate proofing of future expenditure. Specifically, more clarification and improvements would be needed regarding the following provisions:

- Earmarking;
- Taking into account climate adaptation in assessment procedures;
- Implementing ex-ante conditionality;
- Integrating climate adaptation in community-led development;

- Integrating climate adaptation in the performance framework and related targets, milestones and indicators as well as the use of the performance reserve in this regard; and
- Better use of technical assistance and funds for institutional capacity needs in relation to risk assessments and adaptation options.

The European Commission should adopt specific provisions in the **Implementing Regulations** that specify detailed implementation provisions for the integration of climate change in the CSF funds, including requirements for identifying and reducing climate change risks as well as incorporating adaptation needs in the future PA, OPs and project development. It should set out the framework for an implementation toolbox that contains a set of procedural and institutional instruments that will aid the work of the national/regional managing authorities which are in charge of programming, implementation and reporting of Cohesion Policy.

These Implementing Regulations should also be accompanied by more **operational guidance** to provide additional instructions to managing authorities and step-by-step methodologies for carrying out risk assessments, identifying cost-effective adaptation options and improving the resilience of the overall Cohesion Policy investment portfolio. Such guidance could build on the technical guidance developed in the framework of this project. **Specific needs for guidance,** some of which were identified during the interviews and the stakeholder workshop conducted in the framework of this project, can be summarised as follows:

- Guidance on specific substantive, procedural and institutional tools for climate proofing programmes and projects particularly in vulnerable sectors;
- Guidance on SEA, EIA and cost-benefit analyses with a view to incorporate resilience needs into OPs and project development respectively;
- Guidance on good practices and 'no regret' options relevant to Cohesion Policy;
- Guidance on rules for developing call for proposals, including project development requirements and selection criteria that take climate change adaptation needs into account;
- Guidance on classifying and reporting 'adaptation' expenditure; and
- Guidance on monitoring indicators, including outcome and result indicators.

The European Commission should also reform the existing instrument for technical assistance - **JASPERS.**[85] It should be modified to provide assistance and technical support to specific climate change related services in programmes and projects. Its mandate could be expanded to all Member States, particularly those who have low adaptive capacity. In the future, JASPERS could for instance:

- Provide technical support to *managing authorities* during the programming of Operational Programmes in terms of assessing vulnerabilities, needs and costs of risk-prone sectors and existing/planned infrastructure; and
- Provide technical support to *project developers,* who often do not have the relevant expertise or may not consider climate change risks, by factoring climate change risks in cost-benefit analyses (CBA) and/or introducing adaptation options in the project design stage. This way, climate proofing could be ensured at the earliest possible stage of project preparation before it is submitted for EU co-financing.

In practice, climate proofing the future Cohesion Policy will need to be delivered at national and regional levels of governance. It requires **systematic consideration of specific vulnerabilities and adaptation options into the entire investment portfolio** of the future Cohesion Policy. This means

[85] This is an instrument under the 2007-2013 Cohesion Policy managed by DG Regional Policy and the EIB which is aimed at providing technical assistance (e.g. feasibility studies, project preparation, technical issues, etc.) to new Member States in the preparation of big infrastructure projects.

that climate change adaptation needs to be embedded at every stage of the policy cycle including strategic planning, programming, implementation, monitoring/reporting and evaluation. The draft Cohesion Policy Regulations provide sufficient basis for this in some cases while in others they would benefit from further improvement of specific provisions. We provide recommendations on how this could be ensured in practice.

Strategic planning: This is the very first step of the policy process where strategic consideration of climate change impacts should be ensured. It would require enhancing integrated planning systems at national level with a special attention to linking spatial and infrastructure planning with climate change risks and resilience options. The analysis underlying the preparation of the future *Partnership Agreements* should take into account risks to specific sectors / regions, assess the necessity for and urgency of public intervention and identify key principles and potential priorities for adaptation. They should also stress the potential benefits for economic and social cohesion and the transition to the green economy. PA should link to existing climate change adaptation strategies with a view to ensure policy coherence and informed choices for funding priorities.

Programming: Operational Programmes will be the main framework to operationalise climate proofing at the level of programmes and projects. This can be done in three steps:

1) Mobilising *direct investment* in climate change adaptation (under thematic objective 5);
2) *Strengthening the resilience* of other expenditure (under all other relevant thematic objectives); and
3) Setting out specific *procedural requirements, communication and institutional mechanisms* for enabling climate change integration in project development, implementation, monitoring and reporting.

Thematic objective 5 is an important driver for **mobilising direct investment** in risk prevention and climate change adaptation. It is most suitable for promoting cross-cutting options, such as urban and regional strategies, the prevention of the further accumulation of assets in vulnerable areas, early warning systems, awareness raising and information systems, etc., as elaborated in the CSF. However, climate change affects expenditure across various sectors and therefore adaptation options should also be **promoted into the priority axes for the at-risk receptors**. This means that adaptation options could be promoted under most thematic objectives where future expenditure might be vulnerable to climate change impacts. In practice, it means that when planning basic infrastructure, investment in the built environment and providing industry support, part of the total budget allocated for such activities should be ring-fenced for improving their resilience to climate change. Importantly, this not only implies changes in the technical design but also soft measures such as green infrastructure alternatives, awareness raising or developing risk assessment tools and prevention methodologies. For example:

- Adaptation options for the *transport* sector could be promoted under thematic objective 7 so as to ensure that new infrastructure developments are made more durable to extreme weather events. Further to this, funding under this objective could also be allocated for activities aimed at retrofitting existing infrastructure if the transport sector is assessed as being particularly vulnerable;
- Under thematic objective 9, there is an interesting opportunity related to the new provision for *community-led development*. Concrete bottom-up initiatives could be promoted with a specific focus on integrating climate change adaptation needs and actions; and
- Under thematic objective 4 on promoting low carbon development adaptation options could also be promoted by prioritising integrated projects which foster *synergies between mitigation and adaptation*. In this way the artificial divide between the two, which usually has led to less attention being paid to adaptation, can be overcome. Further to this, such

integrated projects could be financed not only through traditional grants but also financial instruments (e.g. under the JESSICA initiative) as they could potentially yield a higher internal rate of return due to the realised energy savings.

Importantly, the list of options (both cross-cutting and sectoral) discussed in this chapter provides a menu of options, which is not-exhaustive. These options should be understood as guiding options for national/regional authorities, which in turn should develop spending priorities based on their national/regional circumstances and needs. For example, the ex-ante appraisal indicates that improving the resilience of all basic infrastructures and strengthening adaptive capacity should be a priority for Mediterranean and Central-Eastern European regions; risk prevention and adapting public buildings to floods should be a higher priority in North and North-west regions whereas adaptation options for tourism and public health need to be stepped up in the Mediterranean region.

In order to ensure the additionality and complementarity of Cohesion Policy, it should be stressed that EU funding should prioritise spending in regions with lower adaptive capacity. For example, it can be anticipated that certain adaptation options in more developed regions would occur autonomously or should be borne by private operators (e.g. adaptation measures in industry, private railway and airport companies, etc.). In order to enhance autonomous adaptation and make a convincing case for involving the private sector, EU public funding could provide considerable added value if it is concentrated on the development of the knowledge and information base (e.g. weather predictions, analysis and interpretation; quantification of climate risks as well as associated damage and adaptation costs, etc.) raising awareness and strengthening institutional capacities and skills. In this way, certain more cost-effective options could be encouraged through private means.

The assessment of risks and adaptation options should be delivered through an improved ex-ante evaluation procedure, which in practice could be delivered as part of the SEA. The SEA could also put forward specific monitoring indicators that can be integrated in the performance framework of the respective OP. However, more guidance on how the future ex-ante assessment and SEA will take adaptation needs into account is needed. Ideally, this should be developed as a priority in 2012 in order to be available in time for the start of the programming process at national / regional levels.[86]

Implementation: This stage is mainly concerned with the development, selection and implementation of projects. Climate proofing would require the introduction of specific rules and requirements for embedding climate change needs and considerations into the following:

- Preparing calls for proposals;
- Developing project application forms;
- Setting out climate relevant project evaluation and selection criteria;
- Setting out rules on integrating climate change adaptation needs in the ToR of the CBA and EIA; and
- Setting out safeguards for avoiding maladaptation.

Designing project selection criteria systems have proven to be effective tools for promoting more climate resilient projects by ensuring that such projects receive more points during the selection procedures. Another practical option to stimulate the preparation of more climate resilient projects could be by rewarding such projects with higher co-financing rates.

[86] This guidance could build on the technical guidance on Cohesion Policy developed for this project and on a guidance that is currently being prepared by DG ENVI on integrating climate change and biodiversity into SEA.

Procedurally, the cost-benefit analysis and the EIA can be useful tools to provide analysis of climate change risks and assess potential adaptation options at this stage. As with the SEA, however, specific guidance on this would be needed and tailored to the needs of managing authorities. This could also require a closer cooperation between managing authorities, officials responsible for SEA/EIA, project promoters and the SEA/EIA consultants. For larger scale projects, the role of JASPERS could be strengthened in this regard (see above).

Monitoring and reporting: Improving the performance and result-orientation of future EU spending requires a stronger focus on monitoring and reporting rules. The draft Regulations make important improvements in this regard but without an explicit reference to climate change adaptation. Indicators for climate change exposure, risks, impacts and options should be embedded in the performance framework of OPs and the project monitoring plans of projects. The lack of proper indicator systems and the availability and accessibility of data however have been highlighted several times in the ex-ante appraisal and were also raised by a number of interviewees as a particular barrier to climate change adaptation. One solution would be to invest funds from the technical assistance under ERDF for the development of proper indicator systems and engage with research / university intuitions.

Evaluation: Systematic evaluations provide an important feedback loop to policy-makers and stimulate policy learning. Specific thematic and ex-post evaluations related to climate change adaptation in the context of Cohesion Policy in terms of outcomes and achievements should be undertaken in a timely manner. These could be used to identify lessons learnt, common barriers and good practices that could be disseminated across other EU regions.

Throughout the different stages of the policy cycle, the effective climate proofing of the future Cohesion Policy will depend to a large extent on the **awareness, preparedness and capacity of the different stakeholders** (e.g. including managing authorities, final beneficiaries and all relevant partners). The future PA and OPs are likely to be developed in short timeframes which will put additional pressure on managing authorities. Climate proofing therefore requires concentrated actions and investment in raising the awareness, developing skills and building the capacity of stakeholders. This should ideally already begin in 2012 and 2013 and would require:

- Carrying out continuous training and skill development of managing and environmental authorities, as well as partners, beneficiaries and non-governmental organisations. Funds from the European Social Fund (ESF) and technical assistance under the ERDF can be used for this purpose.

Another way to enhance the institutional capacity of managing authorities is by ensuring the involvement of environmental officials and non-governmental organisations in the preparation of PA, OPs and project selection procedures. This could be achieved through a range of **coordination mechanisms and institutional tools, e.g.**:

- Establishing *inter-institutional working groups* where environmental authorities and NGOs participate and provide input into the assessment of climate change impacts and vulnerability as well as in the development of objectives, priority axes and project selection criteria of sectoral and regional programmes and projects;
- Similarly, environmental authorities and NGOs should participate in the sessions of the *Monitoring committees* of the different OPs and provide expertise and input in the reporting on climate change expenditure and indicators;
- Creating a *new position* for climate change mainstreaming in sectoral and regional managing authorities (e.g. following the example of the sustainability managers in the UK, where the

responsibility for sustainability integration, including climate proofing, is assigned to a dedicated administrative position);

- Establishing and/or strengthening the role of *national networks* that bring managing and environmental authorities together to discuss specific issues and challenges, disseminate good practices and new ideas, and strengthen networking and mutual learning.
- At the EU level, the existing ENEA-MA network could also be strengthened by enhancing the participation of DG Clima in its sessions and systematically discussing issues related to climate proofing Cohesion Policy spending.

More effective climate proofing requires more investment in the development of the **knowledge and information base** that should inform the development of PA, OPs and specific projects. As a first step, better use should be made of available information and data sources such as the CLIMATE-ADAPT platform. Additional targeted investment in the knowledge base will also help authorities better deal with uncertainty underlying the expected climate change impacts in EU regions. Funds from the technical assistance under the ERDF, but also under the future LIFE programme and the Horizon 2020, could be used to develop specifically:

- National/regional adaptation strategies (where these do not exist)
- Regional vulnerability maps and quantification of damage costs
- Indicators systems

5 Policy assessment of the 2014-2020 CAP: addressing Climate Adaptation priorities and Needs

5.1 Background and Policy Context

The 2009 Commission Staff Working Document on 'Adapting to climate change: the challenge for European Agriculture and rural areas' that accompanied the adaptation white paper (SEC(2009) 417) highlighted that 'the key objectives of adaptation for EU agriculture are to ensure resilience to climatic variations, socio-economic viability of agriculture and rural areas, and coherence with environmental protection objectives' and that the CAP, particularly rural development policy offered a range of measures to support 'activities that contribute to adaptation to climatic changes'. The CAP also plays an important role in helping the EU's forest sector prepare for climate change, as highlighted in the 2010 Commission Green Paper 'Forest Protection and Information within the EU: Preparing forests for climate change' (COM(2010) 66 final).

Rising to this challenge and making the most of the opportunities available remains an important priority for the 2014-2020 programming period. This chapter reviews the Commission's proposals for the 2014-2020 CAP and examines what opportunities these offer for addressing climate adaptation needs for agriculture, forestry, biodiversity and in rural areas more generally. It assesses the extent to which climate concerns are integrated into the proposed new framework for the CAP and considers how to ensure that future Rural Development Programmes are climate-proofed in practice, with reference to the political, institutional, technical and practical constraints and barriers that face Member States/regions in achieving this. It concludes by offering a series of recommendations and possible solutions for ensuring effective climate proofing of the CAP, particularly RDPs for the 2014-2020 programming period. Many of these are taken up in the technical guidance for climate proofing the CAP and the capacity building strategy, produced as part of the outputs of this study.

Not all actions to respond to climate change need support from public funds. Many actions to adapt to predicted climate impacts will be taken by land managers themselves as part of their normal business decision processes. However, support may be needed to help land managers adapt sustainably and to support actions needed for biodiversity. While some actions are needed urgently in the short-term, other responses will become more relevant over the coming decades. The CAP is only one policy tool that can help the land based sectors respond to climate change. Alongside the CAP, there also needs to be investment in research and development and the effective implementation of regulation, for example in relation to water, biodiversity and greenhouse gas emissions.

It should be noted, that this assessment of the CAP has been carried out on the Commission's proposed texts, which are subject to change as a result of the ongoing negotiations with the Council and the European Parliament. Indeed, no final decisions on the CAP proposals are likely before spring 2013 as much hinges on the outcomes of the decisions on the EU budget for the next multi-annual financial framework. This needs to be taken into account when considering the recommendations set out at the end of this chapter.

5.1.1 The CAP 2007-13

The need for agriculture to address the challenges of climate change has been recognised in relation to the CAP, particularly through its rural development policy (the European Agricultural Fund for Rural Development - EAFRD), since the start of the last programming period. Although the focus has been more on climate change mitigation rather than adaptation, the Community Strategic Guidelines for rural development for the 2007-13 programming period included climate change as one of the

core priorities for measures focussed on agricultural land management in order 'to protect and enhance the EU's natural resources and landscapes in rural areas'[87]. In addition, water availability/scarcity issues were highlighted as critical for adaptation and these are also a core priority for rural development policy.

The Health Check of the CAP, agreed in 2008, provided an increased level of financial resources available within rural development policy for a suite of Community priorities, one of which was climate change and another of which was water, thereby reinforcing these issues as key priorities for rural development policy[88]. Although the focus was primarily on climate mitigation goals in relation to reducing greenhouse gas emissions and increasing carbon sequestration as a means of meeting the EU's international agreements, the need for adaptation measures was highlighted specifically in relation to future water resource use[89].

Despite this, it is difficult to assess the extent to which CAP expenditure is currently 'climate-proofed', particularly Rural Development Programmes (RDPs) as it is not possible to break down CAP expenditure by specific priorities, only by measure. There are also no indicators to assess climate adaptation outcomes. However, of the €5 billion of additional funds made available for rural development policy under the Health Check, water management was allocated the second largest proportion by Member States (€1,332 million or 27 per cent), with an additional 14 per cent (€704 million) allocated to the climate objective to reduce greenhouse gas emissions from agriculture and to climate-proof Community expenditure. In addition, monitoring data from the 2007-13 programming period indicate that by 2010, almost 20 million hectares of land were 'under successful land management for climate change', accounting for 10.8 per cent of utilised agricultural area (UAA)[90], although it is likely that a large proportion of the area relates to GHG emission reductions rather than improving resilience to climate impacts.

5.1.2 The CAP post 2014

The Commission launched the legislative proposals for reforming the CAP for the 2014-2020 financial perspective on 12 October. Commissioner Cioloș presented the proposals as 'a new partnership between Europe and its farmers' in order to meet the three objectives of viable food production, sustainable use of natural resources and climate action and territorial development'. Addressing the challenges presented by climate change is signalled as an important priority for the CAP, in keeping with the priorities of the EU2020 strategy.

This is reflected in all elements of the CAP proposals. In relation to Pillar 1 this is visible through the introduction of a new 'greening' component to direct payments in order to ensure 'that all EU farmers in receipt of support go beyond the requirements of cross compliance and deliver environmental and climate benefits as part of their everyday activities'[91]. It is proposed that 30 per cent of direct payments should be allocated to this group of three measures (crop diversification, permanent grassland and ecological focus areas). Also relevant within Pillar 1 are the proposals for the ability to shift funding between the CAP's two pillars. Positive for climate adaptation, there is a proposal to allow Member states to voluntarily continue to transfer up to 10 per cent of their

[87] Council Decision of 20 February 2006 on the Community strategic guidelines for rural development (programming period 2007- 2013) (2006/144/EC) (OJ L 55/20, 25.02.2006).

[88] An additional €5 billion of funds were generated for rural development from the higher rate of compulsory modulation resulting from the CAP Health Check (€3.9 billion) and the EU Economic Recovery Plan (€1 billion).

[89] Council Decision of 19 January 2009 amending Decision 2006/144/EC on the Community strategic guidelines for rural development (programming period 2007- 2013) (2009/61/EC) (OJ L 30/112, 31.1.2009)

[90] Hart *et al* (2011) based on result indicator data from DG Agriculture and Rural Development

[91] COM (2011) 625/3 – Proposal for a Regulation of the European Parliament and the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy

national ceilings to be used to fund activities under rural development policy. Less positive, however, is the potential for 12 Member States to move up to 5 per cent of their budget allocation for rural development back into Pillar 1 to make up for a lower than average direct payment allocation. In relation to cross-compliance there is increased focus on soil management and the protection of carbon rich soils[92].

The climate focus is particularly highlighted in relation to rural development policy[93], where climate adaptation features much more strongly as an objective within the proposals for 2014-2020 than has been the case in the past. A number of the Union priorities for rural development are relevant to climate adaptation, and it features as a cross-cutting objective that Member States must demonstrate they are addressing across all measures used within their Rural Development Programmes[94]. It is anticipated that this prioritisation will be reinforced in the Community Strategic Framework which should stress the need for climate adaptation to be integrated not just across rural development policy, but across all EU funds for which there is shared competence.
Of the Union priorities for rural development that are of most relevance to climate adaptation are the following:

- Fostering knowledge transfer and innovation (Priority 1);
- Enhancing the competitiveness of agriculture and farm viability (Priority 2)
- Restoring, preserving and enhancing ecosystems (Priority 4); and
- Promoting resource efficiency and transition to a low carbon economy (Priority 5).

There is a whole range of measures within the rural development proposals that can help promote climate adaptation in relation to agriculture, forestry, biodiversity and rural areas more generally. These include:

- Support for the development of human capital in the form of capacity building and the provision of advice etc.
- Investments in infrastructure related to farming and forestry activities
- Support for environmentally beneficial land management activities

In addition, the recitals to the proposals (not legally binding) suggest that Member states should ensure that 25% of the EAFRD proportion of rural development funding should be allocated to 'climate change mitigation and adaptation and land management, through the agri-environment-climate, organic farming and payments to areas facing natural or other specific constraints measures'[95].

Running horizontally across all the CAP proposals, there is a much greater emphasis on the importance of advice, collaborative action and innovation. For example, the minimum scope of the Farm Advisory Service, which all Member States must operate, has been extended to include both cross compliance (as previously) as well as the implementation of Pillar 2 measures, and which must now cover advice on actions relating to climate change adaptation[96].

[92] COM(2011) 628/3 – Proposal for a Regulation of the European Parliament and the Council on the financing, management and monitoring of the common agricultural policy

[93] COM(2011) 627/3 – Proposal for a Regulation of the European Parliament and the Council on support for rural development by the European Agricultural Fund for Rural Development

[94] Article 5 of COM(2011) 627 final

[95] recital 28 of COM(2011) 627 final2

[96] Article 12 and Annex I of COM(2011) 628/3

Such an emphasis on climate adaptation (and mitigation) in the legislative texts should help meet the proposals for the 2014-2020 Multi-Annual Financial Framework that 20 per cent of the overall EU budget should contribute to meeting climate objectives (COM(2011) 500 final), reiterated in the common provisions regulation proposals (COM(2011) 615 final). However, if the CAP is to contribute proportionately to meeting this objective, then it will be necessary for both Pillar 1 and Pillar 2 expenditure to be contributing to achieving climate goals, given that Pillar 1 continues to constitute the largest share (75 per cent) of the EU CAP budget.

The sections that follow look at the opportunities for translating the provisions in the regulations into practice to ensure the CAP is climate proofed. It also considers the key barriers to climate proofing the CAP and possible solutions.

5.2 Ex Ante Appraisal

In section 3.2, a list of key adaptation options for agriculture, forestry and biodiversity was evaluated according to several criteria and the options were categorized into those that were considered to be a priority for 2014-2020, based on an assessment of their urgency and likely effectiveness. It is important to note that this list is an indicative list of options most likely to be relevant for adaptation across the EU. In making a selection of measures to include in the RDPs, Managing Authorities will need to choose those which are most suited to their regionally specific conditions, taking into account any synergies between adaptation (for productivity and environmental purposes) and mitigation impacts of different practices and any potential trade-offs[97].

The ex-ante analysis in the following section seeks to assess the extent to which the proposed new CAP regulations enable priority actions for climate adaptation identified earlier in the report to be taken forward by Member States as well as whether appropriate safeguards are in place to avoid maladaptation and investments that lock in specific paths of actions that would not allow adjustments to be made to future climate changes. It considers both the specific types of expenditure permitted as well as the procedural processes and provisions. It identifies gaps and areas where further information, guidance or assistance may be needed to enable Member States to be in a position to climate proof RDPs effectively.

Although the CAP also provides funding for measures in rural areas more broadly, the focus is on the agriculture, forestry and biodiversity related measures rather than those for rural development. This is because these represent the majority of expenditure (approximately 80%) under the current CAP programming period and this is unlikely to change in the 2014-2020 period. These are also the most likely measures to support 'no-regret' options in terms of improving the resilience of rural areas to climate change. However, it should be stressed that all expenditure carried out under the CAP, no matter what its purpose, needs to be climate proofed to avoid maladaptation.

5.2.1 Funding provisions for adaptation options

Rural development policy (Pillar 2 of the CAP) offers the greatest opportunities for supporting targeted adaptation options for agriculture, forestry and biodiversity as well as within rural areas more generally. Climate adaptation features much more strongly as an objective within the proposals for 2014-2020 than has been the case in the past, with a number of 'priorities' relevant to climate adaptation, as well as featuring as a cross-cutting objective that Member States must demonstrate they are addressing across all measures used within their Rural Development Programmes. Based on

[97] For example, catch crops and winter plant cover, while leading to improved soil quality and carbon sequestration, place an additional burden on scarce water resources and demand further irrigation.

initial indications[98], it looks likely that this prioritisation will be reinforced in the Common Strategic Framework which should also ensure that climate adaptation needs are integrated not just across rural development policy, but across all EU funds for which there is shared competence.
In terms of the availability of measures to fund specific options and actions on the ground, Table 22 illustrates that the current CAP proposals provides a sound basis for funding the different adaptation options identified in section 3.2. The table focuses on those measures that have been identified as 'no-regret' options[99].

There are a number of rural development measures in particular that are the most relevant for funding adaptation options[100]. These are:

- the **agri-environment-climate** measure (Article 29), which provides support to farmers for adopting environmental or climate related management on their land;
- **investments in physical assets** (Article 18), providing support for investments in 'tangible and/or intangible investments which can improve the competitiveness of the business or be non-productive in nature, linked to achieving requirements under the agri-environment-climate or forest-environment measures;
- **Natura 2000 and Water framework directive payments** (Article 31), compensating beneficiaries for the restrictions placed on them in these areas which are not experienced by those farmers/foresters outside these areas;
- Various **forestry measures**, in particular article 23 for the afforestation and creation of woodland, article 24 for the establishment of agri-forestry systems and article 35 for forest-environmental and climate services and forest conservation; and
- **Knowledge transfer and information** actions (Article 15) and providing support for **advisory services**, farm management and farm relief services (Article 16).

A number of other rural development measures are also relevant, for example those measures that help to prevent and restore damage to agricultural production and forests as a result of forest fires, natural disasters and other catastrophic events (Articles 19 (agriculture) and 25 (forests)). However feedback from interviews with a range of rural development experts from Member State managing authorities and stakeholders highlights the need to take care that the availability of funding under these measures does not disincentives land managers from taking proactive steps to make their businesses more resilient to climate change impacts. This is also a concern raised in relation to the new provisions for the 2014-2020 programming period on risk management (providing contributions to insurance premia and mutual funds to reduce the risk of economic losses caused by adverse climatic events and animal or plant diseases or pest infestations. One example cited concerned the use of the measure to compensate for losses from natural disasters currently operating (2007-13) to provide farmers with compensation for harvest losses from droughts, which are viewed by some as providing a disincentive for proactive adaptation to the greater risk of droughts. Other experts simply referred to the fact that currently land managers tended to use insurance to cover any production losses from extreme weather events, rather than planning to adapt to likely future climatic conditions.

[98] See for example, European Commission (2012) Elements for a Common Strategic Framework 2014-2020, Part I and II, Commission staff working document, SWD(2012)61, 14.3.2012, Brussels

[99] The assessment was based on the relevance, urgency, and effectiveness of particular measures, that were chosen according to: a) the identification of threats and vulnerabilities; b) the identification of common types of expenditure that are essential to climate proof (i.e. high expenditure infrastructure that is only renewed on a long-term basis; and c) priority measures/options for addressing climate adaptation needs for agriculture, forestry and biodiversity over the 2014-2020 (based on the assessment of their relevance, urgency, and effectiveness

[100] To note that article numbers may change in the final approved legal text

A greater emphasis is placed on flexibility, cooperation, and innovation as well as the need to facilitate action at a broader landscape scale, beyond the farm holding level. These are welcome principles in general and could also benefit the delivery of the land management actions needed for climate adaptation by increasing the scale at which these actions are planned and implemented.

The Leader approach continues to play an important role within the EAFRD, with greater emphasis placed on using bottom up approaches for innovation and rural development. A minimum spending requirement on Leader is stipulated (at least 5% of total EAFRD contribution) (Article 65 (5)). The Leader approach has proven to be effective for stimulating bottom-up and innovative activities, and there is potential that it could contribute also to climate adaptation provided that adaptation is highlighted sufficiently in the preparatory support (Article 43) for Leader action groups and that other capacity building and planning infrastructure also provides some impetus for action.

In addition, under Pillar 1, the proposed green direct payments are intended to provide significant levels of funding for three measures (crop diversification, permanent grassland and ecological focus areas) aiming at providing a minimum level of environmental management across the EU. The requirement for Member States to set up a Farm Advisory Service that covers both Pillar 1 and the agricultural land management measures in Pillar 2 and addresses climate adaptation will also play an important role in improving the adoption of climate adaptation action on the ground.

It should be noted that any measure that is financed that encourages agricultural land management activities, these must go beyond the baseline requirements set out under cross compliance, as required under the CAP financing regulations[101]. In relation to the priority options identified for climate adaptation, this relates mainly to those options which impact upon soils and water (quality and quantity). Of particular note are the proposed new GAEC standards for maintaining soil organic matter and protecting carbon rich soils, which should free up some funding to allow rural development measures to support more ambitious soil management actions.

[101] COM(2011) 628/2 final - Proposal for a Regulation of the European Parliament and of the Council on the financing, management and monitoring of the common agricultural policy

Table 22: Funding provisions within CAP proposals to support key adaptation options[102]

Adaptation option		Funding provisions within current CAP		
	Thematic focus	**Pillar 1 Measures**	**Pillar 2 Rural Development Measures**	**Associated Union Priorities (Pillar 2 only)[103]**
Farm infrastructure options				
Adaptation of agricultural infrastructure (egg. Buildings)	Avoidance of damage from extreme events		Article 18 – Investments in physical assets	2, 3, 4
Improvement of animal rearing conditions (shading and sprinklers)	Avoidance of heat stress		Article 18 – Investments in physical assets Article 34 – Animal welfare Article 23 – Afforestation and creation of woodland Article 29 – Agri-environment-climate	2, 3
Cooling of stables	Avoidance of heat stress		Article 18 – Investments in physical assets	2, 3
Setting up of anti-hail nets	Protection from hail		Article 18 – Investments in physical assets	2, 3
On farm harvesting and storage of rainwater	Improved water management		Article 18 – Investments in physical assets	2, 3, 4
Irrigation efficiency	Improved water management		Article 18 – Investments in physical assets	3, 4, 5
Land management options				
River restoration (buffer zone), restoration of wetlands	Improving habitat / biodiversity resilience Protection against flooding		Article 18 – Investments in physical assets Article 31 – Natura 2000 and Water framework directive payments Article 29 – Agri-environment-climate	4, 5

[102] Priority options (high urgency, no-regret and high effectiveness) are highlighted in light orange

[103] 1 - Fostering knowledge transfer and innovation in agriculture, forestry and rural areas; 2 – enhancing competitiveness of all types of agriculture and enhancing farm viability; 3 – promoting food chain organization and risk management in agriculture; 4 – restoring, preserving and enhancing ecosystems dependent on agriculture and forestry; promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy; 6 – promoting social inclusion, poverty reduction and economic development

Adaptation option		Funding provisions within current CAP		
	Thematic focus	Pillar 1 Measures	Pillar 2 Rural Development Measures	Associated Union Priorities (Pillar 2 only)[103]
Buffer strips (permanent vegetation)	Improving water management, Biodiversity resilience	Ecological Focus Areas	Article 29 – Agri-environment-climate Article 18 – Investments in physical assets	4, 5
Further conservation areas and habitat restoration	Improving habitat / biodiversity resilience		Article 29 – Agri-environment climate Article 18 – Investments in physical assets; Article 31 – Natura 2000 and Water framework directive payments	4, 5
Conservation soil tillage	Soil and water management		Article 29 – Agri-environment-climate	4, 5
Afforestation (e.g. of cropland and grassland with native species, not on natural/semi-natural grassland)	Soil and forest management		Article 23 – Afforestation and creation of woodland; Article 22 – Investments in forest area development and improvement of the viability of forests	4, 5
Plant winter cover	Soil and water Management		Article 29 – Agri-environment-climate	4, 5
Maintenance / reintroduction of terraces	Soil Management Biodiversity resilience		Article 29 – Agri-environment-climate Article 18 – Investments in physical assets Article 19 - Restoring agricultural production potential and introduction of appropriate prevention actions	4, 5
Reduce grazing pressure to reduce risk of erosion from flash flooding	Soil and water management		Article 29 – Agri-environment-climate	4, 5
Enhance floodplain management (re-creation of flood meadows)	Improving habitat / biodiversity resilience Water management		Article 29 – Agri-environment-climate Article 18 – Investments in physical assets Article 31 – Natura 2000 and Water framework directive payments	4, 5
Maintenance of permanent grassland	Improving habitat / biodiversity resilience Soil Management	Maintenance of permanent grassland	Article 29 – Agri-environment-climate Article 18 – Investments in physical assets Article 31 – Natura 2000 and Water framework directive payments	4, 5

Adaptation option		Funding provisions within current CAP		
	Thematic focus	Pillar 1 Measures	Pillar 2 Rural Development Measures	Associated Union Priorities (Pillar 2 only)[103]
Organic farming	Soil and water management Biodiversity resilience		Article 30 – Organic farming	2, 4, 5
Diversified crop rotations	Soil and water management	Crop Diversification	Article 29 – Agri-environment-climate	4, 5
Intercropping	Soil and water management		Article 29 – Agri-environment-climate	4, 5
Use of adapted crops	Protection from droughts		Article 29 – Agri-environment-climate	4, 5
Establishment of agroforestry systems	Soil Management Improved habitat and biodiversity resilience		Article 24 – Establishment of agro-forestry system Article 19 - Restoring agricultural production potential and introduction of appropriate prevention actions; Article 35 – Forest-environment and climate services and forest conservation	4, 5
Improved forest management	Forest management Protection against pest and diseases		Article 35 – Forest-environment and climate services and forest conservation Article 26 – Investments improving the resilience and environmental value of forest ecosystems Article 25 – Prevention and restoration of damage to forests; Article 27 – Investments in new forestry technologies and in processing and marketing of forest products	4, 5
Residue management	Soil Management		Article 29 – Agri-environment-climate	4, 5
Pest/disease monitoring and integrated pest management	Protection against pests and diseases		Article 29 – Agri-environment-climate Article 19 - Restoring agricultural production potential and introduction of appropriate prevention actions; Article 25 – Prevention and restoration of damage to forests	4, 5

Adaptation option		Funding provisions within current CAP		
	Thematic focus	**Pillar 1 Measures**	**Pillar 2 Rural Development Measures**	**Associated Union Priorities (Pillar 2 only)[103]**
Use of native livestock breeds to promote genetic diversity	Protection against heat, pests and diseases		Article 29 – Agri-environment-climate Article 19 - Restoring agricultural production potential and introduction of appropriate prevention actions	2, 4, 5
Farm management				
Insurance schemes	Risk management		Article 38 – Crop, animal and plant insurance Article 39 – Mutual funds for animal and plant diseases and environmental incidents	3
Livestock diversification	Risk management		Article 29 – Agri-environment-climate	2, 4, 5
Farm Advice				
Farm Advice	Advice / Capacity Building for land managers	Farm Advisory Service	Article 15 – Knowledge transfer and information actions Article 16 – Advisory services, farm management and farm relief services	1 – 6

The proposed suite of rural development measures for 2014-2020, therefore, provide the scope for a significant degree of ambition in terms of design of specific requirements to help build the resilience of the agriculture and forestry sectors and related habitats to anticipated climate change impacts. However, Member States do not always take advantage of the flexibility embodied in the programming process for developing RDPs and, although the potential to address climate adaptation needs exists in theory, this may not be identified as a priority for implementation at the national or regional level.

This situation should improve for the 2014-2020 programming period, however, given that Member States will be required to demonstrate how they address adaptation in relation to all spending priorities. However, actual implementation and effectiveness ultimately depends on the interests of farmers and other land managers or rural actors to engage in changing their practices and adopting the actions for which support is offered. . A key challenge will be to articulate clearly the benefits that adapting to climate change and building system resilience through sustainable resource use bring in relation to maintaining and improving the long term productivity of the agricultural sector.

Rural development measures are deliberately multi-objective and Member States are given the flexibility to use measures in ways that meet their local needs and priorities under the principle of subsidiarity. Many of the rural development measures identified in Table 22 are not necessarily focused directly on climate adaptation. Their focus may be on other objectives which also improve the resilience of rural areas to climate change, but they may also be applied in ways which would be counterproductive. A prime example of potential this is where expenditure is used in ways that encourages the unsustainable use of water. Equally, if not designed appropriately, with suitable conditions attached it is possible that some measures could act as a means of delaying beneficiaries from taking action to adapt to moderate climate change, for example by providing support to compensate for damage from extreme climatic events. On the other hand, under the proposed regulations, the availability of this kind of support can now be linked to funding for taking preventative actions and given the unpredictability of the frequency, type and intensity of climate impacts, could provide an important incentive to farmers and foresters to start to take account of climatic changes in relation to their business choices. Nonetheless, it is essential that sufficient safeguards are put in place to ensure that funding does not lead to negative consequences for adaptation (see section 5.2.2).

Finally, a key adaptation measure that goes beyond the holding or business unit is the provision of advice. Member States are required to include climate change adaptation within the remit of advice offered to farmers via the Farm Advisory System (FAS)[104]. The FAS will now also cover Pillar 2 measures as well as cross compliance. The beneficial impact will depend on the nature and content of the service developed in Member States. Given that farm advisory systems are crucial for all Union priorities for rural development, some indication is needed on how to facilitate integrated advice to farmers in order to ensure that messages are harmonized, not conflicting, and to use the limited resources effectively. Guidance on this or sharing best practice examples would be valuable. Planning and decision support tools are also needed in the forestry sector and this can be funded through the rural development regulation, although is not required in the same way as is the case for agriculture. The importance of advice and guidance and capacity building for the recipients of CAP funding is a point that was also highlighted in the web survey and interviews with rural development experts carried out for this study.

[104] Article 12c of COM(2011) 628 final/2

5.2.2 Procedural / implementing requirements and provisions[105]

The degree to which rural development measures and Pillar 1 payments will deliver climate adaptation benefits in practice depends on their design, use and subsequent implementation in Member State and ultimately their update by land managers and other rural actors. The flexibility built into the rural development programming process means that to ensure climate-proofing at Member State level, clear requirements and provisions must also be built into the design and implementation of programmes and Partnership Agreements between the Member States and the European Commission.

There are a number of stages of CAP development and implementation into which climate adaptation considerations need to be built. These largely relate to the transposition of the EAFRD into Rural Development Programmes but also relate to the implementation of elements of Pillar 1. They are reviewed in the following section and are grouped as follows:

A. The development of the strategic framework, including:
    a. The CSF and Partnership Agreements

B. Rural Development Programme development, design and content, including:
    a. Process for RDP development and structure
    b. Ex ante conditionalities
    c. Union priorities
    d. Earmarking of funds
    e. Performance Reserve
    f. Partnerships and Networks (EIP and ENRD)
    g. Programme Approval

C. RDP Implementation, including:
    a. Safeguards, eligibility criteria and expenditure approval criteria
    b. Conditions for the receipt of payments – the reference level

D. Monitoring and Evaluation, including:
    a. The CMEF and development of Indicators
    b. Evaluation requirements and processes
    c. Monitoring and Coordination Committees

Some important elements will be relevant to all stages of the programming cycle, for example the use of partnerships and networks, but to avoid repetition, these are addressed under what is thought to be the most relevant heading.

A climate proofing checklist could be produced as a useful aide memoire for Managing Authorities to ensure that climate adaptation considerations are taken into account at each point in the

[105] COM(2011) 627/3 – Proposal for a Regulation of the European Parliament and the Council on support for rural development by the European Agricultural Fund for Rural Development

COM(2011) 615 final – Proposal for a Regulation of the European Parliament and the Council laying down common provisions on the European Regional Development Fund, the European Social Fund, the cohesion Fund, the European Agricultural fund for Rural Development and the European Maritime and Fisheries Fund covered by the Common Strategic Framework and laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion fund and repealing Regulation (EC) No 1083/2006

COM(2011) 628/3 – Proposal for a Regulation of the European Parliament and the Council on the financing, management and monitoring of the common agricultural policy

programming cycle. This would also be useful for Commission desk officers for use during the programme approval stage. The technical guidance, produced as a separate output from this study, attempts to provide such a checklist.

A: Development of the Strategic Framework for Rural Development

Introduction of the CSF and development of Partnership Contracts: As set out chapter 4 one of the new strategic instruments introduced for the 2014-2020 programming period, is the introduction of a Common Strategic Framework, providing an overarching set of priorities for all EU funding programmes of shared competence with the Member States. For EAFRD, this will replace the current fund specific set of Community Strategic Guidelines for Rural Development[106]. One of the priorities proposed for the CSF is 'promoting climate change adaptation, risk prevention and management'. This should ensure that all regions and Member States at the very least actively discuss and consider how to integrate climate adaptation needs into their proposed expenditure programmes, including Rural Development Programmes, as part of the development of Partnership Agreements. However, although climate adaptation is the specific focus of one objective, in fact **all actions prioritised within the EAFRD, no matter which thematic objective they relate to, need to be assessed against projected/anticipated climatic effects to ensure they are resilient to climate change in keeping with the principle of sustainable development.** Indeed, this point is reinforced in the Commission's staff working document 'elements' for the CSF 2014-2020[107], which states that 'investments made with the support of the CSF-funds should be resilient to the impact of climate change and natural disasters'.

The Commission's staff working document also emphasises the importance that, in each Member State, 'all ministries and managing authorities responsible for the implementation of the CSF funds work closely together in the preparation, implementation, monitoring and evaluation of the Partnership Contract and programmes'. This is welcome and, if realised in practice, should help to overcome some of the issues highlighted in the current programming period of government departments working in silos (see Section 5.3).

To ensure that these ambitions are achieved in practice, however, **Member States will benefit from support and guidance on how to integrate climate adaptation within their Partnership Agreements to ensure there is a solid foundation for the more focussed development of RDPs**. This will not only be relevant for those Member States whose adaptive capacity has been assessed as low/medium (see section 2.4), but also for those where adaptive capacity as a whole is high, as evidence from interviews with experts showed that even where adaptation strategies for the agriculture and forestry sectors had been developed and priorities for action identified, this does not necessarily translate into actions being prioritised for expenditure within EAFRD. **Ensuring RDPs are climate-proofed with involve Member States to consider**:

- **how climate change will impact the different types of expenditure** prioritised in the RDP, particularly where this concerns infrastructure that is only renewed on a long-term basis, and what can be done to make them more resilient.
- **the opportunities for direct funding of climate change adaptation activities** - Identifying and prioritising dedicated adaptation actions that are in keeping with existing national and regional adaptation strategies and action plans to increase the resilience of rural areas to the effects of climate change; enabling the agricultural and forestry sectors to develop in a way

[106] Council Decision 2006/144/EC of 20 February 2006 on Community strategic guidelines for rural development (programming period 2007 to 2013)

[107] European Commission (2012) Elements for a Common Strategic Framework 2014-2020, Part I and II, Commission staff working document, SWD(2012)61, 14.3.2012, Brussels

that ensures their long term sustainability in the face of climatic changes; and increase the resilience of biodiversity and associated ecosystem services

Annex 1 of the Commission's staff working document identifies in some detail some preliminary priority actions under each thematic objective for each of the different funds, including the EAFRD. Although climate adaptation is one of the thematic objectives, actions under other objectives will also contribute to meeting climate adaptation needs. At present, the list of suggested actions highlighted for the EAFRD is very narrow, highlighting only sustainable water management, improved soil management and promoting genetic diversity. Although many of the priority options identified within this study could sit under one of these headings, a number do not. Although this is intended only as an indicative list, **it would be helpful to mention other types of activities that could be funded to address climate adaptation needs to encourage as wide a consideration of actions by Member States as possible**. Examples of other options that might be included are:

- investments that might be needed to help avoid heat stress, particularly to livestock or to improve water or energy efficiency;
- the role that EAFRD can play in improving the resilience of biodiversity to climate change;
- restorative actions that may be needed in response to natural disasters; and
- the role of advice, knowledge transfer and innovation

The importance of ensuring synergies and complementarities with actions under other objectives and other policy instruments (both within the CAP and outside it) is emphasised. This should in principle help to ensure that climate adaptation is prioritised within other elements of the CAP, such as the Farm Advisory Service and the green direct payments, but again, advice and guidance will be useful to demonstrate and encourage the sorts of synergies that are desirable.

B: Rural Development Programme Development, design and content

It is important to note that the following analysis is only based on the proposals for the new EAFRD regulation for 2014-2020. The detailed requirements of many of the articles referred to will be set out in the implementing regulations and delegated acts that will be produced and approved once a formal agreement on the main regulations have been reached. Where more detailed reference to climate proofing is needed in the main EAFRD text and/or where detailed requirements need to be set out in the implementing texts, this is made clear in the text.

Process for the development of RDPs: Adaptation is embedded much more centrally within the requirements stipulating the content of RDPs than previously. The SWOT analysis explicitly needs to consider adaptation (Article 9 (1)c), adaptation needs must be integrated into the programme itself (Article 9 (1)c-iv), sufficient advisory capacity for climate action needs to be ensured (Article 9 (1)c-vi), compliance with ex ante conditionalities, which include a number relevant to climate adaptation, needs to be demonstrated and the link with the EIP on agricultural productivity and sustainability need to be planned (Article 9 (1)c-vii and g).

The process for developing RDPs appears sensible, logical and well structured. If followed through it should lead to the design of coherent programmes that address climate adaptation. However, experience shows that **both time and capacity are needed to ensure good programme design.** Interviews conducted under this study with different Member States show that capacity is lacking in many countries. Although many Member States have started to develop their priorities and initial structure for RDPs already, based on the proposed legislative texts, the timeframe for the submission of programmes for Commission approval (three months after the adoption of the CSF and at the same time as the Partnership Agreement) means that they may well be finalised in a rush, with risks

that important details and safeguards are not sufficiently thought through to avoid perverse effects occurring. Strong path dependency also suggests that there will be a temptation simply to adjust existing programmes rather than incorporate new approaches and schemes. This further increases the importance of clear guidance on measure design.

Moreover, **there is a need to share experiences and best practice on adaptation in the period leading up to and during programme development, including through the European Network for Rural Development (ENRD)**. For example, the ENRD is currently providing support to a 'Focus Group' looking at how to improve the delivery of environmental services through rural development, to inform *inter alia* the drafting of the EAFRD implementation regulations and the development of RDPs. Although not currently in the workplan, a similar process could be facilitated in relation to climate adaptation, for example through the new Focus Group on Knowledge Transfer and Innovation, through the organisation of workshops and seminars, or production of suitable materials if this were to be suggested by the Member States and stakeholders on the Coordination Committee. Climate adaptation issues could also be incorporated into the seminar on 'successful programming' planned for December 2012. The use of the European Climate-ADAPT platform could also be explored in this context.

Ex Ante Conditionalities: A number of ex ante conditions have been introduced that Rural Development Programmes need to comply with before they can be approved. These are structured according to the different Union Priorities. Those conditions relevant for climate adaptation are set out below and should help ensure climate adaptation issues are more fully considered in Member States, providing an improved foundation on which RDPs can build.

- Condition 4.4 requires the existence of national risk assessments for disaster management, that take into account climate adaptation, and considering, where appropriate, national climate adaptation strategies - since many countries have not yet established integrated adaptation strategies at national level, individual sectoral strategies (for example, for biodiversity, agriculture, forestry) that consider adaptation needs should be considered, as well as more general risk assessments relating to climate change impacts on the environment
- Condition 5.3, relating to the priority 5 on promoting resource efficiency and supporting low carbon and climate resilient economy, requires the presence of a water pricing policy - this should lead to a more efficient use of water.
- condition 1.2 requires sufficient capacity to provide advice in relation to climate action in agriculture and forestry, and a description of the structure of extension / advisory system is required - the design of the system and the way adaptation is incorporated will influence the effectiveness of this provision.

Under the horizontal conditionalities, the HC.2 condition on human resource allocation requires that Managing Authorities have sufficient capacities for the management and implementation of RDPs. Interviews carried out for the purposes of this study and result from the web survey have shown that climate adaptation issues in relation to the CAP are not sufficiently understood within the relevant government departments and there is a need for awareness raising and capacity building at institutional level for the issue to be incorporated sufficiently into programme design. Requiring sufficient thematic capacity (for example on adaptation) could be a useful additional requirement under this conditionality.

Six Union priorities and the cross-cutting objective: Six Union priorities are set out in Article 5 of the proposed EAFRD regulation and these translate the relevant thematic objectives of the CSF into objectives relevant for rural development policy. These priorities replace the current axis structure of the EAFRD. In so doing, more flexibility has been introduced and there are no longer any constraints

on which measures can be used to deliver which priority. This should help to increase the scope and incentive for Member States to address these priorities as creatively as possible and to use packages of measures to deliver the needs identified within their programmes (ENRD, 2011; European Commission, 2011b).

There is a new requirement that the six Union priorities for rural development all need to contribute to the cross-cutting objectives of innovation, environment and climate change mitigation and adaptation. This should help ensure that climate proofing takes place during RDP design and should help to building synergies between different priorities, objectives and measures to deliver multiple objectives.

With climate adaptation featuring as a cross cutting theme, this structure could lead to an increase in transparency in the way in which Member States design their RDPs and propose to use measures to improve resilience to climate change, as all RDPs will need to set out the objectives and targets that they intend to address and the full range of different measures and actions that they intend to use to deliver these. If the relationship between the action supported by the proposed measure and climate adaptation is clear, then this should in theory also lead through to increased transparency and clarity in terms of monitoring and evaluation - as long as indicators can be identified, and that adequate data and expertise is available and accessible to measure progress.

The EAFRD regulation or implementing regulations could included suggestions or examples of how to facilitate the achievement of cross-cutting objectives.

Earmarking of funding for adaptation: Although not legally binding, the EAFRD Regulation includes a provision for earmarking of funding for climate action. Specifically, it is proposed that 25% of total EAFRD contribution should be included in each programme for action on climate change mitigation and adaptation and land management by supporting agri-environment-climate, organic farming payments, and payments to areas facing natural or other specific constraints measures. Given that many of the high priority options to increase the resilience of rural areas are in fact land management options (rather than infrastructure investments), this requirement could help ensure that Member States place sufficient emphasis on land management options. Conversely, the absence of such a requirement could risk such measures losing out in terms of their prioritisation and expenditure to other measures.

The requirement for 30% funding of greening measures under Pillar 1 also could have positive benefits for adaptation depending on the actual design of the three proposed measures and free up funds within RDPs to be used for more demanding actions for climate adaptation. However, the green direct payments are one of the most controversial elements of the current CAP negotiations and, at the time of writing, the likely outcome of the debates on these measures remains very unclear.

Performance Reviews and the Performance Reserve: Another new element of the current proposals is the introduction of the "performance reserve", which involves a mechanism to allow some funding to be reserved for regions who demonstrate they have met their targets. While the idea itself could be very useful to establish the linkage between performance and funding, and thus incentive for better performance, it is not clear how performance would be evaluated especially in terms of achieving adaptation. Since adaptation requires flexible and tailored regional responses, it may not be possible to include consistent criteria for a performance reserve. Moreover, since adaptation is an emerging field and the outcomes related to adaptation extremely variable, it may be premature to come up with criteria for withholding funds. It may also encourage Member States to be overly conservative in the design of their RDPs, fearing the withholding of their performance reserve if

innovative approaches fail. To avoid this, it is suggested it has been suggested that **a failure tolerance should be built into RDPs so that innovative approaches are able to flourish** (Dwyer et al, 2012).

Alternatively, instead of a dedicated performance reserve, **improved performance in programme management could be ensured through the ex-ante conditionality requirements on the capacities of Managing Authorities, clear (prescriptive) guidance on project selection criteria and where relevant eligibility requirements, as well as clear specifications about monitoring and evaluation requirements.**

Partnerships and Networks: The importance of partnerships and networks for sharing knowledge and experiences as a means of improving the delivery of RDP outcomes, facilitating the emergence of creative solutions to issues faced and capacity building, is already a core element of the EAFRD. Under the current programming period the regulations required the establishment of the European Network for Rural Development (ENRD) and for all Member States to establish National Rural Networks (NRN). This continues to be a requirement for the next programming period and in addition, new partnerships are envisaged under the auspices of the European Innovation Partnership (EIP) on Agricultural Productivity and Sustainability through the development of an EIP network and operational group. These **networks will be a critical resource that can be used to improve the climate proofing of CAP expenditure in the future.**

The **EIP on Agricultural Productivity and Sustainability**[108] includes twin headline objectives of promoting productivity and efficiency of the agricultural sector, and securing the sustainability of agriculture (soil functionality). This provides opportunities to integrate adaptation concerns into both the development of new technologies as well as encourage a wider understanding of adaptation vulnerabilities and priorities amongst different stakeholders. A strategic implementation plan will be prepared, following a consultation process with Member States, European Parliament and stakeholders, to give more clarity about the strategic objectives and the format for the EIP. **This plan would need to set out clearly that adaptation concerns should be a priority and establish clear timelines and milestones. Moreover, it needs to include some safeguard mechanisms for basic climate-proofing of all activities and options to be pursued.**

Innovative adaptation strategies for the priority areas of biodiversity, ecosystem services and soil functionality are explicitly highlighted within the proposals. The EIP could also be used for the testing and piloting of more systemic adaptation where integrated approaches (for example, adjustments along supply chains as well as cross-sectoral and territorial approaches) are pursued. This could, for example, also include elements such as improvements in information systems and institutional capacities. Inclusion of these aspects would increase the potential value of this EIP for adaptation.

The effectiveness of the EIP will depend to a large extent on the governance structures that are put in place. Operational groups made up of different actors, including farmers, scientists, advisers, NGOs and enterprises, will be formed around specific topics of interest. How these are run and linked with each other will determine their effectiveness. Also relevant for climate adaptation is the EIP on Water[109], which is supposed to interact with the agricultural EIP, with the latter focusing on farm level actions and the water EIP dealing with infrastructure and allocation issues beyond farm level.

[108] COM (2012) 79final Communication from the Commission to the European Parliament and the Council on the European Innovation Partnership 'Agricultural Productivity and Sustainability'

[109] COM (2012)216 - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the European Innovation Partnership on Water

Close coordination and exchange between the two EIPs is planned and should be ensured in practice so as to avoid overlap and maximize synergies, particularly given the importance of water resource use for the land based sector and the need to achieve significant efficiency savings in the face of increasing water scarcity in many regions.

Turning to the ENRD, this, together with the NRNs plays an important role for the networking among the various stakeholders involved in rural development, as well as for the sharing of information and expertise between Member States and regions. As part of its role it provides a particular role in networking the various Leader activities in the EU. In addition to contributing to improved quality of the RDPs, the ENRD aims to increase involvement of stakeholders in RDP implementation and the dissemination of information about the benefits of rural development policy. It could play a valuable role in the expertise and information exchange around adaptation, for example, by setting up a thematic group for adaptation, incorporating adaptation issues into existing thematic groups and support other types of networking and co-operation activities, such as workshops and seminars (see above).

Programme Approval: All RDPs (and Partnership Agreements) must be submitted to the Commission for approval before funding is released and they can be implemented. This is a good opportunity to ensure that climate adaptation needs have been taken into account in the design and development of RDPs. It will be important to ensure that all RDPs are checked to see that they are climate-proof and changes required if necessary as part of this process.

C: RDP Implementation

Safeguards and avoidance of maladaptation: Clear safeguards to ensure that rural development expenditure supports adaptation or at the very least does not lead to maladaptation are not sufficiently evident in the current proposals, except for the provision for funding irrigation investments, where it is proposed that only investments that lead to a reduction of previous water use by at least 25% shall be considered as eligible expenditure (Article 46 (3))[110]. However it is unclear if these savings have to be returned to the environment or can be used by other sectors or at other places, and therefore it is not clear if they will lead to an actual reduction in the pressure on water resources. A number of Member States have voiced concerns about the blunt nature of this safeguard, however, particularly Mediterranean countries where issues of water availability and use are critical for the continued profitability of their agriculture sectors. They are calling for safeguards to be developed at the Member State level to ensure they are appropriate to local circumstances. If this is changed, then it will be critical to ensure that the Commission approval process reviews the safeguards to ensure that they are climate-proofed.

Ensuring that any future investments in infrastructure are climate proofed will depend upon the establishment of suitable project choice criteria and safeguards. Article 46 sets out the eligibility criteria for investments, includes the provision that environmental impacts of investment operations need to be assessed. **Similar provisions for climate adaptation could be added to require that all investments are assessed to ensure that they are resilient to future climate change** and do not lead to maladaptation, in line with the requirements relating to sustainable development set out in the Staff Working Document on the CSF 2014 – 2020.

Moreover, **adaptation and climate-proofing safeguards should also be included in the criteria for the selection of projects** (Article 49) **and stipulated in the rules for area related payments** (Article

[110] By way of derogation, in the Member States that adhered to the Union from 2004 onwards investments in new irrigation installations can be considered eligible expenditure in cases where an environmental analysis provides evidence that the investment concerned is sustainable and has no negative environmental impact.

47). This is critical, particularly for example in relation to expenditure on afforestation, where the species composition of any new planting should reflect changing climate conditions. Not only do these articles need revising to include the relevant safeguards, but guidance from the Commission will be needed to ensure that adaptation concerns are fully considered in the implementation of RDPs and the provision of funding to beneficiaries.

To avoid concerns that the proposed articles that support risk management could deter land managers from taking action to adapt to climate change, it is suggested that beneficiaries of support under these measures (Articles 38 and 39) are required to demonstrate that they have taken account of the likely impacts of climate change in their future planning of their operations before support is provided.

Conditions for receipt of payments – the reference level: Cross compliance requirements stipulate a range of legislative requirements and minimum standards with which farmers have to adhere in order to receive direct payments as well as area payments under Pillar 2. These conditions provide an important baseline and, if adequately controlled and enforced, should ensure a minimum level of sustainable management of agricultural land. As such, together with the proposed new green direct payments, they should provide a good starting point to help improve the resilience of agricultural land to climate change and allow agricultural land management measures under the EAFRD to encourage more demanding actions.

Although Statutory Management Requirements (SMR) essentially require farmers to comply with elements of certain pieces of EU legislation that are applicable at farm level, evidence has shown that linking compliance to the receipt of payments does increase awareness of the requirements and therefore adherence to them. Therefore, the proposal to include the Water Framework Directive as a SMR should increase awareness and action in relation to water scarcity. However, this is another area where there is considerable resistance to the proposals from Member States currently and it is unclear to what extent WFD requirements will become part of cross compliance in the final CAP agreement or if they do, the timing of their actual inclusion.

D: Monitoring and Evaluation

Indicators: The Common Monitoring and Evaluation Framework, previously only applicable to expenditure under rural development policy, is now to be extended to all CAP instruments, including direct payments and cross compliance. This has the potential to help drive an improvement in assessing progress in the delivery of climate adaptation as long as suitable indicators are developed.
The development of indicators to measure the impacts of the CAP on climate adaptation is currently underway in some countries (for example, Germany already has them, albeit not linked to CAP expenditure), however this is proving to be very difficult, particularly due to the fact that it is almost impossible to separate climatic drivers from other economic drivers or the adaptation impact of a measure from its other impacts (for example in relation to other environmental or economic outcomes) and therefore the proportion of expenditure allocated to climate change adaptation activities. This latter issue also presents problems for assessing the climate dimension of the earmarking of 25% of the budget for environmental and climate purposes as well as the contribution of the CAP to the 20% target of overall EU expenditure for climate actions proposed under the MFF. In addition, other indicators for soil, water and forestry are also relevant for evaluating adaptation in CAP.

Urgent discussion is needed on how it may or may not be possible to assess the climate adaptation impacts of RDPs. The Evaluation Network for Rural Development play an important role in

facilitating evaluation activities and exchange of experience[111]. This is an important resource and **increased focus is needed on facilitating work to develop indicators for measuring the success of programme measures in relation to adaptation.**

Evaluation Requirements: The evaluation requirements for the 2014-2020 programming period consist of the need for all Member States to carry out an *ex ante* and an *ex post* evaluation of their RDPs[112]. There is no information currently on the details of what these will need to contain as this will be set out in the relevant implementing acts. **These should include the need to assess the degree to which RDPs are climate-proof and the extent to which climate adaptation needs have been addressed in the implementation of RDPs.** The development of suitable indicators (see above) and qualitative methods to assess this will be essential if evaluations are to provide robust information on climate adaptation actions at the national and regional level.

Monitoring Committees/ Coordination Committee: In order to monitor and evaluate the climate proofing of programmes, it is necessary to ensure transparency and flow of information and data on adaptation, which in turn necessitates that adaptation indicators are developed and incorporated, that programme design is improved as well as that capacity building around adaptation issues achieves sufficient priority (see sections above) Therefore, **the mandates of both the Monitoring Committees[113] and the ENRD Coordination Committee[114] should include the responsibility to monitor and evaluate the extent to which programmes are climate proofed.** The ENRD Coordination Committee should additionally facilitate thematic work, workshops, seminars and materials on different aspects of climate adaptation to facilitate the sharing of experience between Member States.

5.2.3 Summary of gaps and opportunities

Table 23 presents in a tabular form a summary assessment of the current CAP provisions relevant for adaptation. This shows that there is considerable room for improvement in terms of climate proofing the proposed CAP regulations and their implementation. **Further work is needed to ensure that climate adaptation needs are taken into account sufficiently and that climate proofing becomes an integral part of the design, implementation and monitoring of all CAP regulations,** but particularly EAFRD and RDPS, where most opportunities are to be found. Some solutions to the gaps identified have been identified in the section above and are summarised in Section 5.4.

[111] This was set up under the current EAFRD Regulation and its continuation is required under the proposals (Article 54).

[112] The current requirement for a mid-term evaluation to be carried out in the middle of the programming period has been removed.

[113] Monitoring Committees (Article 79 – 82) are to be established for each programme, as well as at the national level if deemed useful in countries with multiple regional programmes. Their aim is to monitor the quality of programme implementation by means of indicators, as well as to be consulted on different aspects of programme implementation.

[114] In the current programming period a Coordination Committee for the ENRD was set up, to assist the European Commission in the coordination of the ENRD's activities, the choice of thematic working groups and advises on the working plan. Its continuation is not made explicit in the proposed EAFRD regulation. Instead, the organisational structure and operation of the ENRD is left to the Commission to determine in implementing acts. The extension of its mandate, or at least a group with similar powers, into the next programming period would be important.

Table 23: Summary evaluation of the provisions for adaptation within the proposed CAP Regulations

Measures and Procedural/Implementing Provisions	Evaluation[115]
Availability of measures within Pillar 1 and Pillar 2	+
Introduction of the CSF and development of Partnership Contracts	+/-
Process for the development of RDPs and the requirements for their content	+/-
Ex ante conditionalities for RDPs	+/-
Move from Axes to six Union Priorities	+/-
The requirement for all EAFRD priorities to address climate change adaptation (and mitigation) needs	+
The requirements on Member States to use 25% of EAFRD funds for environmental and climate related purposes	+/-
The introduction of performance reviews and the use of the performance reserve	-
The European Innovation Partnership on 'Agricultural Productivity and Sustainability' - Art 53 and Art 61 – 63	+/-
European Network for Rural Development and National Rural Networks	+/-
Safeguards and avoidance of maladaptation	-
Conditions for receipt of payments – the reference level	+/-
Indicators	-
Programme Approval	+/-
Programme Evaluation	+/-
Coordination Committee / Monitoring Committee	+/-

5.3 Common barriers and issues affecting the successful integration of climate adaptation needs within the CAP

The implementation behaviour of EU Member States (and ultimately uptake by beneficiaries) is critically important for determining the extent to which climate adaptation can be integrated within the practical implementation of the different elements of the CAP. A range of issues can impact upon a Member State or region's ability to climate proof CAP expenditure fully and effectively. Those that are most commonly experienced are set out below, based on a series of interviews with government officials, stakeholders and climate experts in a range of Member States[116] as well as a review of the literature. However, these barriers can be overcome in a variety of ways, through more creative thinking, adjustments to management structures and/or shifts in resources and institutions (Moser and Ekstrom 2010, Jones 2010). In some Member States, solutions have already been found to some of the barriers identified, and where this is the case these are highlighted in the text.

[115] + - provisions are sufficient, +/- some gaps exist, - provision(s) needs significant improvement

[116] Stakeholder interviews were carried out in nine Member States (Austria, , Czech Republic, France, Hungary, Germany, Lithuania, Slovenia, Spain, and UK) to ensure a good coverage geographically in the EU-27 to present different situations in relation to climate impacts, vulnerabilities and needs as well as different governance structures and issues. In addition, a series of questions were distributed to members of the expert group on agriculture, to experts for rural development, national authorities, to officials from the permanent representations and to external experts (such as research institutes and NGOs).

The main barriers identified that hinder the integration of climate adaptation priorities within the CAP include the following:

- Political (political commitment, priority for action, lobbying power of political interest groups)
- Institutional (institutional capacities, knowledge, expertise)
- Financial (financial resources, allocation of funds)
- Integrated Planning and Delivery (coordination between government departments, policy/strategic frameworks, preparatory work)
- Information/data availability (availability of data, risk assessments, maps of vulnerability)
- Knowledge transfer/exchange

These are considered in turn below.

5.3.1 Political barriers

The lack of political commitment to addressing climate adaptation as a key issue was highlighted in a number of Member States, particularly where National Adaptation Strategies have not yet been produced, are still in production or where they were not felt to be resourced sufficiently. However even in countries where climate adaptation features more clearly on the political agenda, some political resistance remains to considering climate adaptation needs when prioritising expenditure, particularly within rural development policy.

In many countries, climate mitigation is seen as a more pressing issue that requires immediate action, with the need to climate proof expenditure or for actions directly focused on climate adaptation not seen as requiring immediate attention. This is not a situation that is unique to the CAP (Moser 2009, Nilsson & Swartling 2009, Preston at al 2010).

Although land managers will take some actions autonomously, in some areas, policy intervention is needed. Where this concerns, for example, expenditure on afforestation, infrastructure to increase the efficiency of water use or actions to improve the resilience of biodiversity, long term thinking is needed. In relation to forestry it is critical that new planting and changes in management anticipate the impacts of future climatic changes now given long management cycles for trees. Equally, building resilience to habitats for biodiversity, especially where this involves habitat restoration, requires long term planning given the time taken for habitats to establish. Reluctance to plan for the longer term has been exacerbated by the current economic crisis, with the tendency to focus on short term needs than on long-term transitions (Berrang-Ford et al. 2011, Burch 2010).

The lack of political commitment is closely connected to two other barriers: lack of awareness of the importance of climate change adaptation and the fact that adaptation impacts and the priorities to address these are often uncertain and disputed (Clar et al 2012). Politicians are reluctant to fund costly actions that are guided by uncertain projections particularly when there is competition for funds. To resolve this, it will be important to ensure that climate adaptation becomes more mainstreamed as an issue throughout government. **The importance of climate proofing all policies (EU, national, regional, and local), including the CAP, needs to be clearly articulated in all Member States and governments urged to elaborate a business case for adaptation in the relevant sectors that is clearly and widely communicated.** In the case of the CAP, this will require the interaction of policy officials and Ministers from a number of different government departments (see below) and a recognition of and commitment to the importance of taking action made at the highest level. There

is also a need to increase public awareness of the importance of climate adaptation, including those involved in the agriculture and forestry sectors, to help raise the issue up the political agenda.

5.3.2 Institutional barriers

Adaptation is a relatively new and complex policy field that cuts across a range of sectoral competencies and levels of government (for example agriculture, forestry, landscape planning, housing, tourism and water management (FAO 2007; Yohe et al 2007; OECD 2008; European Commission 2007; Burton et al 2006). As a result, the responsibilities for taking forward the adaptation agenda are not always adequate or sufficiently clear. The outcome of this is that adaptation issues often lack a champion to raise them onto the political agenda and as a result climate adaptation does not feature strongly as an issue to be integrated within individual policies (Amundsen et al 2010; Moser 2009).

Lack of coordination, cooperation and even conflict between different government departments is a common issue that hampers climate adaption needs being addressed. A number of interviewees cited inefficient coordination between the needs of different sectors addressed by the CAP, both within the Ministry of Agriculture as well as with other Ministries, as a significant barrier to the integration of climate adaption measures in the CAP in some countries. Rigid administrative structures and the strength of sectoral interests hinder the exchange of experience across various levels of government lead to a lack of coordinated action (Beck et al. 2009; Nilsson and Swartling 2009; Clar et al 2012). In one example, despite efforts to get ministries to work together when developing the national adaptation strategy by setting up operational groups for each sector, still different ministries issued separate adaptation strategies with conflicting messages.

There are numerous ways in which these issues can be overcome, many of which are identified in the literature. These include, for example ensuring that one person or team is given overall responsibility for leading the adaptation process, developing a common knowledge base, putting in place an information network for targeted communication (for example newsletters, platforms or workshops), and using existing cross sector cooperation on other issues as a conduit for addressing climate adaptation (expert interviews; Snover et al. 2007, ICLEI Oceania 2008, Bizikova et al. 2008, Mullan et al. 2008, Ribieiro et al. 2009, Brown et al. 2011). Many of these solutions are already being adopted in some Member States where national adaptation strategies have been produced and where relevant sectoral strategies are being reviewed to determine where there are needs that require support through the CAP. However, much remains to be done to achieve a truly joined up approach.

A **lack of adequate numbers of staff as well as the availability of suitably trained personnel** with sufficient qualifications, knowledge and expertise is seen as a major factor hindering the successful integration of adaptation needs within the CAP (expert interviews; Burch, 2010; Jones, 2010; Moser and Ekstrom 2010). However, the process of developing national adaptation strategies appears to be helping to address this to some degree.

A number of interviewees stressed t**he need for new institutional structures** to embed climate proofing into the design, implementation and monitoring and evaluation of the CAP. Indeed, a perceived lack of flexibility to define new procedures, measures and, reporting tools is seen as hindering progress in climate proofing the CAP in some countries. For example, one interviewee suggested that if there were more of a focus on analysing the effects of measures on climate adaptation in reporting requirements and evaluations of the CAP, that this would help ensure climate change adaptation concerns were integrated more systematically within the different elements of the policy. More generally, it was felt that institutional structures needed to evolve to be able to

address the new requirements for addressing climate adaptation within the CAP, for example through the introduction of an advisory board on climate change.

5.3.3 Financial barriers

In the short term, autonomous adaptation is likely to dominate. This can be informed by the outputs of investments in research and development, innovation (e.g. determining which crop varieties, tree species or livestock breeds are best suited to changing climates in different regions) as well as guidance from commercial sources (advice on planting, harvesting etc), funded both through public and private sources. These sorts of activities, funded from outside the CAP are seen as important as the use of funding through the CAP.

Nonetheless, a broad range of actions are necessary, even in the short term to build resilience against likely climatic changes (on soil, water, ecosystem services). Financial rewards are necessary to encouarge farmers to engage in more sustainable production methods and to fund investments in infrastructure, for example to promote energy or water efficiency, which they might not otherwise be able to afford or see as a short-term priority. **It is also essential that all CAP expenditure is climate proofed against future climate impacts to avoid the inefficient use of public money.** However, ensuring the prioritisation of limited funds for climate adaptation is hampered by the uncertainties of predicted impacts. **Demonstrating that actions for climate adaptation also deliver multiple social, economic and environmental benefits is critical to ensure sufficient funds are allocated.** Indeed this will become more important in the future. After 2030, estimates of climate change are more dramatic and more strategic planning will be needed, and with it the funding needed is likely to increase substantially.

In addition to the financial resources available within the CAP budget, it is also important that the national/regional institutions responsible for climate change are adequately resourced so that they have sufficient staff employed to ensure that CAP expenditure is climate-proofed and that the activities funded are appropriately designed and located to be of most benefit.

5.3.4 Integrated planning and delivery

Long-term planning, integrating the needs of multiple sectors has been highlighted by a number of interviewees as essential if rural land use is to become more resilient to climate change over time and in a sustainable way, addressing economic, environmental and social needs. A holistic and balanced approached is needed.

Indeed where climate adaptation measures are planned and carried out by individual sectors rather than in an integrated manner, as highlighted above, there is a real risk that this may lead to maladaptation, especially between forestry, agriculture, and biodiversity. Developing a common knowledge base and improving communication between government departments and other stakeholders, including cross sector cooperation can help to ensure adaptation achieves more prominent consideration in policy making (ICLEI Oceania 2008, Mullan et al 2008, Brown et al 2011).
The timescales associated with the impacts of climate change create a significant barrier to climate-proofing policies. This is particularly true of the CAP, given that the majority of funding is focused on the agricultural sector, with a significant emphasis on land management activities which can be altered year on year. The uncertainty of projections of impacts, the lack of a sense of imminent problems (with the exception perhaps of water scarcity) and the fact that land managers are used to dealing with climate variability in their decision making, makes it even more difficult to communicate the need to plan strategically now for the future, particularly when in a situation of limited resources. One interviewee suggested that some countries are not being sufficiently strategic in their prioritization of climate adaptation actions as the scale of long term change is viewed as too challenging and therefore often overlooked. Particularly for biodiversity, there are concerns that the

current conservation framework does not adequately address the future implications of climate change, with objectives framed by the past condition of habitats and the need to improve habitat resilience rather than taking a much longer perspective (say 100 years) to habitat needs, as has been undertaken in some Member States, such as some Scandinavian countries.

5.3.5 Information availability

One of the core issues for policy makers in climate proofing the CAP in relation to their regional situation, is the availability of solid data and information on the likely impacts and damage costs associated with climate change on the sectors concerned. As demonstrated in Chapter 2, **there is a paucity of data on damage costs in relation to the agriculture and forestry sectors and attempts to assess damage costs for biodiversity and ecosystem services is particularly problematic**.

Indeed, the lack of basic information is a significant barrier to taking forward climate adaptation actions via the CAP in some areas. Where National Adaptation Strategies are not yet fully developed, this is a particular issue as there is a lack of technical information on the types of actions needed to facilitate improvements in the resilience of agriculture, forestry and biodiversity to climate change.
A number of types of information were flagged by interviewees as needing improvement. These included:

- information systems for monitoring of soil fertility,
- surveillance systems for detecting and monitoring forest pest and pathogen outbreaks (for forestry and agriculture);
- monitoring and alert systems for heat stress in livestock;
- design of a pilot network of areas for testing adaptation measures (eco-remediation areas) which can include a whole range of land management practices.
- better co-operation in the provision of data and in sharing monitoring techniques within the EU, particularly through National Forest Inventories.

The need for information on the economic costs of climate change and the cost effectiveness of different climate adaptation actions for agriculture and forestry was also felt to be critically important to underpin policy decisions on which sorts of measures to support. However, these sorts of data are often unavailable. Some initial calculations for a range of CAP relevant options have been undertaken for the purposes of this study see chapter 3.2, but more work is needed and methods developed that can be applied at the regional or local level.

The uncertainties regarding climate change adaptation are often due to scientific or methodological problems in predicting future developments and impacts and in assessing the consequences of adaptation options. **There is a need to improved applied research to ensure that scientific results can be understood, interpreted and applied to policy, in particular at the local level** (Polakova et al, forthcoming; Clar et al 2012, Aaheim and Aasen, Biesbroek et al 2010, Moser 2009). However, there is also a need to recognise that evidence will never be perfect. While this may lead to conservation estimates of the impacts of climate change being made, it should not prevent action being prioritised. Action should be based on the best scientific evidence available, even if this is viewed as 'high-risk' to implement as the risk of doing nothing may be greater.

There is a potential role for the Commission in providing such information and this could be achieved via a number of routes, for example under the Horizon2020 research framework, using the EIPs on agriculture and water as well as the use of the LIFE+ programme for testing and piloting new approaches (see **Error! Reference source not found.**).

Box 1: Developing the knowledge base - examples of relevant LIFE+ projects

The Vaccia Project – Finland (2009-2011)

The key aims of the VACCIA project were to:

- Derive realistic environmental change scenarios.
- Demonstrate and develop the use of remote sensing information (GMES) for the assessment of ecosystem services and their changes.
- Develop modelling, geographic information system (GIS), and database tools for ecosystem change assessments.
- Assess how anticipated climate change would change the production of ecosystem services, and identify critical change thresholds.
- Identify options for adaptation to the changing conditions.
- Disseminate information to authorities, decision-makers, and citizens.
- Support local and regional planning and decision-making.
- Provide information for development of national and EU climate change adaptation strategies.

The scenario developed for agriculture was as follows: A warming and lengthening growing season facilitates higher yields than before and the introduction of a broader range of crops. However, these changes require the breeding of crops and development of farming methods. By means of plant breeding, efforts can be made to improve, for instance, plants' intake of water and nutrients. Climate change will not only bring positive developments to Finnish agriculture. The occurrence of extreme weather events threatening crops, such as heavy rains, long rainy periods, floods, storms, and periods of drought, is expected to increase. Rainy winters with little snow and heavy rains may weaken land capability and increase erosion. In addition, pests adapted to a warm climate may become a problem for Finnish agriculture. Global climate change may reduce yields in agricultural production areas outside Finland, which could enhance the importance of agriculture practiced in the north as a guarantor of food supply.

Adaptation options developed: In the future, agriculture must increasingly manage its own climate and environmental impacts. Water protection must be intensified by aiming for a closed nutrient cycle, which would reduce the load on water bodies. Increasing precipitation, on the other hand, requires good maintenance of ditch networks. Land capability can be managed by rotating a larger variety of crops; simultaneously, this would improve tolerance of plant diseases. Climate change necessitates effective water protection, plant conservation and water management methods suited to local conditions. In agriculture, breeding of crops and increased variety of production are excellent means of adaptation.

Source: http://www.ymparisto.fi/download.asp?contentid=114258&lan=en

Climforisk – Finland (2011 – ongoing)

This project aims to improve knowledge of how forest growth could change in future by compiling existing data and models. Information compiled by the project will establish a better basis for regional forest management planning in the context of climate change.

Planned outputs include:

- A map of changes in future forest growth and carbon mitigation potential;
- A map of changes in the susceptibility of forests to drought and selected biotic disturbance (pests/pathogens);
- A map of LAI and biomass distribution in Finland; and
- An Internet-based GIS-application for stakeholders and the general public, which disseminates the most important results of the project.

The results of the project will enable regional forest management to adapt to climate change and help forest decision-makers and managers in their work

Source: LIFE+ database

The lack of experience with monitoring and evaluation practices in the context of adaptation also contributes to the lack of visibility of the issue within the CAP. While indicators and evaluation

processes have been established for climate change mitigation, many questions still surround the best ways of assessing climate impacts and responses in the agriculture and forestry sectors and on the ecosystem services associated with these land uses. In addition, there are particular issues with determining the impact on improving climate resilience of individual CAP measures, when these are inherently multi-objective in nature added to the fact that it is difficult to disentangle the impacts of different economic drivers. This is an issue not just experienced in relation to climate adaptation, but also other environmental and economic measures. Often, suitable indicator-sets are missing and as a consequence there is no clear understanding of what should be monitored or how to share and accumulate the data (Perez and Yohe, 2005). Nonetheless, despite these problems, work is underway in many Member States to develop adaptation indicators for the land based sectors, albeit not yet related to establishing the effects of CAP expenditure. Examples of the indicators developed to date for Germany are set out in **Error! Reference source not found.**.

Box 2: Development of climate adaptation indicators in Germany

A first proposal for possible **indicators** that could be used to measure progress of the German Adaptation Strategy has been developed[117]. For agriculture seven impact indicators and 11 response indicators have been identified. The indicator selection is now subject to a consultation process and is expected to be concluded by the middle of 2013.

The **impact indicators** for agriculture include: 1) Shifting of agri-phenological phases, 2) Changes in crop yields, 3) Hail damage in agriculture, 4) Wine quality, 5) Number of warnings issued for damage occurrence risk, 6) Number of reports on damage occurrences, 7) Livestock mortality.

The **response indicators** include: 1) Farm advisory services, 2) Farm advisory actions for plant protection, 3) Production and coverage with thermophilic crop varieties, 4) Development of crop types with different varieties, 5) Corn varieties with different maturity timing, 6) Production of thermophilic red wine grape varieties, 7) Adjustment of cultivation timing, 8) Domestic sales of plant protection substances, 9) Intensity of application of plant protection substances, 10) Coverage of agricultural irrigation, 11) Trends in wheat prices.

In addition to these indicators, which are focused specifically on agricultural production, other environmental indicators for soil and forestry are also relevant in the context of CAP climate proofing.

Potential soil indicators, for example, include impact indicators: 1) water availability in agricultural soils and 2) Soil temperature and response indicators: 1) Soil organic matter build-up in agricultural soils, 2) maintenance of peatland, 3) cultivation of peatlands and 4) grassland area.

For forestry, impact indicators include: 1) species composition in nature reserves, 2) endangered spruce stands, 3) timber growth, 4) Use of damaged timber, 5) forest fire risk and forest fires, 6) composition of forest stands. Proposed response indicators for forestry are: 1) advisory information for adaptation in forestry, 2) coverage of mixed stands, 3) investments in forest restructuring, 4) restructuring of endangered spruce stands, 5) maintenance of forest genetic resources, 6) actions against damages by pests and diseases in forests, 7) maintenance and build up of soil organic matter and water content in forest soils.

5.3.6 Knowledge transfer

The need for interaction and knowledge transfer between research expertise and practical experience is crucial to build a robust evidence base to inform policy and programme development and aid the development of adaption measures. With this in mind, many interviewees felt that agricultural research needed to be strengthened to consider climate adaptation vulnerabilities, needs and responses in a holistic way. **Understanding of climate adaptation issues in relation to the land use sectors needs to be improved significantly in many regions, to ensure that CAP measures used can be regionally tailored to address the issues being faced**. This information exchange and

[117] Schönthaler, K. et al (2001) „Entwicklung eines Indikatorensystems für die Deutsche Anpassungsstrategie an den Klimawandel“. See www.umweltdaten.de/publikationen/fpdf-l/4230.pdf

dissemination needs to flow through to those actors implementing the measures on the ground to ensure that they are as effective as possible.

Inadequate knowledge transfer or dissemination emanating from poor communication between the scientific community and policy makers or those operating in the field can hamper the effective integration of climate concerns into policy. These problems often arise from the very different disciplinary backgrounds and languages in science, policy and practice (Clar et al. 2012, Hinkel 2011). To overcome these issues **greater exchange of information and experience on the impacts of climate change and how to address them is needed between the range of different actors involved in Member States and regions and the European Commission**. The future CAP provides a number of opportunities for achieving this, through use of the ENRD (to capture and collate valuable lessons, strategies and assumptions and make them easily accessible to all affected stakeholders), the EIP innovation partnerships (whose specific aim is to bridge the science-policy-practice divide) and the European Evaluation Network (sharing and disseminating information on evaluation methods and indicator development).

Many of the interviewees from a range of countries highlighted **that it would be helpful for the Commission to provide guidance on the types of measures that would increase the resilience of agricultural and forestry land to climate change and ways in which they might be implemented to achieve optimal outcomes.** The study provides a contribution to this in the form of the technical guidance. Others felt that Member States should share risk assessments and good practice experience amongst themselves. Confidence in the results of research and the knowledge being disseminated, however, is paramount. The evidence based must be relevant have legitimacy and be believed by the end user or it risks not being translated into "actionable knowledge" (Meinke et al, 2006a and b). The new EU Platform on Climate-ADAPT can play an important role in providing a portal for non-CAP specific information relating to climate adaptation and could provide links to those sites providing CAP specific tools. The LIFE+ programme can also play a role by exploring new ways of disseminating information and best practice in relation to climate adaptation as seen in **Error! Reference source not found.**.

Specifically in relation to knowledge transfer to land managers, Interviewees in a number of countries highlighted the current trend among farmers to act after climate change has impacted to cover losses rather that to prepare for the future by adapting in advance. This needs to be addressed and **the importance of knowledge transfer and capacity building for farmers was highlighted by most Member States**. In addition, the lack of coherency for farmers in terms of what they are being asked to deliver was mentioned - they are being asked to meet multiple objectives through multiple measures and it was felt that **there needs to be better integration between policy initiatives to ensure joined up messages are being communicated to land managers.** Local delivery and advisory systems and extension services were highlighted as one way of helping with this. In addition, care needs to be taken to avoid using policy measures in a way that may perpetuate short term thinking amongst land managers and disincentivise longer term thinking about adaptation strategies and options.

Box 3: Knowledge Transfer on climate adaptation – some examples funded by LIFE+

Changing the Change - Spain (2009-2010)

Surveys had shown a lack of awareness and understanding of climate change amongst many farmers in Galicia, Spain. The LIFE+ project therefore organised workshops for farmers (1300 farmers in attendance); school activities to raise awareness among rural youth (targeting +500 children directly); setting up stalls at two big fairs in Galicia (+130,000 people in attendance); environmental advisors in all 37 agrarian offices (these advisors were trained and kept up to date).

About 7000 requests for information was recorded were recorded during the project and approximately 2000 land managers from the four most important land based subsectors (livestock, horticulture, vineyards, forestry took part in a survey every 6 months.
Communication activities included the production of 'Ecoguides', brochures, posters, stickers, conference materials and educational materials for schools. The project received wide coverage in regional and local media.

From this, an adaptation strategy for agriculture and forestry (specific to the key subsectors identified in the region was developed (**UPA (2010) Estrategias para la adaptación del Cambio Climático en el sector agroforestal** - http://www.unionsagrarias.org/lifecambiarocambio/docs/Estrategias_para_adaptacion_cambio_climatico_sector_agroforestal.pdf
Results of the project:

- Increase in the use of biofuels; Increase in the surface of solar panels installed; Decrease in the consumption of water; Increase of agricultural area dedicated to agrofuels crops; Decrease in the use of nitrogen fertilisers/Increase in the use of organic fertilisers; Increase of carbon content of soils; Increase in afforestation.
- The project team contacted main farmers unions in Spain (in all regions) and in other European countries (Portugal, Italy and Poland) to disseminate results. Exchange of information has proved fruitful and several regions in Spain are now willing to replicate the experience in their regions (mainly the Canary Islands, Valencia and Balearic Islands).
- Relationships formed among technicians are long standing and will be a good technical asset in the future.

AdaptFor – Greece (2010 – ongoing)
The aims of this project involve:

- Assessment of the effects of climate change on selected forest ecosystems in Greece;
- Incorporation in selected forest management plans of climate change considerations;
- Creation of guidelines on the adaptation of forest management to climate change in Greece;
- Wide dissemination of information on the need to adapt forest management to climate change, and methodologies for achieving this; and
- Training of forest service personnel to incorporate climate change considerations into their forest management practices.

No results are available as yet
Source: LIFE+ database

5.4 Solutions and policy recommendations

Building on the analysis in the preceding sections, this section sets out policy recommendations on how to improve the integration of climate adaptation needs within the CAP to ensure that all CAP expenditure is effectively climate proofed and so that it delivers improved outcomes for climate change resilience. These recommendations provide a key input into the Technical Guidance for Climate Proofing the CAP as well as the Capacity Building Strategy and its associated materials that have been produced as part of this study.

The ex ante appraisal of the CAP legislative proposals with respect to the CAP have shown that considerable progress has been made in incorporating climate adaptation as an objective within the CAP. There are a number of important requirements that have been introduced that should help increase the visibility of climate adaptation as an issue to be addressed. These include:

- The inclusion of climate action as part of the three overarching objectives for the CAP
- The inclusion of climate adaptation and risk management as a thematic objective in the Common Strategic Framework
- The introduction of ex ante conditionalities relating to climate adaptation (risk management, water efficiency, energy efficiency)
- The inclusion of climate adaptation as a cross-cutting objective that Member States must demonstrate they are addressing across all measures used within their Rural Development Programmes – also reinforced in the requirements stipulated for programme content;
- The suggested earmarking of 25% of the EAFRD proportion of rural development funding for 'climate change mitigation and adaptation and land management', through three land management measures;
- The requirement for the Farm Advisory System to include advice on climate adaptation and broaden its scope beyond cross-compliance to rural development measures;
- The strengthening of cross compliance GAEC requirements in relation to soils;
- The introduction of green direct payments in Pillar 1, which could contribute to increasing the resilience of agricultural land to climate impacts
- The introduction of the EIP on Agricultural Productivity and Sustainability.

However, there remain a number of areas where improvements to the EU legislative framework could be made (see below). While the measures and legislative framework may be largely sufficient to address climate adaptation needs, the degree to which any investments are climate-proofed in practice or that Member States and regions will choose to use these measures in a way that improves the resilience of agricultural and forestry land and their associated habitats to climate change is far from certain. The assessment of barriers and capacity needs in relation to climate adaptation shows that there is still some way to go to ensure RDPs and the activities they fund are sufficiently climate proofed for the next programming period.

A number of recommendations on how to ensure that future CAP expenditure is climate-proofed for the 2014-2020 period and beyond are set out below. Two aspects are important:

- Additional suggestions for embedding climate adaptation considerations in all aspects of the CAP regulations to provide the hook by which to hold Member States and regions to account.
  Providing Member State authorities, extension services and relevant stakeholders with the tools and skills needed to address climate adaptation within their RDPs and at all stages of the programming cycle – this includes improving the knowledge base; Improving institutional capacity; and improving the dissemination of information to all actors involved – from the European Commission to the beneficiaries of CAP funding.

Embedding climate adaptation further within the CAP regulations: Climate adaptation is already written into certain aspects of the CAP regulations, as highlighted above. However, there are some areas where it does not feature sufficiently strongly and this needs to be rectified. Some areas where further specificity on the need to take climate adaptation into account is needed, either within the overarching regulations or the implementing regulations, include:

- **Programme development and approval** - clear criteria relating to climate proofing should be established by which RDPs are assessed by the Commission prior to approval – this could be provided in the form of a climate proofing checklist to be used as a useful aide memoire for Managing Authorities during programme development and by Commission desk officers when going through the approval process.
- **Requirements for programme content** – alongside the existing requirements, an additional stipulation should be added that RDPs need to demonstrate coherence with national adaptation plans and integration with other adaptation initiatives as well as other relevant plans and strategies
- **Safeguards, eligibility and project selection criteria** – apart from the water reduction requirements for irrigation investments, there are no criteria within the current EAFRD regulation which require the resilience of expenditure to climate impacts to be assessed. This needs to be rectified.
    - A requirement to assess the climate resilience of investments could be added to the current requirement to assess environmental impacts (Article 46).
    - Adaptation and climate proofing safeguards should also be included in the criteria for the selection of projects (Article 49) and rules for area payments (Article 47)
    - The provision of funding for risk management should be conditional on applicants demonstrating that have taken account of the likely impacts of climate change in their future planning of their operations
- **Monitoring and Evaluation procedures**: Although it is clear that the intention is to assess the effects that CAP expenditure is having on improving the resilience of rural areas to climate change, how this is to be achieved in practice is not yet clear. With this in mind:
    - The need to assess the degree to which RDPs are climate-proof and the extent to which climate adaptation needs have been addressed in practice should be stipulated in the requirements for the content of the *ex ante* and *ex post* evaluations
    - The mandates of both the Monitoring Committee and the ENRD Coordination Committee should include the responsibility to consider the extent to which the CAP and RDPs specifically are climate proofed in practice
    - Efforts to develop indicators for measuring the success of programme measures in relation to climate adaptation need to be reinforced and be a focus of attention of the ongoing discussions that the European Evaluation Expert Network are having with Member States
- **Networking and sharing good practice** – given that climate adaptation is an emerging area of focus for the CAP, additional efforts need to be made to ensure that existing networks, such as the ENRD, include climate proofing in their work programme, so that it is incorporated into thematic activities, and features as a focus of workshops, seminars and associated materials. Climate adaptation should also form a central plank of the implementation plan for the proposed agricultural EIP.
- **Performance Reserve:** reconsider the operation of the performance reserve to avoid constraining innovative approaches and consider ways of building in a failure tolerance so that innovative approaches can flourish

Providing the necessary tools and skills for effective climate-proofing: No matter how embedded climate adaptation is within the legislative framework, for climate adaptation to be addressed in practice requires the necessary capacity and technical knowledge at all levels from Commission officials to Managing Authorities, stakeholders and the recipients of funding themselves. Climate adaptation is a relatively new area of focus for many of those involved in the development of RDPs and their subsequent implementation. Understandably, therefore, significant gaps in the knowledge base, institutional capacity and the dissemination of information still remain. The following recommendations point to some of the solutions needed and the information within the Technical Guidance and Capacity Building Strategy provide one means of facilitating this process.

Improving the knowledge base: Our assessment has shown that significant efforts are needed to improve the evidence base that is urgently needed to inform the climate proofing process and aid the development of adaption measures in relation to the CAP. In particular, robust data and information on the likely impacts and damage costs associated with climate change on the sectors concerned are needed as well as information on the cost effectiveness of different climate adaptation actions for agriculture and forestry to underpin policy decisions on which sorts of measures to prioritise through the CAP.

There is a potential role for the Commission, in collaboration with Member States and research institutes, in providing such information and this could be achieved via a number of routes, for example under the Horizon2020 research framework, using the EIPs on agriculture and water as well as the use of the LIFE+ programme for testing and piloting new approaches.

There is also an urgent need for work to develop indicators to measure a) the proportion of the CAP budget being spent on climate adaptation, particularly to determine how to track spend on climate adaptation when measures used are multi-objective; and b) to measure the impact/success of actions supported through the CAP, for example to determine the extent to which the measures implemented contribute to the improved resilience of the agriculture and forestry sectors or biodiversity, for example, to climate change impacts.

Improving Institutional capacity: The development of national adaptation strategies, especially where detailed sectoral strategies have been developed, has increased the capacity of Member States to address climate adaptation issues within the CAP, however this is not yet an issue on which knowledge is widespread amongst government departments and stakeholders. As part of the process of improving the climate proofing of the CAP, it will be essential to stimulate institutional capacity-building amongst the those involved in policy development and delivery, improving their ability to understand how climate adaptation fits within the CAP's goals and how this can be delivering in practice at the local level, particularly in those Member States that do not yet have a high level of adaptive capacity. There are a number of ways in which this can be achieved:

- Requiring the interaction of all government departments who have responsibilities relating to the thematic areas of focus of the CSF funds in the development of Partnership Agreements, not just those departments with a responsibility for implementation. In relation to the EAFRD, this needs to include government departments responsible for the environment and climate alongside agriculture.
- Provide Member States with sufficient time to develop their RDPs etc. to ensure that they are as comprehensive, integrated and robust as possible. This is even more important when new concepts and issues need to be addressed, such as is the case with climate adaptation. Although preparatory work can take place in advance, currently Member States are given only three months to finalise their RDPs and Partnership Agreements from the date of the CSF being published. An ex ante evaluation and public consultations (in some countries)

need to be initiated well before any final agreement on the legislative texts at the EU level to ensure sufficient time for proper consultation between government departments and external stakeholders.

- Developing and promoting the use of tools that facilitate planned adaptation, such as risk assessments, cost effectiveness methodologies, targeting tools for multi-objective measures with guidance about where to find such tools or how to develop them if they are not available.
- Provision of technical training for staff in government departments, Managing Authorities, paying agencies and extension services.

Information dissemination and guidance: Finally, the importance of ensuring that all actors involved in the design, implementation, monitoring and evaluation of CAP expenditure have sufficient guidance and information at their fingertips to enable them to carry out climate-proofing effectively and efficiently cannot be underestimated. Guidance on how to climate proof all aspects of the programming cycle is essential Managing Authorities and staff in other government departments and statutory authorities as well as more practical information available to the recipients of funding explaining the importance of building resilience to climate change and why action needs to start now.

It is also clear that more emphasis needs to be placed on the sharing of experiences and best practice in the period leading to the programme development and subsequently, including through the ENRD. The use of the European Climate-ADAPT Platform will also play an important role. The potential of the agriculture EIP needs to be maximised in relation to climate adaptation as a means of improving technological know-how, and transferring science into practice.

Specific areas where guidance needs have been highlighted, and which are addressed in the Technical Guidance document accompanying this study, include:

- **Partnership Agreements:** Member States will need some support and guidance on how to integrate climate adaptation within their Partnership Agreements to ensure there is a solid foundation for the more focussed development of RDP – the Staff Working Document on the CSF for 2014-2020 provides examples of some of the activities relevant to climate adaptation in relation to the EAFRD, but it would be useful to extend this list to include a more comprehensive list of the different types of options (investments and advice alongside land management options) to encourage creative thinking.
- **RDP design**: Given the low experience with adaptation, sufficient guidance should be provided to Member States on best practice for incorporating adaptation concerns. This should include, guidance on the different ways in which measures can be used to encourage adaptation, including demonstrating the sorts of synergies that are desirable and should be encouraged, particularly those synergies with climate mitigation but also other environmental and economic objectives.
- **Programme Implementation**: guidance and advice on the development and application of project selection criteria and rules for the granting of support for different measures will be helpful to ensure that maladaptation is avoided. Technical guidance and training will also be useful for staff in the farm extension services that are providing advice to land managers to ensure that have the most up to date information on how to improve the resilience of particular holdings or businesses to climate change.
- **Monitoring and evaluation**: guidance is needed on developing indicators or other methods for monitoring and evaluating the achievement of climate adaptation in practice.

6 Capacity needs and guidance

6.1 Background and approach

The previous sections have shown that there is a need to climate proof investment under Cohesion Policy and CAP and that the Commission's respective proposals for the 2014-2020 programming period provide an opportunity to do this. One of the key challenges will be to ensure that these opportunities are taken up in practice. In this respect, climate-proofing expenditure under Cohesion Policy and CAP requires an ongoing, well-targeted and systematic improvement of the capacities of relevant public authorities and related key target groups to tackle the issue at all stages of the programming and project cycle. It is the core responsibility of Member States to provide for the needed capacities to conform to the needs of implementing EU legislation. EU level funding can provide, however, an important support function, particularly in Member States with weaker administrative capacities. Strengthening capacities, both in terms of resources and thematic guidance, will have important added value for effectively achieving the goals of EU Cohesion Policy.

As part of this study we have developed a capacity building strategy and technical guidance for Cohesion Policy and CAP as well as capacity building material to support the strategy. This involved a stakeholder consultation that included a series of telephone and face-to-face interviews on capacity needs and structural barriers for adaptation mainstreaming and climate proofing, a stakeholder workshop, and a web survey. Experts consulted were mainly those from environmental/climate authorities with knowledge about Cohesion Policy and CAP programmes. A number of capacity building needs were identified as part of this assessment.

However, before these guidance documents could be developed, it was necessary to undertake an assessment of capacity needs for both Cohesion Policy and CAP. In other words, it was important to assess the existing capacity shortcomings across the EU Member States are assessed according to strategic themes in order to identify the needs for capacity building. In addition to the stakeholder consultation noted above, an overview of existing EU and national level capacity building materials was undertaken in order to ensure that the guidance documents developed contained useful and innovative tools and activities. The shortcomings and capacity needs assessments, as well as conclusions with respect to Cohesion Policy are presented in Section 6.2, while the same information for CAP is presented in Section 6.3.

6.2 Cohesion Policy: Capacity needs assessment and conclusions

6.2.1 Shortcomings and capacity needs for Cohesion Policy

Capacity needs will vary considerably across the Member States, and the overall relevance of climate change impacts will be higher in those Eastern and Southern states where Cohesion Policy expenditure is highest and a large percentage of it is dedicated to higher-risk infrastructural sectors (e.g. energy, environment, social infrastructure and transport). These states are also typically the ones with lower institutional capacity for adaptation in general.

A clear understanding **that climate change adaptation is an important issue for all areas of Cohesion Policy spending**, not just environment or direct funding for risk prevention/management, is urgently required. This is especially important for sectoral authorities but in many cases even climate change authorities/experts need these concepts to be clearly emphasised. In some cases this is not about awareness or understanding but about legitimacy.

Related to this, authorities also require greater understanding of the methods and tools at their disposal for mainstreaming climate change adaptation into overall economic development and

spatial plans. If the **relevant legal frameworks for climate change adaptation** in a Member State are unclear or under-developed, it is more difficult to integrate these issues into Operational Programmes and Partnership Agreements and programme implementation arrangements.

Overall, authorities and project beneficiaries need **greater awareness about the impacts of climate change on programmes and projects,** in a format that is accessible and digestible for them. Ways in which resulting specific adaptation options can be integrated into programmes and eligible funding expenditure are also needed. In addition, authorities need more information on how they can **integrate climate change issues across the programme and project cycles**, starting with programming documents through to project implementation and monitoring.

These issues are all inter-related and many can be addressed simultaneously through different capacity building measures, including written guidance, workshop-style training, mentoring programmes and others. In some cases, advice and guidance on administrative reforms that would enable new staff, or creating dedicated units or other initiatives, to focus on and support project preparation, implementation and monitoring will be required. The following section proposed some detailed capacity building measures and discusses how these measures might be implemented.

6.2.2 Conclusions for Cohesion Policy

The Cohesion Policy programme cycle is a useful framework for organising capacity building measures in terms of content and timing. The typical programme cycle shown in Figure 6 gives the main stages that a programme goes through and highlights aspects of that stage which will require increased capacity of public authorities and other stakeholders to enable the better inclusion of climate change adaptation. The use of the cycle also serves as a reminder that capacity building must target the full cycle to have the desired impact. The programming stage has already begun, and will finish shortly after the relevant legislative proposals are adopted; programme implementation will start as of 1 January 2014.

Figure 6 Programme cycle and opportunities for capacity building

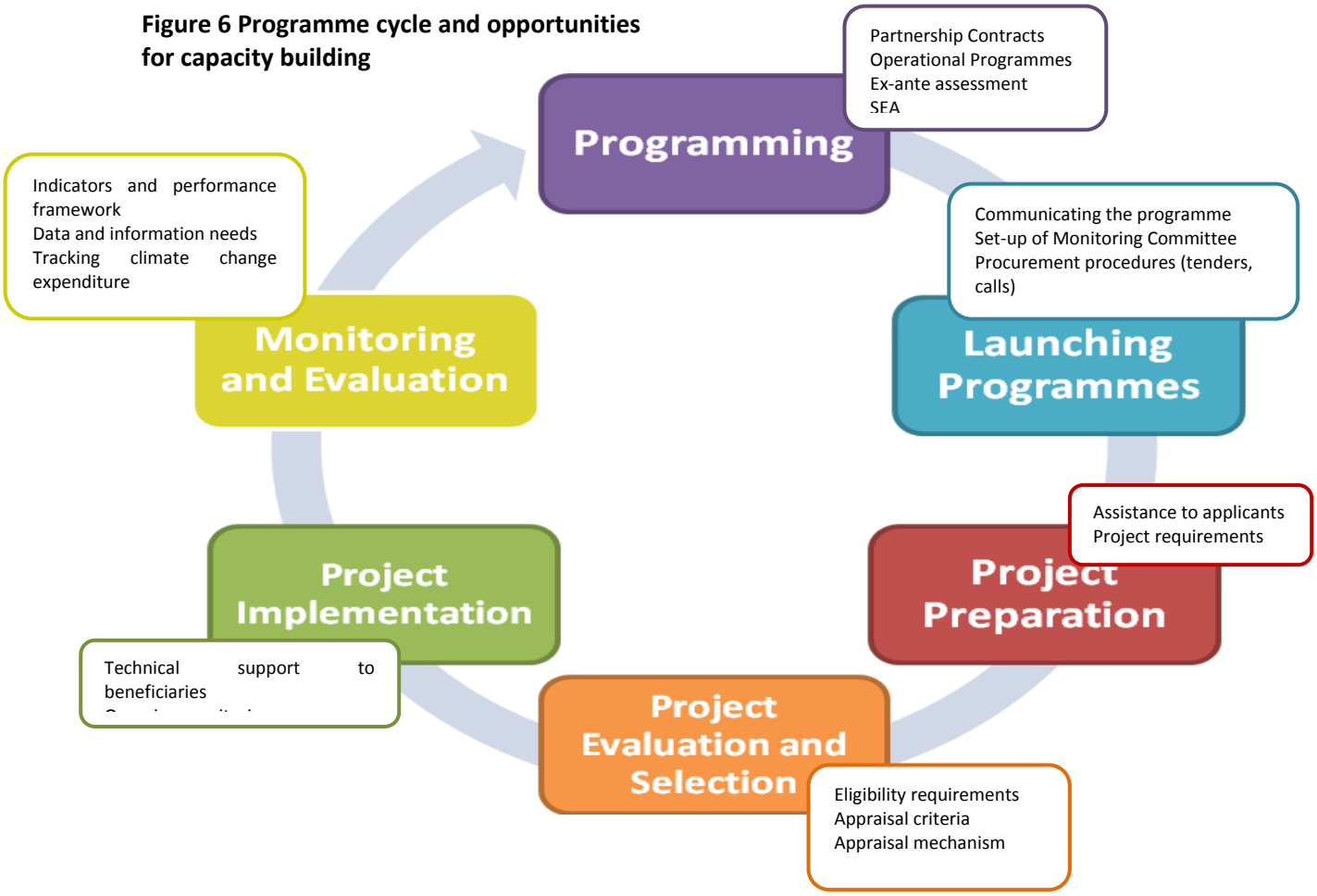

Table 24 and Table 25 provide a summary of the capacity building measures identified, which are presented in more detail in the guidance document. The measures should be seen as a menu of options that, taken together, may provide a comprehensive approach to capacity building for climate proofing Cohesion Policy, but may also be implemented piecemeal subject to the actual needs of the Member State. Some of the measures can be addressed through the capacity building training programme provided to complement this strategy. These measures are highlighted in a darker shade.

Table 24 Written Guidance Materials for capacity building under Cohesion Policy

Capacity measure	Organisers/developers	Target group(s)	Programme cycle stage and timing
Guidance on climate proofing Cohesion Policy, including sectoral information	Drafted within current project. May be issued by DG CLIMA/DG REGIO and other relevant Commission services as EC Guidance.	Adaptation experts within climate change authorities Other adaptation experts Managing Authorities	Could be used across the project cycle. Can serve as a master guidance and be the basis of other specialised national guidance materials. To be issued as early as possible so that MS can use it during programming.
Detailed sectoral guidance	Member States, possibly on the basis of EC basic guidance and the Climate-Adapt platform	Managing Authorities and project developers	Prior to tendering and project development. To be at the disposal of project developers during project design and implementation.

Capacity measure	Organisers/developers	Target group(s)	Programme cycle stage and timing
Project type-specific guidance	May be issued by the European Commission, or Member States	Managing Authorities and project developers	Launching programmes and project preparation
Information on cost-benefit ratios of different measures	Some available within the current project. EU or MS level research projects.	All; emphasis	Programming and project preparation
Guidance on integrating adaptation into support tools (EIA,SEA, CBA)	Commission to issue May be tailored by Member States	Managing Authorities and project developers	Programming and project preparation
Information on monitoring indicators	Most likely Member States, tailored to specific situation	Managing Authorities	Necessary at programming stage but may possibly be integrated later for monitoring

Table 25: Training for capacity building under Cohesion Policy

Capacity measure	Organisers/developers	Target group(s)	Programme cycle stage and timing
'Train-the-trainer' sessions	Climate change authorities/adaptation experts in Member States (with possible support from DG CLIMA)	Ministries in charge of climate change adaptation Networks of environmental authorities Adaptation experts from NGOs or other bodies	Programming stage, as early as possible
'Roll-out' training (by trainers) on climate proofing the programme cycle	Adaptation experts trained in previous measure	Managing Authorities, implementing bodies, and others responsible for programmes	Programming stage, as early as possible
Training on support to project developers	Adaptation experts trained in first measure	Managing Authorities	
Sector-specific training	Adaptation experts trained in first measure. May require support from specialised	Sectoral Managing Authorities responsible for high-risk sectors (e.g. energy, environment, transport, social infrastructure)	Programming stage, as early as possible. Can be repeated annually and/or linked to major tendering deadlines

Capacity measure	Organisers/developers	Target group(s)	Programme cycle stage and timing
	sectoral experts		
Training/awareness sessions for project appraisal panels, monitoring committees and evaluation experts	Adaptation experts or Managing Authorities	Appraisal panels, monitoring committees, evaluation experts	Project evaluation and selection Monitoring and reporting Throughout the programme cycle
Other topics and modules	Adaptation experts, or Managing Authorities, support by specialist expertise as required	All stakeholders, as needed	Throughout the programme cycle
Additional activities for trained "trainers"			
Consultative support to Managing Authorities for the development and assessment of programming documents and arrangements			
Consultative support on resources and advisory services for project developers			
Roles on programme monitoring committees and project appraisal and selection panels			
Capacity Building Training Programme delivered separately			
Capacity building programme objectives and overview and delivery details for training sessions			
Power point presentations for 12 training sessions on rationale for capacity building; general concepts; climate proofing the programme cycle; and for seven Cohesion Policy sectors.			
Printable handout documents for reference and exercises for sessions			
Awareness-raising brochure			

6.3 CAP: Capacity needs assessment and conclusions

6.3.1 Shortcomings and capacity needs for CAP

As with Cohesion Policy, capacity needs under CAP will vary considerably across Member States, and the overall relevance of climate change impacts will be higher in Eastern and Southern countries; these Member States are also typically the ones with lower institutional capacity for adaptation in general.

The concept of 'climate proofing' must be clarified and understood. Likewise, it is crucial to clarify **the overall idea that climate change adaptation is an important issue for all areas of CAP spending**. The importance of climate proofing CAP expenditure needs to be extended beyond measures that focus directly on climate adaptation to ensuring that non-climate focused investments and land management activities are resilient to future climatic impacts.

Related to this, authorities also require greater understanding of the methods and tools at their disposal for mainstreaming climate change adaptation into Rural Development Programmes. If the **relevant legal frameworks for climate change adaptation** in a Member State are unclear or under-

developed, it is more difficult to integrate these issues into Rural Development Programmes and Partnership Agreements.

Lack of knowledge and information is the main reason why climate change adaptation is not a priority. **Awareness - especially of politicians and policy makers - on climate change threats**, potential climate change impacts and associated damage costs needs to increase. Clarity and knowledge on costs of adaptation measures and associated benefits from early action needs to be enhanced – as this can be a powerful catalyst for action.

The lack of technical knowledge on the type of specific adaptation measures and their cost/benefit and time horizon characteristics leads to uncertainties in how to integrate adaptation needs into programme design and implementation. To answer this need **continuous capacity building for managing authorities, evaluators and farm advisers on concrete types of measures** is very important.

Innovative tools and procedures for integrating climate change adaptation across the programme need to be collected and made available for all relevant actors in the Member States. The CLIMATE-ADAPT-platform should be used for networking and information exchange but also **existing networks** like the ENRD, the National Rural Networks and emerging networks, such as those to be developed under the new EIP, **can be involved in information and expertise sharing**.

Uncertainty about the way in which measures can be used to address climate adaptation priorities results in a disincentive for farm advisory services as well as for farmers to implement activities that could improve resilience to climate change in practice. Therefore knowledge has to be enhanced on the **link between what is technically possible, recommended and what is fundable under different elements of the CAP and different rural development measures**.

Many of these issues are inter-related and many can be addressed simultaneously through different capacity building measures, including written guidance, workshop-style training, mentoring programmes and others. In some cases, advice and guidance on administrative changes that would enable new staff, or creating dedicated units or other initiatives, to focus on and support project preparation, implementation and monitoring will be required. The following section proposes some detailed capacity building activities that could be carried out and discusses how these measures might be implemented.

6.3.2 Conclusions for CAP

Given the focus on Pillar 2 of the CAP, the rural development policy programme cycle is a useful framework for organising capacity building measures in terms of content and timing. The typical programme cycle shown in Figure 7 gives the main stages that a programme goes through and highlights aspects of that stage which will require increased capacity of public authorities and other stakeholders to enable the better inclusion of climate change adaptation. The use of the cycle also serves as a reminder that capacity building must target the full cycle to have the desired impact. The programming stage has already begun, and will be completed shortly after the relevant legislative proposals are adopted; programme implementation will start from 1 January 2014.

Figure 7: Different stages of the CAP programming cycle and entry points for climate adaptation

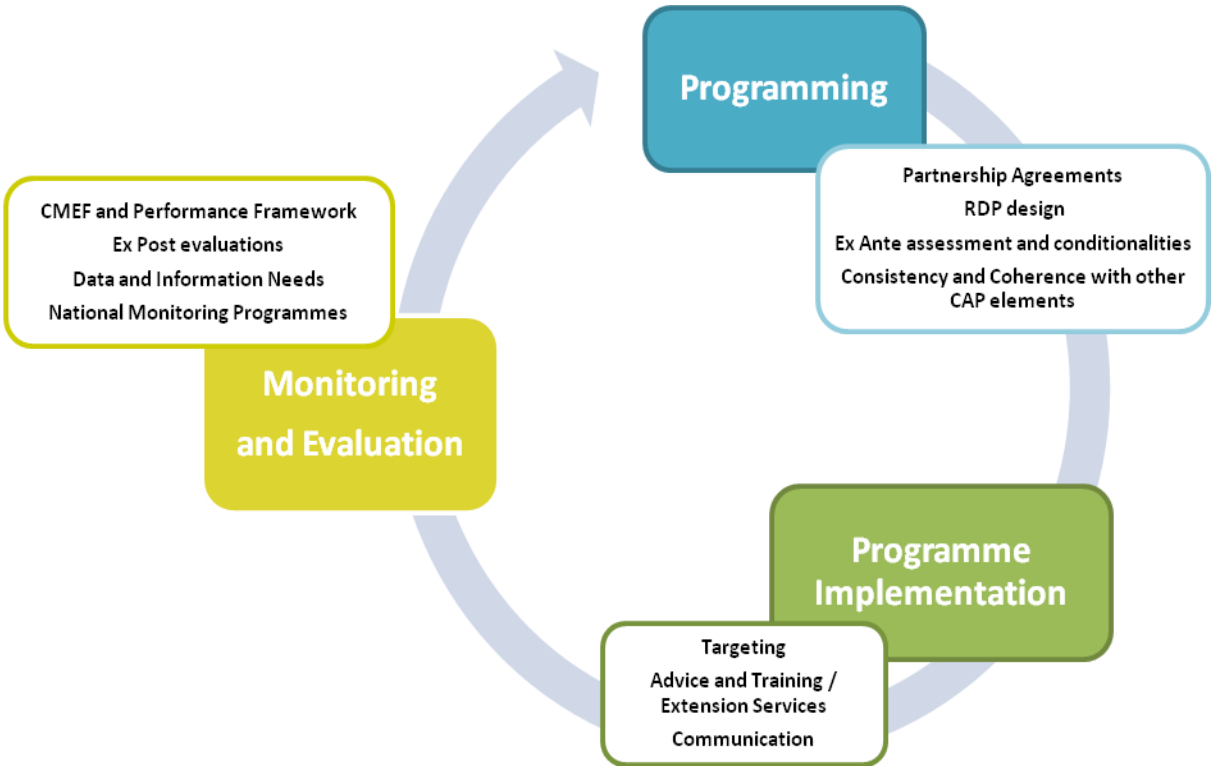

Table 26 and Table 27 provide a summary of the capacity building measures identified, which are presented in more detail in the guidance document. The measures should be seen as a menu of options that, taken together, may provide a comprehensive approach to capacity building for climate proofing rural development policy, but may also be implemented piecemeal subject to the actual needs of the Member State. Some of the measures can be addressed through the capacity building training programme provided to complement this strategy. These measures are highlighted in a darker shade.

Table 26 Written Guidance Materials for capacity building under CAP

Capacity measure	Organisers/developers	Target group(s)	Programme cycle stage and timing
Guidance on mainstreaming climate change adaptation into the CAP	Drafted within current project.	Adaptation experts within climate change authorities Other adaptation experts Managing Authorities	Could be used across the project cycle. Can serve as a master guidance and be the basis of other specialised national guidance materials. To be issued as early as possible so that MS can use it during programming.
Detailed guidance for adaptation in relation to specific issues (biodiversity, afforestation,	Member States, possibly on the basis of EC basic guidance and the Climate-Adapt platform	Managing Authorities and Extension Services	Could be used across the project cycle, important for developing eligibility criteria, implementation as well as evaluation

Capacity measure	Organisers/developers	Target group(s)	Programme cycle stage and timing
increasing water efficiency etc)			
Information on cost-benefit ratios of different measures	Some available within the current project. EU or MS level research projects. Mentioned the methodology already developed	All	To be available for programme design, implementation and later on
Guidance on integrating adaptation into support tools (EIA, SEA, CBA)	Commission to issue. May be tailored by Member States EEA?	Managing Authorities and evaluators undertaking *ex ante* assessments	Programme preparation
Information on monitoring indicators	Most likely Member States, tailored to specific situation	Managing Authorities	Programme monitoring indicators and monitoring methods available before programme design; indicators for meadures—before implementation
Information on good practices in climate change adaptation	Provided by Member States via ENRD Contact Point project database Climate-ADAPT?	All target groups	To be available for programme design
Technical paper on addressing the ex-ante conditionality	European Commission	Programme designers	As soon as possible, before or during the start of preparation for the next CAP period

Table 27 Training for capacity building under CAP

Capacity measure	Organisers/developers	Target group(s)	Programme cycle stage and timing
'Train-the-trainer' sessions	Climate change authorities/adaptation experts in Member States (with possible support from DG CLIMA)	Ministries in charge of climate change adaptation Networks of environmental authorities Adaptation experts from NGOs or other bodies	Programme design, as early as possible
'Roll-out' training (by trainers) on mainstreaming in the programme cycle	Adaptation experts trained in previous measure	Managing Authorities, implementing bodies, and others responsible for programmes	Programming stage, as early as possible
Training sessions for extension services, particularly organisations delivering the Farm Advisory Service	MS climate change authorities, Managing Authorities	Extension Services	Programme implementation
Other topics and modules	Adaptation experts, or Managing Authorities, support by specialist	All stakeholders, as needed	Throughout the programme cycle

Capacity measure	Organisers/developers	Target group(s)	Programme cycle stage and timing
	expertise as required		
Additional activities for trained 'trainers'			
Consultative support to Managing Authorities for the development and assessment of programming documents and arrangements			
Roles on programme monitoring committees			
Capacity Building Training Programme delivered separately			
Capacity building programme objectives and overview and delivery details for training sessions			
Power point presentations for training sessions on rationale for capacity building; general concepts; climate proofing the programme cycle; and adaptation options for RDPs.			
Printable handout documents for reference			
Awareness-raising brochure			

7 References

Adger, W.N., Arnell, N.W. & E. Tompkins (2005), Successfull adaption to climate change across scales. In: Global Environmental Chenge 15(2),77-86

Amelung, B., Nicholls, S., Viner, D. (2007), Implications of global climate change for tourism flows and seasonality. Journal of Travel Research, 45, 285-296

Amelung, B., Viner, D. (2006), The sustainability of tourism in the Mediterranean: Exploring the future with the tourism climatic index. Journal of Sustainable Tourism, 14, 349-366

Amundsen, H., Berglund, F. & H. Westskog (2010): Overcoming Barriers to climate change adaption – a question of multilevel governance? Environment and Planning C: Government and Policy, advance online publication

Baltzar, E., Varbova, V and Zhechkov, R. (2009) Improving the Climate Resilience of Cohesion Policy Funding Programmes: An overview of member states' measures and tools for climate proofing Cohesion Policy funds, ENEA-MA and REC for CEE.

Berrang-Ford, Lea; J. Ford & J. Paterson (2011): Are we adapting to climate change? Global Environmental Change 21 (2011): 25-33

Brander, Luke M. et al. (2011): Using Meta-Analysis and GIS for Value Transfer and Scaling Up: Valuing Climate Change Induced Losses of European Wetlands. Environmental and Resource Economics: Springer-Verlag GmbH

Brown S, Nicholls RJ, Vafeidis A, Hinkel J, and Watkiss P (2011). The Impacts and Economic Costs of Sea-Level Rise on Coastal Zones in the EU and the Costs and Benefits of Adaptation. Summary of Results from the EC RTD ClimateCost Project. In Watkiss, P (Editor), 2011. The ClimateCost Project. Final Report. Volume 1: Europe. Published by the Stockholm Environment Institute, Sweden, 2011

Burch, Sarah (2010): Transforming barriers into enablers of action on climate change: insights from three municipal case studies in British Columbia. Global Environmental Change 20 (2010): 289-297

Burton, I, Diringer, E. & J. Smith (2006): Adaption to Climate Change: International Policy Options, paper, prepared for the Pew Center on Global Climate Change

Burton, Ian; S. Huq; B. Lim; O. Pilifosova & E.L.F. Schipper (2009): From Impacts Assessment to Adaptation Priorities: The Shaping of Adaptation Policy. In: Schipper, E. Lisa F. & I. Burton (Eds.), The Earthscan Reader on Adaptation to Climate Change, Earthscan, London/Sterling, VA: 377-394

Ciscar, J.C., Iglesias, A., Feyen, L., Goodess, C.M., Szabó, L., Christensen, O.B., Nicholls, R., Amelung, B., Watkiss, P., Bosello, F., Dankers, R., Garrote, L., Hunt, A., Horrocks, L., Moneo, M., Moreno, A., Pye, S., Quiroga, S., van Regemorter, D., Richards, J., Roson, R., Soria, A., (2009), Climate change impacts in Europe. Final report of the PESETA research project, European Commission, Joint Research Centre — Institute for Prospective Technological

Studies, Luxembourg: Publications Office of the European Union – Final report of the PESETA research project

Commission of the European Communities (2007): Communication from the Commission - Agenda for a sustainable and competitive European tourism. Brussels, 19.10.2007, COM(2007) 621 final, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52007DC0621:en:HTML

Council of the European Union (2011) Press release – 3138th Council meeting: General Affairs, 18720/11, 16.12.2011, Brussels

Council of the European Union (2011) Cohesion Policy legislative package - Presidency report, 18097/11, 7.12.2011, Brussels

Council of the European Union (2011) Cohesion Policy post-2013: Questions for the orientation debate at the General Affairs Council on 16 December 2011, 18099/11, 7.12.2011, Brussels

Council of the European Union (2011) Summary of the orientation debate on the Cohesion Policy post-2013 at the General Affairs Council on 16 December 2011, 19.12.2011, Brussels

Council of the European Union (2011) Press release – 3138th Council meeting: General Affairs, 18720/11, 16.12.2011, Brussels

Council of the European Union (2012) 3143rd Council meeting, Press Release. 27.1.2012, Brussels

Council of the European Union - General Affairs: Cohesion Policy – Press conference, 16.12.2011, Brussels

Council of the European Union (2011) Cohesion Policy legislative package - Presidency report, 18097/11, 7.12.2011, Brussels

Council of the European Union - General Affairs - 3138th meeting, 16 December 2011, Brussels, live webstreaming

Council of the European Union (2011), Conclusions of the Justice and Home Affairs Council, 11-12 April 2011, Conclusions on the further developing risk assessments for disaster management in the European Union

Court of Auditors (2012) Opinion regarding the Commission the proposal for a Regulation of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund covered by the Common Strategic Framework and laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and repealing Regulation (EC) No 1083/2006. Opinion 7/2011, Official Journal of the European Union, C47/1, 17.2.2012, Brussels.

De Bruin, K., Dellink, R.B., Ruijs, A., Bolwidt, L., van Buuren, A., Graveland, J., de Groot, R.S., Kuikman, P.J.,Reinhard, S., Roetter, R.P., Tassone, V.C., Verhagen, A. & E.C. van Ireland

(2009): Adapting to climatechange in The Netherlands: an inventory of climate adaptation options and ranking of alternatives. In: Climatic Change 95:23-45. Springer

EC (2007): White Paper: Together for Health: A Strategic Approach for the EU 2008-2013. Brussels, 23.10.2007, COM(2007) 630 final, http://ec.europa.eu/health/strategy/policy/index_en.htm

EC (2007): Communication from the Commission - Agenda for a sustainable and competitive European tourism. Brussels, 19.10.2007, COM(2007) 621 final, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52007DC0621:en:HTML

EC (2007): White Paper: Together for Health: A Strategic Approach for the EU 2008-2013. Brussels, 23.10.2007, COM(2007) 630 final, http://ec.europa.eu/health/strategy/policy/index_en.htm

EC (2007): Green Paper from the Commission to the Council, The European Parliament, the European Economic and Social Committee and the Committee of the Regins, Adapting to climate change in Europe – options for EU actions, COM (2007) 0345 final, Brussels

EC, COM (2011) 625/3 – Proposal for a Regulation of the European Parliament and the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy

EC, COM(2011) 628/3 – Proposal for a Regulation of the European Parliament and the Council on the financing, management and monitoring of the common agricultural policy

EC, COM(2011) 627/3 – Proposal for a Regulation of the European Parliament and the Council on support for rural development by the European Agricultural Fund for Rural Development

EC, COM(2011) 615 final – Proposal for a Regulation of the European Parliament and the Council laying down common provisions on the European Regional Development Fund, the European Social Fund, the cohesion Fund, the European Agricultural fund for Rural Development and the European Maritime and Fisheries Fund covered by the Common Strategic Framework and laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion fund and repealing Regulation (EC) No 1083/2006

EC (2011): Our life insurance, our natural capital: an EU biodiversity strategy to 2020. Brussels, 3.5.2011, COM(2011) 244 final

EC (2011): Our life insurance, our natural capital: an EU biodiversity strategy to 2020. Brussels, 3.5.2011, COM(2011) 244 final

EC (2006): Thematic Strategy for Soil Protection - Impact Assessment of the Thematic Strategy on Soil Protection, European Commission Staff Working Document; Document Accompanying the Communication from the Commission to the Council, The European Economic and Social committee and the Committee of the Regions Impact Assessment of the Thematic Strategy on Soil Protection

EC, DG Regional Policy (2009) Regions 2020: the climate change challenges for European regions. Brussels

EC, Fifth Cohesion report. November 2010. http://ec.europa.eu/regional_policy/sources/docoffic/official/reports/cohesion5/pdf/5cr_en.pdf

EC (2010) Europe 2020: A strategy for smart, sustainable and inclusive growth, Communication from the Commission, COM(2010)2020, 3.3.2010, Brussels

EC (2010) The EU Budget Review. Communication from the Commission. COM(2010)700, 19.10.2010, Brussels

EC (2011) A Budget for Europe 2020 – Parts I and II, Communication from the Commission, COM(2011)500, 29.06.2011, Brussels

EC (2008), The 2009 Ageing Report: Underlying Assumptions and Projection Methodologies. Luxembourg: Office for Official Publications of the European Communities http://ec.europa.eu/economy_finance/publications/publication13782_en.pdf

EC (2008), The 2009 Ageing Report: Underlying Assumptions and Projection Methodologies. Luxembourg: Office for Official Publications of the European Communities http://ec.europa.eu/economy_finance/publications/publication13782_en.pdf

EC (2011) Proposal for a Regulation laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund covered by the Common Strategic Framework and laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and repealing Regulation (EC) No 1083/2006, COM(2011)615, 6.10.2011, Brussels

EC (1999), Application of the polluter pays principle: differentiating rates of Community assistance for Structural Funds, Cohesion Fund and ISPA infrastructure operations. Technical Paper 1. 6/12/1999

EC (2011), Proposal for a Regulation on specific provisions concerning the European Regional Development Fund and the Investment for growth and jobs goal and repealing Regulation (EC) No 1080/2006, COM(2011)614,6.10.2011, Brussels

EC (2011), Proposal for a Regulation on the European Social Fund and repealing Regulation (EC) No 1081/2006, COM(2011)607, 6.10.2011, Brussels

EC (2011), Proposal for a Regulation on the Cohesion Fund and repealing Council Regulation (EC) No 1084/2006, COM(2011)612, 6.10.2011, Brussels

EC (2011), Proposal for a Regulation on specific provisions for the support from the European Regional Development Fund to the European territorial cooperation goal, COM(2011)611, 6.10.2011, Brussels

EC (2011), Proposal for a Regulation amending Regulation (EC) No 1082/2006 of the European Parliament and of the Council of 5 July 2006 on a European grouping of territorial

cooperation (EGTC) as regards the clarification, simplification and improvement of the establishment and implementation of such groupings, COM(2011)610, 6.10.2011, Brussels

EEA, 2010, The European environment — state and outlook 2010: synthesis. European Environment Agency, Copenhagen

EEA, 2009, Regional climate change and adaptation: the Alps facing the challenge of changing water resources. EEA report 8/2009. Copenhagen.

EFI, BOKU, INRA - UMR Biodiversité Gènes et Communautés, IAFS, 2008, Impacts of Climate Change on European Forests and Options for Adaptation, Report to the European Commission Directorate-General for Agriculture and Rural Development

ENRD (2010), Climate Change and Renewable Energy measures in EU RDPs 2007 – 2013 Member state profile – LITHUANIA, http://enrd.ec.europa.eu/app_templates/filedownload.cfm?id=06A01ECE-BA01-69D1-AFFA-51FCDD21BA20

Enei, R., C. Doll, S. Klug, I. Partzsch, N. Sedlacek, J. Kiel, N. Nesterova, L. Rudzikaite, A. Papanikolaou, V. Mitsakis (2011):, Vulnerability of transport systems, Main report: Transport Sector Vulnerabilities within the research project WEATHER (Weather Extremes: Impacts on Transport Systems and Hazards for European Regions) funded under the 7th framework program of the European Commission

European Parliament and of the Council (2007): Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0060:EN:NOT

European Parliament and of the Council (2007): Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0060:EN:NOT

European Parliament and the Council (2000): DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities, 22.12.2000

European Parliament and the Council (2000): DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities, 22.12.2000

European Parliament and the Council (2009): Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds. Official Journal of the European Union, 26.1.2010

European Parliament and the Council (2009): Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds. Official Journal of the European Union, 26.1.2010

European Parliament and the Council (2009): Decvision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. Official Journal of the European Union, 5.6.2009

European Parliament and the Council (2009): Decvision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. Official Journal of the European Union, 5.6.2009

European Parliament and the Council (2009): Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Official Journal of the European Union, 5.6.2009

FAO (2007): Adaption to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities, Interdepartmental working group on climate change, Food and Agriculture Organisation of the United Nations, Rome

Feyen, L. and Watkiss, P. (2011). Technical Policy Briefing Note 3. The Impacts and Economic Costs of River Floods in Europe, and the Costs and Benefits of Adaptation. Results from the EC RTD ClimateCost Project. In Watkiss, P (Editor), 2011. The ClimateCost Project. Final Report. Published by the Stockholm Environment Institute, Sweden, 2011

Hanger, S., Lung, T., Haug, C. and Bouwer, L.M. (2011) Catalogue of programmes and policies related to regional development and infrastructure ('Baseline assessment'). RESPONSES project: Deliverable D6.1.IVM, JRC and IIASA

Hart K, Baldock D, Tucker G, Allen B, Calatrava J, Black H, Newman S, Baulcomb C, McCracken D (2011) Costing the Environmental Needs Related to Rural Land Management, Report Prepared for DG Environment, Contract No ENV.F.1/ETU/2010/0019r. Institute for European Environmental Policy, London

Heck, P., Bresch, D., and Trober, S., 2006, The effects of climate change: Storm damage in Europe on the rise, Swiss Re Focus Report

Hilpert, K., Mannke, F., Schmidt-Thomé, P., 2007. Towards Climate Change Adaptation Strategies in the Baltic Sea Region - Developing Policies and Adaptation Strategies to Climate Change in the Baltic Sea Region, Espoo, http://www.astra-project.org/07_publications.html

Hjerp, P., Medarova-Bergstrom, K, Skinner, I., Mazza, L. and ten Brink, P. (2011) Cohesion Policy and Sustainable Development-Policy Instruments, Supporting Paper 5. A report for DG Regio, February 2011.

Holland, M.; Kinghorn, S.; Emberson, L.; Cinderby, S.; Ashmore, M.; Mills, G.; Harmens, H.. 2006 Development of a framework for probabilistic assessment of the economic losses caused by ozone damage to crops in Europe. NERC/Centre for Ecology and Hydrology, 50pp. (CEH: Project Report Number C02309) (Unpublished)

Hooghe, L. & G. Marks (2001): Types of Multi-Level Governance. European Integration online Papers (EIoP), 5/11

IEEP, 2010, Manual for European Environmental Policy, Earthscan

Iglesias A., Garrote L., Quiroga S., 2011, Agriculture –The Impacts and Economic Costs of Climate Change in Agriculture and the Costs and Benefits of Adaptation, FP7 funded project ClimateCost WP2B, D3, Stockholm Environment Institute, Oxford, Universidad Politecnica de Madrid, Spain

Iglesias, A., Avis, K., Benzie, M., Fisher, P., Harley, M., Hodgson, N., Horrocks, L., Moneo, M., (2007), Adaptation to climate change in the agricultural sector, European Commission DG AGRI, AEA Energy & Environment, Harwell International Business Centre, Didcot

IPCC – Intergovernmental Panel on Climate Change (2007): Assessing key vulnerabilities and the risk from climate change, In: Climate Change Impacts, Adaption and Vulnerability, Full working group II Contribution to the Fourth Assessment Report, Chapter 19

IPCC (2007) Climate Change 2007: Synthesis Report
Je Olesen, M. Bindi, Agricultural Impacts and Adaptations to Climate Change in Europe, Dept. of Agrometeorology, Danish Institute of Agricultural Sciences, Tjele, DISAT-UNIFI, Firenze, Italy

Kettunen, M., Genovesi, P., Gollasch, S., Pagad, S., Starfinger, U. ten Brink, P. & Shine, C. (2009) Technical support to EU strategy on invasive species (IAS) - Assessment of the impacts of IAS in Europe and the EU (final module report for the European Commission) Institute for European Environmental Policy (IEEP), Brussels, Belgium

Klein, R.J.T., Huq, S., Denton, F., Downing, T.E., Richels, R.G., Robinson, J.B. & F.L. Toth (2007): Interrelationships between adaptation and mitigation. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment

Kovats, Hunt, and Watkiss, 2011, D2E.2: Climate change impacts on health in Europe, The ClimateCost Project

Kovats, R., Edwards, S., Hajat, B., Armstrong, B., 2004, The Effect of temperature on food poisoning: time series analysis in 10 European countries; Epidemiology and infection, v. 132, no. 3, p 443-453

Jung, T., Lavalle, C., Hiederer, R. and L. M. Bouwer (2011): Report on potential impacts of climatic change on regional development and infrastructure, Deliverable D6.3 of RESPONSES project "European responses to climate change: deep emissions reductions and mainstreaming of mitigation and adaptation"

Markandya, A., and Chiabia, A, 2009, Valuing Climate Change Impacts on human Health: Empirical Evidence from the Literature, International Journal of the Environment, Res. Public Health, 6 (2), pg 759-786

Medarova-Bergstrom et al (2011) Strategies and instruments for climate-proofing the EU budget. IEEP report, London/Brussels: IEEP

Mieczkoswki, Z. (1985), "The Tourism Climatic Index: A method of evaluating world climates for tourism", Canadian Geographer, 29, 220-233

Mima and Criqui, 2011, Analysis of impacts and adaptation of the Europe, USA, China, and India Energy System in the POLES A1B and E1 case under future climate change, ClimateCost

Moser, Susanne & J.A. Ekstrom (2010): A framework to diagnose barriers to climate change adaptation. PNAS, vol. 107, no. 51: 22026-22031

Nordregio (2009) The Potential for regional Policy Instruments, 2007-2013, to contribute to the Lisbon and Göteborg objectives for growth, jobs and sustainable development, Final Report to the European Commission, Directorate-General for Regional Policy, Evaluation Unit, Nordregio: Stockholm

OECD (2008): Economic Aspacts of Adaptation to Climate Change: Costs, Benefits and Policy Instruments – Executive Summary. Edited by Agrawala and S. Fankhauser, OECD, Paris

Perez, Rosa T. & G. Yohe (2005): Continuing the Adaptation Process. In: Lim, Bo & E. Spanger-Siegfried (Eds.), Adaptation Policy Framworks for Climatic Change: Developing Strategies, Policies and Measures, UNDP, Cambridge University Press, Cambridge: 205-223
Rademaekers, K., van der Laan, J., Boeve, S., and Lise, W., 2011, Investment needs for future adaptation measures in EU nuclear power plants and other electricity generation technologies due to effects of climate change, Directorate-General for Energy, European Commission

Pfenninger, S., Hanger, S., Dreyfus, M., Dubel, A., Hernández-Mora, N., Esteve, P., Varela-Ortega, C., Watkiss, P. and Patt, A. (2010) Report on perceived policy needs and decision contexts. Report deliverable for the MEDIATION FP7 research project; IIASA, SEI and UPM

Reidsma, P.; Ewert, F.; Lansink, A. O. (2007): Analysis of farm performance in Europe under different climatic and management conditions to improve understanding of adaptive capacity. Climatic Change (2007) 84:403–422, DOI 10.1007/s10584-007-9242-7.

Richards, J. A. and Nicholls, R. J., 2009, Impacts of climate change in coastal systems in Europe. PESETA-Coastal Systems study, Joint Research Centre – Institute for Prospective Technological Studies, Luxembourg: Office for Official Publications of the European Communities

Schaller, M., Weigel, H.-J. (2007) „Analyse des Sachstands zu Auswirkungen von Klimaveränderungen auf die deutsche Landwirtschaft und Maßnahmen zur Anpassung." Braunschweig, http://literatur.vti.bund.de/digbib_extern/bitv/dk039488.pdf

Schauser, I., Otto, S., Schneiderbauer, S., Harvey, A., Hodgson,N., Robrecht, H., Morchain, D., Schrander, J., Khovanskaia, M., Celikyilmaz-Aydemir, G., Prutsch, A., and McCallu, S., 2010, Urban Regions: Vulnerabilities, Vulnerability Assessments by Indicators and Adaptation Options for Climate Change Impacts, European Topic Centre on air and Climate Change Technical Paper 2010/12

Swanson, D.A., J.C. Hiley, H.D. Venema and R. Grosshans. 2007. Indicators of Adaptive Capacity to Climate Change for Agriculture in the Prairie Region of Canada: An analysis based on Statistics Canada's Census of Agriculture. Working Paper for the Prairie Climate Resilience Project, Winnipeg: International Institute for Sustainable Development.

The Council of the European Communities (1992): Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0043:EN:NOT

The Council of the European Communities (1992): Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0043:EN:NOT

The Council of the European Communities (2006): Communication from the Commission to the Council and the European Parliament on an EU Forest Action Plan. Brussels, 15.6.2006, COM(2006) 302 final

The Council of the European Communities (2006): Communication from the Commission to the Council and the European Parliament on an EU Forest Action Plan. Brussels, 15.6.2006, COM(2006) 302 final

Tietz A., 2010, Auswirkungen von Health Check und EU-Konjunkturprogramm auf die ländlichen Entwick-lungsprogramme der deutschen Bundesländer", 3/2010, http://literatur.vti.bund.de/digbib_extern/bitv/zi044148.pdf

Tol, R S J, 1995, the damage costs of Climate Change Toward More Comprehensive Calculations, Environmental and Resource Economics, 5:353-374

Tol, R.S.J., (2002). Estimates of the damage costs of climate change, Part I: Benchmark estimates, Environ. Resour. Econ., 21, 47-73

Wehrli, A., Herkendell, J., and Jol, A, 2010, Mapping the impacts of natural hazards and technological accidents in Europe: An overview of the last decade, European Environment Agency Technical report No 13

Yohe, G.W., Lasco, R.D., Ahmad, Q.K., Arnell, N.W., Cohen, S.J., Hope, C., Janetos, A.C. & R.T. Perez (2007): Perspectives on climate change and sustainability. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 811-841

8 Annex 1: Summary of Receptor Reports

8.1 Climate impacts on economic sectors and systems

8.1.1 Agriculture

Main threats, impacts and damage costs

It is predicted that climate change and climate variability will have a substantial affect on agricultural production both in terms of crop yields and the location where different crops can be grown. The effects of climate change differs in different parts of Europe and in different farming systems, and, often, the various impacts are mutually reinforcing and interrelated.

When studying the effects of climate change on agriculture in Europe, most literature makes a distinction between effects in Northern and Southern Europe. In Northern Europe, more positive impacts of climate change on agriculture are expected. These are related to longer growing seasons, the introduction of new crop species and varieties, higher yields, and the expansion of suitable areas for crop cultivation (Carter 1998). Less positively, rising sea levels may lead to a loss of farmland as a result of inundation and increasing salinity of soils and fresh water supplies, particularly in low-lying areas such as the Netherlands (Iglesias et al. 2009; Falloon and Betts 2010).

In Southern Europe however, the benefits of projected climate change will be limited, while the disadvantages will be more prevalent. Disadvantages include increased water scarcity and periods of water deficit at a time when demand is likely to increase, extreme weather events (heat, drought, storms), loss of soil carbon content, erosion, lower harvestable yield and higher yield variability, increased pesticide requirements and crop damage, and reduction in suitable areas of traditional crops (Olesen and Bindi 2004; Commission of the European Communities 2009; Maracchi et al. 2005). Temperature increases and extremes also affect animal health, growth and reproduction. Greater variability in crop yield as a result of pests and diseases and severe storms is expected.

Two studies have been identified that provide some estimate of damage costs to the EU agricultural sector as a result of climate change (see Table 28). The first study (Centre for Ecology, 2006) has estimated the baseline costs associated with ozone induced yield loss, and projected the short-term impacts to 2020. A second study (Schauser et al, 2010) has assessed the effects of heat waves on the sector as a baseline estimate but has not provided an estimate of future impacts. A third study by Ciscar (2009) has examined the possible climate impacts on the sector in some detail, but presents the impact assessment as a share of GDP; it is not clear how these estimates should be presented.

Table 28. Summary of published annual EU damage costs on agriculture due to climate change impacts (€bn)

	Annual damage costs, €bn			
Study	**Baseline costs / current costs**	**2020**	**2050**	**2080**
Centre for Ecology and Hydrology, 2006, Ozone-induced yield losses in Europe	€5 (2000 baseline year, 2000 prices)	€2.8bn/yr (2000 baseline year, 2000 prices)	No estimate provided	No estimate provided
Schauser et al, 2010, Effect of heat waves on agriculture in Europe	€13 (2003 baseline year, 2005 prices)	No estimate provided	No estimate provided	No estimate provided

Source: Estimates extracted from referenced sources

See Supplementary Material report.for a more detailed assessment of the impacts and damage costs in relation to agriculture.

Damage costs to the agricultural sector as a result of flooding have been accounted for in flood estimates, however impacts of water scarcity, soil erosion, disease and temperature increases have not been included in estimates due to a lack of data. As such overall damage cost estimates are likely to be an underestimate.

The impacts of climate change on the agricultural sector are extremely varied between and within regions. Most of the impacts considered in this section have looked at the effects of climate change on agricultural production, particularly crop production (yields and location) as there is little literature that has examined the impacts on livestock. The impacts are necessarily generalised and mask high-impact disturbances that may occur within regions. It is important to note that these impacts are still extremely uncertain and that impacts on production can be both negative and positive. For example, yield improvements for some crops have been predicted in Northern Europe as a result of increase CO2 levels in the atmosphere, although other factors such as predicted increases in water scarcity, increased soil erosion and storm events are likely to constrain such increases in reality.

Water scarcity is already being experienced in some areas of Europe and longer and more frequent droughts are anticipated in large parts of Southern Central and Eastern Europe, as well as parts of Northern Europe, with significant risks to crop yields. More arid conditions are likely to exacerbate soil degradation as a result of wind erosion and will also cause heat stress for livestock. There is less clarity about the likely changes in precipitation that might be experienced. An increase in magnitude and frequency of high precipitation events is likely in many parts of Northern, Central and Southern Europe which could damage crops and lead to waterlogging and exacerbate soil erosion where bare soil exists. The higher incidence of these types of extreme weather events (droughts, storms) are likely to severely disrupt crop production and increase the unpredictability and variability of crop yields. These higher temperatures and increased rainfall are also likely to lead to a noticeable increase in the incidence of disease, pests and pathogens, including the spread of invasive alien species.

Table **29** aims to assess the relative scale of these impacts on biodiversity.

Table 29. Assessment of the relative scale of impacts on agriculture from climate change, 2020s, EU and regions[118]

	Flooding – Coastal and River[2]	Water scarcity - continuous/ drought[2]	Air quality	Disease/ pest outbreak[2]	Soil erosion	Storms[2]	Temperature extremes inc fires and changes over time[2]	Precipitation[2]
North	Medium	Low-Medium	Low-	Medium	Medium	Medium	Low	Medium
North-West	Medium	Low-Medium	Low	Medium	Medium	Medium	Low	Medium
Mediterranean	Medium	High	Low	Medium	High	High	High	Medium
Central & Eastern	Medium	Medium	Low	Medium	Medium	High	Medium	Medium

Source: *Own assessment. Note the regional assessment reflects the general regional assessment of threats from climate change*

Affected CP and/or CAP expenditure categories

Investments in physical infrastructure in the agricultural sector are largely financed through Pillar 2 of the CAP and are extremely varied, from funding manure storage, to anaerobic digesters to water harvesting and storage units, to equipment for food processing, to farm machinery, livestock housing and so on. In addition a large proportion of expenditure is channelled via Pillar 2 to encourage environmental land management activities.

Rather than these areas of expenditure necessarily being sensitive to climate change themselves, future expenditure in these areas will need to ensure that the infrastructure being funded is able to withstand future climate impacts and ideally contribute to the adaptation needs of the sector.

The main measures that support expenditure that needs to take account of predicted climate impacts are the measures that promote investment in physical assets, both on and off farm (measures 121, 125 and to some extent measure 321, in the 2007-13 programming period). The specific types of investment include:

- Investments in on farm water storage facilities (measure 121)
- on farm investments to improve the re-use of waste water (measure 121)
- more efficient irrigation (to ensure that it does not increase water use as a result) – (measure 121 or 125)
- Investments on off farm water storage – reservoirs etc (measure 125 or 321)
- Investments in livestock housing (measure 121)

[118] This overall assessment should be treated with care. It is extremely difficult to provide this kind of assessment for the agricultural sector for three reasons. Firstly, climate change impacts on the agriculture sector can be positive as well as negative (for example in relation to the CO2 concentrations in the atmosphere), although this matrix assumes a negative impact. Secondly, this sort of regional assessment masks predicted local high-impact disturbances, although they should are important to be taken into account in adaptation strategies. Thirdly, for some threats, for example flooding or storm and pest outbreaks, it is not 'scale' that matters, but the frequency, unpredictability and severity of their occurrence.

Other expenditure that needs to be appropriately designed and planned to ensure it is compatible with climate change impacts includes:

- Land management activities that are used to help mitigate flood event – to ensure appropriately located
- Ensure that any introduction of new types of crop etc do not lead to any increase in use of pesticides, fertilisers etc
- Ensure that environmental land management expenditure is in keeping with biodiversity needs in the future (measures 214, 213)

For other types of land management, e.g. soil conservation measures etc, it is more important that this continues to be required/incentivised and that there is as wide an application as possible to improve the resilience of the sector to climate change impacts.

8.1.2 Forestry

Main threats, impacts and damage costs

Across Europe, the effects of climate change on the forestry sector are diverse and complex, particularly as weather patterns will be heavily altered, with marked regional and seasonal variation.

Climate change will lead to an increase in the incidence of temperature extremes in the summer period across much of Europe, which will lead to a greater incidence of forest fires. The same phenomenon will cause more droughts in Southern Europe.

Increasing temperatures and altered patterns of precipitation influence the frequency and intensity of forest pest and pathogen species, as well as their spatial distribution, size, and geographical range. Climate change will lead to a greater incidence (and greater severity) of storm events. Damage to forests from storms may be greater in combination with water saturated soils and decreased soil freezing, which reduces stand stability. Forest damage by wind and snow are projected to increase under climate change at northern latitudes because of the potential decrease in soil freezing. There will be more (and more severe) flooding across Northern Europe, with damage to forests and natural ecosystems.

However, some positive benefits are also likely to be realised In Northern Europe where growth rates of forests are likely to be enhanced by warmer winters and longer growing seasons.

Towards the end of the 21st century, severe and wide ranging negative climate change impacts on the forestry sector are expected in most European regions, with the Mediterranean region the most vulnerable to climate change. Forest fires are likely to dominate in southern Europe. The limited diversity of tree species in boreal forests enhances the risk of significant pest and disease impacts. Extreme storm events are likely to increase in north, west and central Europe, leading to economic losses. Rising temperatures and CO2 concentrations on the other hand increase forest productivity in northern Europe.

In providing the overall assessment of the relative threats to forestry at EU level, one needs to bear in mind that any generic assessment of a single threat will masks a mixture of positive and negative impacts in each region and will not necessarily capture disturbances with high impact that are likely to occur at regional and local levels and should be therefore foreseen in the adaptation strategies. An example is a forest fire risk which is highly specific to the Mediterranean regions and only to some extent to some Central European regions, but the potential frequency and severity of fires, the potential scale of areas affected, and the potential scale of negative knock-on environmental effects eg on biodiversity and soil, with related second degree damage costs accrued, makes this a threat of

high priority for adaptation from the overall EU perspective. Because of the specific nature of forestry activities which take place at the interface of natural and mane made environments also means that the scale of impacts foreseen to affect forest and forestry due to climate change has to be understood differently for different threats. For some threats, such as soil erosion, 'scale' of impacts could mean the scale of area affected. For other threats, for example disease/pest, storms and flooding, 'scale' is to be more appropriately understood in terms of frequency and/or severity of the disturbance. For such threats as water scarcity and temperature extremes, the severity of disturbance is likely to be the key factor to be considered when assessing the 'scale' of negative impacts on forest and forestry. .

Bearing this in mind, there is ample evidence that temperature extremes (forest fire risk) is a threat to be considered as top priority for the EU adaptation strategy, whilst pest/disease, storms and soil erosion are threats that will have a potentially high negative impacts too. These threats should therefore receive high emphasis in the adaptation strategies. In particular, the threat of pest/disease is estimated to be high in terms of frequency, severity, the potential area affected and the potential damage cost in the majority of EU regions. Storms and soil erosion are likely to be more specific to certain EU regions. However, the evidence provided for the severity and the potential scale of areas affected by these negative effects, as well as the high economic and environmental costs, particularly for storms, makes clear that these threats should be addressed as a an important priority in adaptation strategies in the regions concerned. Storms should be considered as a high threat in Northern, North-Western and Central Europe, whereas soil erosion should be integrated as a critical priority in adaptation strategies for forestry in Southern and South-Eastern Europe, and receive an appropriate emphasis in Central Europe

Table 30 aims to assess the relative scale of these impacts on biodiversity.

Table 30. Assessment of the relative scale of impacts on forestry from climate change, 2020s, EU and regions

Forestry	Flooding - Coastal[2]	Flooding - River[2]	Water scarcity-continuous / drought[2]	Disease/ Pest[2]	Soil erosion	Storms[2]	Ice/Snow (Winter extremes)[2]	Temperature extremes inc fires[2]	Temperature change over time
North	Medium	Medium	Low	High	Low	High	High	Medium	Low
North-West	High	High	Low	High	Low	High	Low	Low	Low
Mediterranean	Medium	Low	High	High	Medium	Medium	Low	High	Medium
Central & Eastern	Medium	High	High	High	Low	High	Medium	Medium	Low

Source: Own assessment. Note the regional assessment reflects the general regional assessment of threats from climate change

1. 'Scale' is understood in terms of frequency, severity and extension, as appropriate.

2. Unpredictability of these threats may further aggravate high and medium impacts for these threats.

Affected CP and/or CAP expenditure categories

The type of CAP expenditure for forestry that it is most important to climate proof to ensure that it takes account of future climate change impacts is expenditure for afforestation and other woodland planting to ensure that the locally appropriate species are chosen and that afforestation takes place in the most suitable location (for example to ensure that shallow rooting, water demanding species

are not planted in areas where increased water scarcity is anticipated). Since these decisions are invariably locally and regionally specific, it should be required that all afforestation projects are approved by the environmental authorities or comply with the technical eligibility criteria dsigned by the environmental authorities. Under the 2007-13 programming period this relates to measures 221, 222, 223 and 226.

8.1.3 Transport

Main threats, impacts and damage costs

Climate change affects all transport modesl but especially road, rail, aviation and shipping infrastructure. The major impacts to the transport infrastructure as a result of climate change are likely to be a result of flooding, storms, extreme events and snow/ice conditions.

Flooded ports are not accessible and roads and railways can be blocked by floods and forest fires. The capacity of railways is limited by heat waves and traffic jams are more likely to occur during rainfall. Inland navigation will more often be faced with restrictions associated with extremely low and high river discharges. Changes in transport capacity may lead to changes in transport costs or to a shift between transport modalities.

The overall scale of current (2010) annual EU weather related damage costs for transport is estimated to be in the order of €2.5 billion. This is projected to increase by 20% over the period to 2050 due to climate change, especially due to increased flood risks, causing particular issues for the rail system (Enei, 2011). This cost although it includes some indirect costs such as the disruption to users also excludes other transport related costs, such as effects on industry supply chains

If transport services are disrupted, then there is a considerable cascade or indirect effects for other industrial sectors including movement of labour and materials. For example, in the case of 'just-in-time' production, where stockpiles of material are kept to a minimum reducing the margin of flexibility if transport is disrupted (DEFRA, 2012), has a substantial indirect cost; provision for which will increase overall production costs.

Economic impacts are closely related to the frequencies of damage, disruption and transport restriction events and the availability of transport alternatives. The estimation of damage costs for transport has been assessed by the WEATHER project (seeTable 31)

Table 31. Summary of published impacts on EU transport sector due to climate change (€bn)

		Annual damage costs, €bn			
Study	**Impact**	**Baseline costs / current costs**	**2020**	**2050**	**2080**
WEATHER Project, (2011)	Damage costs to transport infrastructure and vehicles from climate change	2.5 (2010 prices), 2000-2010 baseline period (EU29)	[2.5], 2010 prices (excludes benefits, intermodal, waterways, EU27)	[3.0], 2010 prices (excludes benefits, intermodal, waterways, EU27)	Not estimated

Estimates in brackets is a GHK estimate based on using regional estimates (2050) and linear extrapolation (2020)
Enei, R., C. Doll, S. Klug, I Source: Weather Project and GHK estimate for 2050 based on data provided in the report
See Supplementary Material report for a more detailed assessment of the impacts and damage costs in relation to transport.

The assessment of impacts provided by the WEATHER project suggests that future impacts to which Cohesion Policy will need to respond include impacts on road and rail in Northern / North-West regions due to floods, heat waves and instability and in railway investments in Central and eastern Europe due to floods and increased/extreme temperatures, (and related fires) may be most vulnerable to climate change.

Table 32 aims to assess the relative scale of these impacts on the transport sector.

Table 32. Assessment of the relative scale of impacts on the transport sector from climate change, 2020s, EU and regions

Health	Flooding – Coastal	Flooding – River	Air quality	Disease	Storms	Temperature extremes inc fires	Temperature change over time
North	Medium	High	Low	Low	Low	Medium	Low
North-West	High	Medium	Low	Low	Low	Medium	Low
Mediterranean	Low	Low	Medium	Medium	Low	High	High
Central & Eastern	Low	Low	Medium	Medium	Low	High	High

Source: Own assessment. Note the regional assessment reflects the general regional assessment of threats from climate change

Affected CP and/or CAP expenditure categories
Cohesion Policy expenditure in the transport sector include motorways, national and regional roads, railways, airports, ports inland waterways, urban and multimodal transport and cycle tracks (expenditure categories 16-32 and 52) . Therefore all of these expenditures under Cohesion Policy have the potential to be sensitive to climate change impacts, however this will be very much dependent on the region and specific location of investments. For example railway, aviation, navigation and road investments in river catchment areas may all be sensitive. Expenditures in inland waterways in southern and parts of central and eastern Europe may also be vulnerable. Expenditures in roads and railways may also be sensitive in areas where higher precipitation (e.g. in parts of northern and central Europe) leads to erosion and subsidence of road bases and rail beds.

In Southern Europe expenditure in railway infrastructure may become vulnerable to extreme temperatures. Fires caused by incandescent particles originating from braking are already a problem.

8.1.4 Construction and buildings

Main threats, impacts and damage costs

Climate change will lead to increased levels of damage to the residential (and industrial and commercial) built stock, as a result of floods and storms. The review (and related review of estimates of health related damage costs) suggests that the most significant impact results from increased risk of floods, especially river floods. In addition users of buildings will employ greater use of air conditioning. In northern regions this will be offset by lower energy use in winter due to milder winters. However, in southern regions a net increase in energy demand is likely.

The estimates of damage costs of floods and storms provide a first approximation of the damage to buildings. In the case of river floods, over 90% of the damage costs relates to damage to residential, industrial and commercial buildings. The combined annual EU damage costs from floods and storms in the 2020s are estimated to be in the order of €30 billion under A1B climate scenarios. In addition increased cooling in residential buildings could result in higher energy costs of at least €3 billion a year (although largely offset by savings in winter energy costs).

The reported assessments suggest that the risks will reflect the distribution of flood and storm risks. These are highest in the Northern and North-west regions, but river flood risks are also high in Central and Eastern Europe. The southern region is the least affected, except as a result of higher temperatures and the demand for cooling.

Table 33 assesses the relative scale of impacts of climate change on buildings.

Table 33. Assessment of the relative scale of impacts on buildings from climate change, 2020s, EU and regions

Buildings	Flooding - Coastal	Flooding - River	Storms	Temperature increase
North	Medium	High	Low	Low
North-West	High	Medium	Low	Low
Mediterranean	Low	Medium	High	Medium
Central & Eastern	Low	High	Medium	Low

Affected CP and/or CAP expenditure categories

The sensitivity of buildings to damage from climate change has implications for Cohesion Policy expenditure in relation to the risks and impediments to the regional development that is being promoted. This in turn argues for substantial investment in risk assessment, well informed spatial and regional development planning; and early warning systems to avoid the worst impacts.

8.1.5 Energy Supply

Main threats, impacts and damage costs

Environmental impact assessment of energy installations almost invariably assesses how the installation may change the environment, but not how the environment might affect the construction and operation of the project over its lifetime (Paskal, 2010). Nevertheless, various components of the system are vulnerable (e.g., see Swart and Biesbroek, 2008; Paskal, 2010; Rademaekers et al., 2010). In particular vulnerable infrastructure includes:

- renewable energy (hydropower, biofuels) as a result of water scarcity for operation;

- thermal facilities (nuclear, fossil-fired, geo-thermal, waste incineration) as a result of water scarcity and higher temperatures affecting cooling;
- offshore or coastal production and facilities as a result of sae level rise; and
- energy infrastructure in cold climates, resting on melting permafrost as a result of higher temperatures.

If climate change poses particular risks to the energy system, this not only depends on the potential impacts, but also on socio-economic developments that affect exposure, sensitivity and adaptive capacity to climate change.

The major impacts affecting the energy infrastructure are likely to be water scarcity, storms, coastal and river flooding. Furthermore, losses in efficiency in power plant generation due to changes in temperature are also likely to be a major impact for the energy sector, pending redesign and replacement of existing plant. There may be a significant increase in demand for energy for cooling in Southern Europe which may have a significant impact on energy infrastructure, although there is also likely to be a reduction in demand for heating in Northern Europe meaning that impacts on demand due to climate change at the EU level are limited overall, but an additional problem for southern and central regions.

The combination of high temperatures and water scarcity may result in a heightened threat, especially in southern and central/eastern regions. The sensitivity of the energy supply sector is largely influenced by the life-times of energy plants and distribution systems. The costs of retro-fitting measures to improve resilience are potentially very costly. These costs are expected to be passed through to energy users, with associated impacts on the residential sector and the industrial and service sector.

The longer-term (2080s to 2100) EU implications of climate change on the vulnerability of the sector and on changes in energy demand, have been the subject of two new reports. Rademaekers (2011) examines the effects of changes in winds, temperatures and precipitation on the operation of power plants and grids. This study estimates a damage cost by 2080 of €50bn, without adaptation measures. Mima et al (2011) examine the effects of climate change on the demand for electricity. One area of overlap between the two studies may be the impacts from the loss of efficiency of thermal power plants due to temperature changes, which result in plants being operated at lower levels of output; with Rademaekers estimating a substantially lower cost than that implied by Mima et al (see Table 34).

Table 34. Summary of published impacts on EU energy sector due to climate change (€bn)

		Annual damage costs, €bn			
Study	**Impact**	**Baseline costs / current costs**	**2020**	**2050**	**2080**
Rademaekers et al, 2011	Damage costs to power plants and grids from climate change	Not estimated	Not estimated	Not estimated	49.3 (2011 prices) (assumed to be cumulative not annual)
Mima and Criqui, 2011	Additional costs for electricity demand for air conditioning in residential and service sector	Not estimated	16.6 (2010 prices)	38.4 (2010 prices)	84.6 [119], (2100 estimate, price base 2010)
	Additional costs for electricity demand in the water supply sector	Not estimated	Not estimated [0.5] (2010 prices)	Not estimated [1.1] (2010 prices	3.5 [120] (2100 estimate, price base unreported, assumed to be current, i.e. 2011)
	Loss in efficiency in power plant generation due to changes in temperature	Not estimated	Not estimated	Not estimated	Not estimated[121]

See Supplementary Material report and Summary of Damage Cost Studies for a more detailed assessment of the impacts and damage costs in relation to energy supply.

We have attempted to summarise this in Table 35.

Table 35. Assessment of the relative scale of impacts on the energy supply from climate change, 2020s, EU and regions

ENERGY SECTOR	Coastal Flooding	River Flooding	Water scarcity - continuous / drought	Storms	Winter / Snowfall	Temperature extremes inc fires	Temperature increase
North	Medium	High	Low	Low	Low	Low	Low
North-West	High	Medium	Low	Low	Low	Low	Low
Mediterranean	Low	Low	High	Low	Low	High	High
Central & Eastern	Low	High	High	Low	Low	High	Medium

Source: Own assessment. Note - the regional assessment reflects the general regional assessment of threats from climate change.

[119] *Warmer conditions will lead to a reduction of €98bn in the EU27 in heating expenditures over the same period*

[120] *US$ figures originally reported have been converted using a 2011 exchange rate €0.7 to $1*

[121] *Report comments that the loss of efficiency by 2100 is equivalent to building 20 nuclear power plants. Assuming a typical nuclear plant new build cost of €6bn per plant, this would represent a total cost of €120bn between 2011 and 2100.*

Affected CP and/or CAP expenditure categories

There are particular Cohesion Policy expenditure categories directly related to energy (expenditure categories 33 to 43). These include electricity, natural gas, petroleum products and renewables (wind, solar, biomass, hydroelectric and geothermal). Investments in hydropower facilities particularly, installations at rivers and streams determined by glacial run-off regimes, may become vulnerable and investments in power plants may also be particularly vulnerable to reduced productivity. Extreme events such as flooding and storms may also put these investments at risk.

Sensitivity is also a function of the time periods of investment, where energy investments with a short lifetime are less likely to be sensitive to climate change. However, those plants with long lifetimes (e.g. nuclear plant and some coal fired plant) may be more sensitive.

8.1.6 Tourism

Main threats, impacts and damage costs

Tourism is a major economic sector in Europe, with the current annual flow of tourists from Northern to Southern Europe accounting for one in every six tourist arrivals in the world. Climate change has the potential to radically alter tourism patterns in Europe by inducing changes in destinations and seasonal demand structure (Ciscar et al. 2009). The likely effects of climate change on the tourism sector vary widely, depending on the location and the season (Altvater et al., 2011).

The study by Ciscar (2009) as part of the PESETA programme has attempted to estimate longer-term (2080s) impacts on tourism in Europe. This has estimated that the location of tourism will shift from southern Europe to northern Europe, with damage costs accruing to southern Europe, but with equivalent benefits to the rest of Europe, with zero damage costs at the level of the EU.

However high levels of economic dependence on the tourism industry in some southern countries will be aggravated by the impacts of climate change. Negative climatic consequences will have particularly serious effects if climate-sensitive tourism has major economic importance. In Europe this applies to Malta, Cyprus, Spain, Austria and Greece. If tourists stay away from these countries, the economic setbacks are extremely serious (Ehmer and Heymann, 2008).

At the EU level the negative impact realised in Southern Europe will be compensated for by benefits occurring in Northern Europe. However this report stresses the need to assess damage costs and deal with climate change impacts on a locations and sectoral basis. In terms of the damage costs currently reported, the benefits and resulting zero impact at EU level must be stressed alongside the damage costs noted for Southern Europe, so as not to distort overall damage costs figures for climate change. A study by Ciscar (2009) as part of the PESETA programme has attempted to estimate longer-term (2080s) impacts on tourism in Europe (see Table 36).

Table 36. Summary of published annual EU damage costs on tourism due to climate change (€bn) (excluding benefits)

	Annual damage costs, €bn			
Study	**Baseline costs / current costs**	**2020**	**2050**	**2080**
Ciscar (2009)	None estimated [0] in 2010	Not estimated [0.4], 2009 prices	Not estimated [1.5], 2009 prices	2.5 (2009 prices)

Note - Damage costs to Southern Europe only, Equivalent benefits from the same climate scenario are projected in the remainder of Europe. Estimates in brackets by GHK based on simple linear extrapolation, assuming damage cost is zero in 2010. See Supplementary Material report and Summary of Damage Cost Studies *for a more detailed assessment of the impacts and damage costs in relation to tourism.*

There are a number of specific projected impacts on the tourism sector as a result of climate change and from increased risks of water scarcity, changes in winter/snowfall and temperature change. The biggest adverse impacts would appear to be from changes in summer tourism flows (in the Mediterranean region) and winter skiing (in the Central region), where funds related to cohesion policy are likely to be concentrated. Overall the EU impact is likely to be relatively low compared to impacts on other receptors.

We have attempted to summarise this in Table 37.

Table 37. Assessment of the relative scale of impacts on tourism from climate change, 2020s, EU and regions

TOURISM	Water scarcity - continuous/ drought	Winter / Snowfall	Temperature extremes inc fires
North	Low	Medium	Low
North-West	Low	Low	Low
Mediterranean	Medium	Low	High
Central & Eastern	Low	Medium	Low

Affected CP and/or CAP expenditure categories

There are particular Cohesion Policy expenditure categories directly related to tourism. These include the promotion of natural assets, the protection of natural heritage, preservation of cultural heritage and development of cultural infrastructure and services. These are the expenditure categories 55-61 covering tourism and cultural infrastructure. Future expenditure can be expected in order to support the diversification of existing tourism destinations, vulnerable to climate change, by investing in new tourism offers (e.g. aimed at diversifying services or activities to be undertaken in summer months in Southern Europe or winter activities in mountainous areas. Expenditure may be used to change the numbers and timing of visits.

8.1.7 Insurance

The damage costs from storms, as with floods, will affect all receptors. The data on the level of EU damage costs is very limited. Two sources provide some information, a report by the EEA, which give some estimate of current costs, and Swiss Re who have made some projections of storm related damage, using climate models (See Table 38)

Table 38. Summary of published annual EU damage costs from storms due to climate change (€m)

Study	Receptor	Baseline costs/current costs, €bn/yr	Annual projected damage costs €bn/yr
Wehrli et al (EEA), 2010	Total cost of storms in the EU	€4.0 (2009 prices) 1998-2009 baseline period	
Heck et al (Swiss Re), 2006	Winter storms in the EU (total loss)	€2.6 (2006 prices) , 2006	€7.0 (2085 estimate, 2006 prices)

Note: Based on Swiss Re: annual increase (2006-2085): 2020 estimate: €3.4bn; 2050 estimate: €5.2bn (GHK estimate based on simple linear extrapolation)
Source: Estimates from referenced sources

8.2 Climate impacts on environmental systems

8.2.1 Soil and biodiversity

Main threats, impacts and damage costs

As a result of the numerous and growing effects of climate change on species, combined with wider knock-on effects on species and ecosystems, together with constraints on adaptation, it is reasonably certain that biodiversity impacts will increase as a result of climate change. Impacts are expected to be mionor for most habitats and species up to 2020, but are expected to increase considerably beyond 2050, leading to substantial changes in the location and extent of habitats and the distribution and population sizes of many associated species (EEA et al, 2008). This is likely to result in decreases in diversity and distributions of habitats and species and in some cases local and even global extinctions.

Furthermore climate change impacts are increasingly being exacerbated by the indirect secondary effects of change mitigation measures (eg biofuels production) and certain adaptation measures (eg hard flood and coastal protection measures, agricultural irrigation), together with on-going pressures from land use change and intensification. Consequently, some scientists have suggested that these pressures are leading to extinction rates that would qualify as the sixth mass extinction in the history of the earth (Barnosky et al, 2011).

There is widespread and growing recognition of the social and economic benefits that ecosystems provide in terms of ecosystem services (EASAC, 2009; EUSATFOR and Patterson, 2011; Maes et al, 2011; Millennium Ecosystem Assessment, 2005; TEEB, 2008). However, very few studies have quantified the overall impact of climate change on biodiversity.

An assessment of the likely impacts of various biological and physical aspects climate change on biodiversity is provided in the table below. However, it should be borne in mind that the impacts are highly dependent on the degree of climate changes that occurs in Europe, its regional variations and the measures that are taken to support adaptation, so all the assessments have a high degree of uncertainty. Furthermore, it must be stressed that whilst many of the expected impacts are likely to be low by 2020 climate change, compared to other threats to biodiversity (such as land use change) profound biodiversity impacts are expected in the long-term terms (eg especially from 2050 onwards). Many of these long-term impacts will not be preventable without urgent actions now. It is

unlikely that biodiversity adaptation measures will be able to make a substantial difference to the long-term impacts of climate change on biodiversity if climate changes occurs at the levels that are currently expected.

Table 39 aims to assess the relative scale of these impacts on biodiversity.

Table 39. Assessment of the relative scale of impacts on biodiversity from climate change, 2020s, EU and regions

Health	Flooding – Coastal	Flooding - River	Water scarcity-continuous / drought	Soil erosion	Storms	Ice/Snow (Winter extremes)	Temperature extremes inc fires
North	Medium	Medium	Low	Low	Medium	Medium	Medium
North-West	Medium	Medium	Low	Low	Medium	Low	Low
Mediterranean	Low	Low	Medium	Medium	Low	Low	Medium
Central & Eastern	Low	Low	Low	Low	Medium	Low	Medium

Source: Own assessment. Note the regional assessment reflects the general regional assessment of threats from climate change

Affected CP and/or CAP expenditure categories

The expenditure categories under Cohesion Policy that are sensitive to climate change impacts on biodiversity is the promotion of biodiversity and nature protection (including Natura 2000) (expenditure category 51) but also some of the expenditure categories under tourism and cultural heritage, such as the protection and development of the natural heritage (expenditure category 54)

For investment categories under CAP there is a need primarily to focus on increasing the resilience of existing populations by increasing the coverage and effectiveness of existing conservation actions, such as:

- maintaining and increasing the area of core habitats within protected areas;
- reducing external impacts, e.g. by controlling pollutant emissions;
- managing / enhancing the ecological quality of habitats, especially in protected areas;
- managing species populations (e.g. controlling exploitation, impacts of IAS); and
- increasing / restoring connectivity through landscape scale conservation measures, e.g. through restoration of stepping stones patches of habitat or, where well justified, the creation of habitat corridors or enhancing the wider habitat matrix.

For this reason, the type of expenditure that will be important for climate proofing is that focussed on environmental land management under the CAP, for example expenditure under the agri-environment measure (214) and the Natura 2000 measure (213).

8.2.2 Water infrastructure

Main threats, impacts and damage costs

Climate change will affect current water management practices and the operation of existing water infrastructures, which are very likely to be inadequate to overcome the negative impacts of climate change on water supply reliability. Due to climate change, existing water-related infrastructure

systems will be wrongly conceived, under- or over- designed, resulting in either inadequate performance or excessive costs, so there is a strong need for revision in the existing infrastructure (Kundzewicz et al., 2008).

Major impacts to the water sector are likely to include:

- damage to water infrastructure due to flooding and storms, particularly considering that water infrastructure is often located close to river or coasts;
- reduced water quality where regions experience temperature increases over time and temperature extremes as well as reduced rainfall level. Furthermore salinization of groundwater may occur from flooding events and will also affect water quality; and
- increased investment and operating costs as result of increased abstraction, distribution and treatment costs.

No study has been identified that has sought to estimate the current or potential future costs on the EU water infrastructure sector as a result of climate change, although there are some national level studies. The only EU level cost of climate change identified the estimated longer-term impact on the EU water supply sector of additional electricity demand (seeTable 40).

Table 40 Summary of published impacts on EU water infrastructure sector due to climate change (€bn)

Study	Impact	Baseline costs / current costs, €bn	Annual projected damage costs, €bn, assumed 2011 price base
Mima and Criqui, 2011	Additional costs of electricity demand for water supply	Not estimated	3.5 (price base unreported) (2100 estimate)

Note: US$ figures originally reported have been converted using a 2011 exchange rate €0.7 to $1
Source: Mima and Criqui (2011). See previous section for a description

Despite the limited availability of coherent data on annual damage costs, the information above confirms the variability of threats and damage costs to EU water infrastructure. The assessment also indicates that water infrastructure is likely to be affected in all regions. To the extent that flood related impacts are relatively less significant than those associated with higher temperatures and reduced precipitation, then the impacts are likely to be more significant in the Mediterranean region and the Central and eastern region.

We have attempted to summarise this in Table 41.

Table 41. Assessment of the relative scale of impacts to the water infrastructure sector from climate change, 2020s, EU and regions

WATER INFRASTR-UCTURE	Flooding – Coastal	Flooding - River	Water scarcity - continuous/ drought	Water quality /salinity	Storms	Temperature extremes inc fires
North	Medium	High	Low	Low	Low	Low
North-West	High	Medium	Low	Medium	Low	Low
Mediterranean	Low	Low	High	High	Low	High
Central & Eastern	Low	Medium	High	High	Low	High

Source: Own assessment. Note the regional assessment reflects the general regional assessment of threats from climate change

Affected CP and/or CAP expenditure categories

Cohesion Policy in the water sector includes expenditures on the management and distribution of water (drinking water supply) and waste water treatment (waste water) (expenditure categories 45 and 46). Investments in new and existing infrastructure in these expenditure categories may be most sensitive from the threat of flooding as infrastructure is often located near to coast or river areas. Additional investment needs and higher operating costs of abstraction, distribution and treatment as a result of climate change is likely to increase CP expenditure needs for water infrastructure, especially in the Mediterranean and the Central and Eastern Region.

8.3 Climate impacts on key geographical areas

8.3.1 Coastal zones

As a result of sea level rise the coastal ecosystems will be significantly reduced and a significant amount of the population is threatened by flooding and erosion. There are two main studies that have examined in detail the damage costs associated with climate change and its impacts on sea level rise leading to coastal flooding. These studies derive from two major studies: the ClimateCost study (Brown, 2011) and the PESETA project (Richard & Nicholls, 2009).

The damage cost assessments are broadly equivalent in that they examine the same types of impact, over the same periods. The ClimateCost study provides a slightly more updated assessment, including the provision of medium-term estimates. Both studies examine the effects of adaptation and the same types of adaptation options.

Table 42 provides a brief overview of a very detailed set of analyses, which have examined a range of different climate and sea level rise scenarios. The overview has taken the mid-point estimates as indicated in the different studies.

Table 42. Overview of published EU annual damage costs from climate change induced se level rise and related coastal flooding (€b)

	EU annual damage costs (€bn)			
Study	**Baseline costs / current costs**	**2020s**	**2050s**	**2080s**
Brown et al (2011)	1990-2000: €2.7 (2005 prices)	€5.2 (2005 prices)	€10.6 (2005 prices)	€25.4 (2005 prices)
Richard & Nicholls (2009)	1995: €1.8 (1995 prices)	€6.0 (1995 prices)	Not estimated	€13.8 (1995 prices)

Source: Estimates extracted from the referenced reports, seeking to take broadly comparable mid-point estimates

See Supplementary Material report and Summary of Damage Cost Studies for a more detailed assessment of the impacts and damage costs in relation to coastal flooding.

The Richards & Nicholls study provides some breakdown of the different damage costs, with flood damage, rather than salinization or migration, responsible for the largest share of total damage

costs. The two studies also examine adaptation options and costs and conclude that they provide very significant benefits compared to costs of implementation, especially in the longer-term.

8.3.2 River Flooding

An increase in likelihood and intensity of extreme high river flows is projected for large parts of Europe due to the increase of more extreme precipitation regimes. The risks of flooding are increasing due to increasing human populations and economic investments. Wet regions may become even wetter in future, while some dry regions such as Mediterranean and Eastern Europe will experience also more extreme precipitation events - unevenly distributed though EU. The British islands and Central, East and south Europe are the most vulnerable (Christensen and Christensen, 2007)

The projected costs take account of expected increases in the incidence and severity of flood risk due to climate change. Identified studies that have sought to estimate these damage costs have tended to indicate an overall cost, without specifying the extent this is due to particular types of damage (e.g. threats to life, to property or to agriculture), but some limited breakdown is available (Table 43).

Table 43 Summary of published estimates of the annual EU damage costs from river flooding due to climate change (€bn)

	Annual damage costs (€bn)			
Study	**Baseline costs / current costs**	**2020**	**2050**	**2080**
Feyen & Watkiss (2011)	€7.0 (baseline period: 1961-1990) (2006 prices)	€20.4 (2006 prices)	€45.9 (2006 prices)	€97.9 (2006 prices)
EEA (2010) The European Environment State and Outlook 2010 Synthesis	Not available	€4.8 (2009 prices), 2030 estimates)*	€6.5 (2009 prices)*	€16.9 (2009 prices), 2100 estimates)*

*Damage costs include river and coastal flooding

See Supplementary *Material report and Summary of Damage Cost Studies for a more detailed assessment of the impacts and damage costs in relation to coastal flooding*

8.4 Social issues

This section reviews the potential impacts and damage costs on population, in terms of health impacts, and employment (as indicated by impacts on industry).

8.4.1 Health

Main threats, impacts and damage costs

Climate change has impacts on human health. This review (and related review of estimates of health related damage costs) suggests that the most significant impact results from increased heat stress from rising temperatures, but especially temperature extremes as experienced during heat waves. There is some possibility that populations can acclimatise to higher temperatures over time, which will to some extent reduce the risks. There may also be some saving of life due to less cold weather and fewer extremes of very cold weather. In addition, risks of air pollution and related health effects, and diseases as a result of climate effects on food safety and the spread of pests and diseases are also identified. This risk is assessed to be greatest in the Mediterranean and Central and Eastern regions.

Two studies have been identified that provide EU estimates of damage costs in terms of the health effects of climate change (see Table 44). The estimates of mortality risk from climate change indicate that the heat related impacts are the largest, with an estimate of EU annual damage costs in the 2020s, assuming some rate of acclimatisation, of €400 million (VOLY estimate, 2010 prices), using the A1B climate scenario (Kovats et al, 2011). A separate estimate (Ciskar et al, 2009) reported a higher impact from heat related effects of €2 billion (VOLY estimate, 2009 prices).

Table 44. Summary of published annual EU damage costs from adverse effects on health and mortality due to climate change (€bn)

	Annual damage costs, €bn			
Study	**Baseline costs / current costs**	**2020**	**2050**	**2080**
Kovats, Hunt & Watkiss (2011) – Heat related mortality	None estimated	(VOLY) €0.4 (2010 prices) (VPF) €14.9 (2010 prices)	(VOLY) €1.4 (2010 prices) (VPF) €5.8 (2010 prices)	(VOLY) €1.2 (2010 prices) (VPF) €45.8 (2010 prices)
Kovats, Hunt & Watkiss (2011) – Flood related mortality	None estimated	(VOLY) <€0.1 (2010 prices)	(VOLY) €0.1 (2010 prices)	(VOLY) €0.7 (2010 prices)
Kovats, Hunt & Watkiss (2011) – Salmonellosis (mid-range)	None estimated	None reported	<€0.1 (2010 prices)	None reported
Ciscar (2009) – based on mortality impacts from heat effects only	None estimated	(VOLY) €1.9 (2009 prices) (VSL) €4.4 (2009 prices)	Not estimated	(VOLY) €23.9 (2009 prices) (VSL) €56.2 (2009 prices)

Note: VOLY=Value of a Life Year; VPF=Value to Prevent a Fatality; VSL=Value of a Statistical Life
Source: Estimates extracted from referenced sources
See Supplementary Material report.for a more detailed assessment of the impacts and damage costs in relation to health.

We have attempted to summarise the relative scale of impacts on health in Table 45.

Table 45. Assessment of the relative scale of impacts on health from climate change, 2020s, EU and regions

Health	Flooding – Coastal	Flooding - River	Air quality	Disease	Storms	Temperature extremes inc fires	Temperature change over time
North	Medium	High	Low	Low	Low	Medium	Low
North-West	High	Medium	Low	Low	Low	Medium	Low
Mediterranean	Low	Low	Medium	Medium	Low	High	High
Central & Eastern	Low	Low	Medium	Medium	Low	High	High

Source: Own assessment. Note the regional assessment reflects the general regional assessment of threats from climate change

Affected CP and/or CAP expenditure categories

The impacts of climate change on health are in themselves unlikely to increase the sensitivity of Cohesion Policy expenditure, except where the impacts translate into increased demand for health services and relate infrastructure.

8.4.2 Employment

Industry in this section refers to manufacturing, commercial services, mining, construction and related informal production activities. Tourism, energy, water supply and transport sectors are considered separately and are not included.

Main threats, impacts and damage costs

The industrial sector is generally thought to be less sensitive to the impacts of climate change than other economic sectors, such as agriculture, energy and water services. This is partly because the sensitivity to climatic variability and change is considered to be comparatively low and partly because industry is perceived as having a high capacity to adapt in response to climate change (Altvater et al, 2011).

Further, supply chains are complex and dependent on a network of interconnected, yet independent, elements; therefore, it is not possible to develop a clear and direct causal link between climate change and supply chain disruption. Many climatic factors (such as heat, precipitation, melting, flooding) can break supply chains, making a single response function, or quantified damage cost estimate, too simplistic (DEFRA, 2012).

Climate change is seldom the main factor in considering stresses on the sustainability of industries. Social, economic and institutional processes to a large extent influence the industrial sector. Therefore, when studying the impacts and threats of climate change, these impacts should be considered in a multi-cause context (Altvater et al, 2011). In the longer term, both extreme events and gradual changes in climate can cause regional shifts in production of specific goods and services. Overall, the shorter term impacts from climate change to industry are likely to be as a result of increased flooding, storms and water scarcity.

Reported damage costs on industry currently reported provide some estimates of impacts from river flooding, the effects of climate change on labour productivity, as a result of health effects, and higher energy costs due to increased demand for energy for cooling in summer months (offset in some regions by a reduced demand for energy for heating in cooler months). Energy costs may also increase because of the pass through of higher production costs caused by climate change impacts on the energy sector. Droughts and water scarcity also impact on the operations of industry but this is not currently quantified.

The main conclusion is that the most significant direct threats from climate change to industry are from flooding. However, direct costs are likely to be substantially less than the indirect costs caused by disruption in other services such as energy, water and transport.

We have attempted to summarise this in the following table (Table 46).

Table 46. Assessment of the relative scale of direct impacts on industry from climate change, 2020s, by region

INDUSTRY	Coastal Flooding	River Flooding	Water scarcity - continuous/ drought	Storms	Extreme prolonged snowfall / ice	Temperature extremes inc fires	Temperature increase
North	Medium	High	Low	Low	Low	Low	Low
North-West	High	Medium	Low	Low	Medium	Low	Low
Mediterranean	Low	Low	Medium	Low	Low	Medium	Medium
Central & Eastern	Low	Medium	Medium	Low	Medium	Medium	Low

Source: Own assessment. Note the regional assessment reflects the general regional assessment of threats from climate change.

Affected CP and/or CAP expenditure categories

Cohesion Policy expenditure is most likely to be affected when focused on SMEs and used to support measures to increase the resilience of businesses to climate threats. However this impact is likely to be relatively small overall.

9 Annex 2: Assessing the adaptive capacities of Member States

A high exposure to potential climate change impacts does not necessarily imply that these impacts unfold. The adaptive capacity of a Member State is a key determinant of the overall climate vulnerability of a Member State and hence a determinant of the future damage costs of climate change. EU funding through CAP and Cohesion Policy is a key influencing factor for adaptive capacity. However, as it will be explained in the remainder of this chapter, the assessment of adaptive capacity and the role of EU policy support within is a complex undertaking. EU policy support should seek to target those areas of action that require support for they would not materialise otherwise. It should not crowd-out action that would have been taken by private actors anyway or should replace domestic support action which oftentimes is also legally required.

This chapter first outlines our methodological approach to assessing adaptive capacity. We reference the findings from recent authoritative studies for the EU and outline how our approach builds on these studies. Following, findings from the analysis of Member States are presented.

9.1.1 Approach to assessing adaptive capacity

The IPCC's Fourth Assessment report outlines several determinants of adaptive capacity. Overall human capital, economic performance and quality and stability of overall governance structures are regarded as crucial determinants of the overall adaptive capacity of a country. Availability of suitable technologies and a high potential for innovation are important factors. Equally important are, however, soft capital factors such as the level of education or overall conditions of health (IPCC 2007).

Several studies and reports provide a more in-depth analysis of adaptive capacity and develop factors and indicators to estimate the capacities of Member States to adapt to climate change and thus to avoid some of the estimated damage costs (e.g. Brooks, Adger and Kelly (2005)). This overview illustrates the approaches of selected studies as basis for developing an approach for our study. The overview focuses on those studies that develop specific indicators for adaptive capacity in the EU.[122] The following sources are analysed concerning the selected determinants and indicators:

- DG Regio study: Proposal for specific indicators for adaptive capacity
- ESPON Climate study: Proposal and application of indicators for adaptive capacity
- Tyndall centre report "New indicators of vulnerability and adaptive capacity (Adger et al. 2004): this report takes a broader approach with the development of overall vulnerability indicators. However, it also proposes some specific indicators for adaptive capacity.
- RESPONSES project: Adaptive capacity indicator as developed in the frame of the EU FP 7 project "European RESPONSES to climate change".

[122] The ESPON climate study gives a good overview on different approaches and indicators developed in the literature.

OVERVIEW ON EXISTING APPROACHES TO ASSESS ADAPTIVE CAPACITY			
Name of the study	**Level of analysis and Evaluation scale**	**Factors influencing adaptive capacity**	**Proposed indicators**
DG Regio study "REGIONS 2020 - THE CLIMATE CHANGE CHALLENGE FOR EUROPEAN REGIONS" (March 2009)	The study only proposes a methodological approach, specific indicators are not yet proposed and applied.	• **Information:** nature and evolution of climate hazards faced by a society and information on socio-economic systems, including both past and possible future evolution. • **Resources:** Including financial and social capital (e.g., strong institutions, transparent decision-making systems, formal and informal networks), human resources (e.g., labour, skills, knowledge and expertise) and natural resources. • **Ability:** of a society to act collectively, and to resolve conflicts between its members (governance, role of key actors).	• No specific indicators are proposed
ESPON Climate study "Climate Change and Territorial Effects on Regions and Local Economies" (2011)	Results are mapped for the regional level, expressed in quintiles (highest capacity, 2nd highest capacity…).	• **Knowledge and awareness (weight: 23%):** play an important role in terms of identifying vulnerabilities in relation to climate change and enable the identification of adaptation options. • **Ability with technology (23%) and infrastructure (16%):** Determine the capacities to move from awareness to action • **Action with institutions (17%) and economic resources (21%):** action is supported by economic resources and institutions that enable a society to carry out the adaptation measures that have been defined.	• Knowledge and awareness: education level, computer skills, attitudes towards climate change from Eurobarometer survey • Ability: share of GDP for R&D investments, numbers of employees in R&D, patents, road network, water exploitation index, hospital beds. • Action: Governement effectiveness, state of NAS, indicator for democracy, GDP/cap, age dependency ratio, unemployment
Tyndall Centre Study "New indicators of vulnerability and adaptive capacity (2004)*	Results are illustrated per country Score reaches from 1-5 *Please note: this study has an international focus, some of the indicators seem less relevant for an EU assessment.*	• **Economic well being:** serves as proxy for political priorities: poorer countries have other priorities than long-term climate adaptation. • **Education:** capacity to adapt to climate change in an anticipatory manner depends strongly on the availability of information relating to climate change, and on the ability of those undertaking adaptation to interpret this information. • **Governance related factors:** Determines ability to act collectively • **Technical capacity:** commitment to and resources for research as well as capacity to undertake research.	• Economic wellbeing: GDP, indebtedness • Education: Literacy and level of education (probably less relevant on EU level), availability of information services • Governance related factors: Internal refugees, control of corruption, government effectiveness, political stability, regulatory quality, rule of law, voice and accountability • Technical capacity: R&D investment, scientists and engineers in R&D

Adaptive capacity indicators identified in the frame of "RESPONSES", Dec 2011	Results are illustrated on a regional level Score reaches from 1-5	• **Financial capital:** economic ability to cope with threats from climate change. • **Human capitcal:** Considering the level of education as well as provision of health services and infrastructure. • **Technical capital:** Brings together indicators that measure the technical capacity to cope with new challenges posed by climate change. Institutional capacity is not considered in this study based on the reasoning that this would require a broad range of stakeholder interviews to capture the level of information.	• Financial capital: GDP /cap, • Human capital: educational attainment, health infrastructure, • Technical capital: research & development expenditure per capita, Internet use

** The Tyndall Centre study develops further determinants which however have a weaker link to adaptive capacity and focus more on exposure and sensitivity: health and nutrition, physical infrastructures, geographical and demographic factors, dependence on agriculture, natural resources and ecosystems.*

Approach for this study

The analysis makes clear that different approaches have been used up to now to assess adaptive capacity of a region or Member State. Concerning the selection of useful indicators for the Climate proofing study, the following observations can be made:

- From the screening of existing studies, the three studies specifically developed for the EU framework (DG Regio 2009, ESPON 2011 and RESPONSES 2011) seem most suited for our assessment regarding CP and CAP.

- The ESPON study goes one step further than the DG Regio report and develops and applies specific indicators for adaptive capacity. A selection of these indicators is also used in the frame of RESPONSES. Some of these indicators seem however either less relevant for CP and CAP (e.g. computer skills) or lists indicators that we consider to be more important for the assessment of impacts and damages (transport and water infrastructures). Also, some of the indicators are policy-field specific, e.g. the number of hospital beds is relating to human health.

Concerning climate proofing of Cohesion Policy and CAP, all three dimensions that are used in the EU-related studies of DG Regio and ESPON are relevant:

- Awareness illustrates if climate change is already an issue in the relevant Member States and if the relevant social, economic and public stakeholders deal with the issue at this level. Otherwise, the action has to be fully addressed on European level.
- Indicators relating to “ability” demonstrate the availability of economic and technological resources on Member State level. If “ability” is assessed to be low, there is a high need for action on EU level.
- If awareness and ability are given, the dimension “action” determines the level of action on Member State level and the remaining need for action and investments on EU level.

Based on these observations, we have developed some key indicators that determine adaptive capacity (seeTable 47). Each indicator should be assessed on a similar scale to allow a straight-forward combination later on. We propose to use a scale with either five values (either “1= very low”, to “5= very high” or an illustration in form of quintiles) or a scale of three values that can be merged with the 5-value scale.

As further step an average of the different indicators will be evaluated for all EU countries. The indicator will then be formulated as very low (1), low (2), medium (3), high (4), very high (5). According to the approach of the ESPON climate study, the indicators will be weighted to take into account their different relevance.

Table 47. Key indicators for adaptive capacity

Indicator	Description	Values	Source	Weight
National information platform available (Awareness)	Illustrates the availability of an online information platform that informs of future climate change impacts, scenarios and need for action.	1= no overall platform available or difficult to access information 2= Platform available but not with highest level of information (e.g. not comprehensive, outdated, etc.) 3= Platform with comprehensive information available	Own research	23%
Technological resources % of GDP for R&D and number of patents (Ability)	Ability of a Member State to develop the necessary technologies for adaptation	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	39%
GDP/capita as proxy for economic resources (Ability)	Ability of a Member State to provide the necessary funds for adaptation funding	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	
National Adaptation Strategy (Action) (specific per policy field)	This indicator illustrates the state of the National Adaptation Strategy. Is a strategy available? Does it include recommendations for adaptation options? Does it include a specific action and financing plan?	1 = NAS under development 2= NAS available, without specific proposals for options 3= NAS available, with action plan and further steps	Own research (based on EEA)	38%
Government effectiveness (Action)	This indicator illustrates the efficiency of government and national decision-making. If decision-making is effective, it is likely that that decisions related to adaptation are taken when necessary	Data from World Bank database where -2.5 = weak and 2.5 = strong. → Transform into 0 = weak and 5 = strong	World Bank	

The situation in the agricultural sector differs strongly from the policy fields included under Cohesion policy. Therefore for the agricultural, forestry and biodiversity (related to CAP) policy field further key indicators are added to the generic indicators as explained above. They cover all three categories awareness, ability and action and follow the basic methodology. The selection of the indicators is based on different literature sources and expert opinions (see Reidsma et al 2007, Swanson et al 2007). The selected indicators and their evaluation scale are illustrated in Table 48 The average adaptive capacity for agriculture and forestry for every MS is estimated on the basis of the general and the additional key indicators.

Table 48: Additional key indicator for agriculture sector

Indicator	Description	Values	Source	Category
Share of households with internet access in rural areas (Awareness)	Shows the possibility to inform farmers easily for knowledge transfer and raising awareness of future climate change impacts, scenarios and need for action.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	Included in Awareness
Farmers' training level (Awareness)	Illustrates the possibility to inform farmers via trainings of future climate change impacts, scenarios and need for action.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	
Research expenditures in agricultural sciences per GDP (Ability)	Ability of a Member State to develop the necessary technologies for adaptation in agricultural sector.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	Included in Ability
Amount of large area farms (over 100 ha) (Action)	It is more likely that larger farms can deal with adaptation in a more efficient way, because they have more resources for knowledge gathering and implementation.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	Eurostat	Included in Action
Share of RDP funding to agri-envrionment measures (Action)	Indicates experience with agri-environmental measures and economic resources for environmental measures	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	European Network for Rural Development (ENRD)	
Share of UAA under agri-environment measures (Action)	Indicates experience with agri-environmental measures and economic resources for environmental measures.	1 = lowest quintile 2 = second lowest quintile 3 = medium quintile 4 = second highest quintile 5 = highest quintile	European Network for Rural Development (ENRD)	

10 Annex 3 Adaptive capacity for Cohesion Policy

Adaptive capacity for Cohesion policy based on ability

	Ability									
	39%									
	GPD/capita (2010)	Rank	Quintile* 1= very low 5= very high	Patents/Mio. capita (2009)	Rank	Quintile* 1= very low 5= very high	R&D investments, % of GDP (2010)	Rank	Quintile* 1= very low 5= very high	Average score ability
AT	31400	22	4	218,4	24	5	2,76	23	5	4,7
BE	29500	19	4	143,61	20	4	1,99	20	4	4,0
BG	3500	1	1	1,22	1	1	0,6	5	1	1,0
CY	19000	14	3	10,44	7	2	0,5	3	1	2,0
CZ	11400	9	2	22,59	12	3	1,56	13	3	2,7
DE	29000	18	4	294,53	26	5	2,82	24	5	4,7
DK	37200	26	5	242,64	25	5	3,06	25	5	5,0
EE	8300	6	2	32,92	14	3	1,62	15	3	2,7
EL	17300	13	3	10,57	8	2	n.A.	n.A.	1	2,0
ES	20600	15	3	31,55	13	3	1,39	12	3	3,0
FI	31000	21	4	215,67	23	5	3,87	27	5	4,7
FR	27400	17	4	134,3	19	4	2,26	22	4	4,0
HU	8800	7	2	21,46	11	2	1,16	10	2	2,0
IE	36400	25	5	77,44	16	3	1,79	18	4	4,0
IT	23500	16	3	81,96	17	4	1,26	11	2	3,0
LT	6700	4	1	4,17	3	1	0,79	9	2	1,3
LU	65600	27	5	154,79	21	4	1,63	16	3	4,0
LV	5600	3	1	9,04	6	2	0,6	5	1	1,3
MT	13000	10	2	13,85	9	2	0,63	7	2	2,0
NL	33200	23	5	179,5	22	4	1,83	19	4	4,3
PL	8100	5	1	6,82	4	1	0,74	8	2	1,3
PT	14800	11	2	14,34	10	2	1,59	14	3	2,3
RO	4200	2	1	1,79	2	1	0,47	2	1	1,0
SE	34100	24	5	332,03	27	5	3,42	26	5	5,0
SI	15300	12	3	61,86	15	3	2,11	21	4	3,3
SK	8900	8	2	8,81	5	1	0,63	7	2	1,7
UK	30200	20	4	83,42	18	4	1,77	17	4	4,0

Adaptive capacity for Cohesion policy based on action

	Action					
	38%					
	Government effectiveness	**Rank**	**Quintile* 1= very low 5= very high**	**Status of NAS (based on EU ClimateAdapt platform)**	**Low = 1 Medium = 3 High = 5**	**Average score ability**
AT	1,9	24	5	Draft version of NAS available	3	4
BE	1,6	21	4	Available, without specific action plan	3	3,5
BG	0,0	3	1	No NAS available	1	1
CY	1,5	18	3	No NAS available	1	2
CZ	1,0	12	3	No NAS available, but some information in National Program	1	2
DE	1,6	19	4	NAS available, Action Plan available	5	4,5
DK	2,2	26	5	NAS available, with specific action plan	3	4
EE	1,2	15	3	NAS under development in the frame of the Astra project	1	2
EL	0,5	5	1	No NAS available	1	1
ES	1,0	11	2	NAS available, without specific aciton plan	3	2,5
FI	2,2	27	5	NAS available, but no specific actions started	3	4
FR	1,4	17	4	NAS avaialbe, including specific sectoral action plans ("fiches actions")	5	4,5
HU	0,7	6	2	NAS avaialbe	3	2,5
IE	1,3	16	3	NAS still under development	1	2
IT	0,5	4	1	No NAS available	1	1
LT	0,7	9	2	NAS under development in the frame of the Astra project	1	1,5
LU	1,7	22	4	No NAS available	1	2,5
LV	0,7	7	2	NAS under development in the frame of the Astra project	1	1,5
MT	-0,9	1	1	No NAS available	1	1
NL	1,7	23	5	NAS avaialble ("Make room for climate") with specific action plans	5	5
PL	0,7	8	2	No NAS available	1	1,5
PT	1,0	14	3	NAS available, but without specific action plan	3	3
RO	-0,1	2	1	No NAS available	1	1
SE	2,0	25	5	No specific NAS available, relevant legislation focuses on mitigation	1	3
SI	1,0	13	3	No NAS available	1	2
SK	0,9	10	2	No NAS available	1	1,5
UK	1,6	20	4	NAS available, Action Plan available	5	4,5

Adaptive capacity for Cohesion policy based on awareness

	Awareness	
	23%	
	Information platform (based on EU ClimateAdapt platform)	**Low = 1 Medium = 3 High = 5**
AT	Website "Klimawandelanpassung.at" with comprehensive information	5
BE	Wesite available (www.climat.be) but focus on mitigation	3
BG	No platform available	1
CY	No platform available	1
CZ	No platform available	1
DE	KOMPASS, with case studies, implementation guides, etc.	5
DK	Webiste (klimatilpasning.dk) with comprehensive information	5
EE	Little adaptation activities ongoing (http://www.envir.ee/1180211)	1
EL	No platform available	1
ES	Very limited information available	1
FI	Website with some information under the Ministry of Agriculture and Forestry	3
FR	Webiste with information on mitigation and adaptation but only medium information content	3
HU	Website available but with broader focus (http://klima.kvvm.hu)	3
IE	Specific webiste under EPA Ireland with medium information content	3
IT	No platform available	1
LT	Platform not yet available	1
LU	No specific platform available	1
LV	Adaptation acitivites just starting, no platform available	1
MT	No platform available	1
NL	Website (klimaatonder zoeknederland.nl) with detailed information on case studies and guidleines	5
PL	Need for platform recognized but not yet available	1
PT	Platform available (adaptacao.clima.pt) but rather general, mostly focus on NAS	3
RO	No platform available	1
SE	Platform available (www.smhi.se/klimat anpassningsportalen) wiht comprehensive information	5
SI	Need for platform recognized but not yet available	1
SK	No platform available	1
UK	UKCIP with comprehensive information, case studies and guidelines	5

11 Annex 4 Adaptive capacity indicators for CAP

Adaptive capacity indicators for CAP based on ability

	Ability												
	39%												
	GPD/capita (2010)	Rank	Quintile* 1= very low 5= very high	Patents/Mio. capita (2009)	Rank	Quintile* 1= very low 5= very high	R&D investments, % of GDP (2010)	Rank	Quintile* 1= very low 5= very high	Research expenditures Agricultural sciences/GDP (2009), in %	Rank	Quintile* 1= very low 5= very high	Average score ability
AT	31400	22	4	218,4	24	5	2,76	23	5	0,000491532	15	3	4,3
BE	29500	19	4	143,61	20	4	1,99	20	4	0,000678109	23	5	4,3
BG	3500	1	1	1,22	1	1	0,6	5	1	0,000694419	24	5	2,0
CY	19000	14	3	10,44	7	2	0,5	3	1	0,00060397	19	4	2,5
CZ	11400	9	2	22,59	12	3	1,56	13	3	0,000567933	17	4	3,0
DE	29000	18	4	294,53	26	5	2,82	24	5	0,000410034	12	3	4,3
DK	37200	26	5	242,64	25	5	3,06	25	5	0,000918449	27	5	5,0
EE	8300	6	2	32,92	14	3	1,62	15	3	0,000482167	14	3	2,8
EL	17300	13	3	10,57	8	2	n.A.	n.A.	1	0	4	1	2,0
ES	20600	15	3	31,55	13	3	1,39	12	3	0,000612419	20	4	3,3
FI	31000	21	4	215,67	23	5	3,87	27	5	0,000861991	26	5	4,8
FR	27400	17	4	134,3	19	4	2,26	22	4	0	4	1	4,0
HU	8800	7	2	21,46	11	2	1,16	10	2	0,000816739	25	5	2,8
IE	36400	25	5	77,44	16	3	1,79	18	4	0,000602226	18	4	4,0
IT	23500	16	3	81,96	17	4	1,26	11	2	0,000271304	7	2	2,8
LT	6700	4	1	4,17	3	1	0,79	9	2	0,000506985	16	3	1,8
LU	65600	27	5	154,79	21	4	1,63	16	3	0	4	1	4,0
LV	5600	3	1	9,04	6	2	0,6	5	1	0,000351649	10	2	1,5
MT	13000	10	2	13,85	9	2	0,63	7	2	0,000204103	5	1	1,8
NL	33200	23	5	179,5	22	4	1,83	19	4	0,00064432	22	4	4,3
PL	8100	5	1	6,82	4	1	0,74	8	2	0,000424283	13	3	1,8
PT	14800	11	2	14,34	10	2	1,59	14	3	0,00063407	21	4	2,8
RO	4200	2	1	1,79	2	1	0,47	2	1	0,000330959	9	2	1,3
SE	34100	24	5	332,03	27	5	3,42	26	5	0,000389596	11	2	4,3
SI	15300	12	3	61,86	15	3	2,11	21	4	0,00021056	6	2	3,0
SK	8900	8	2	8,81	5	1	0,63	7	2	0,000324356	8	2	1,8
UK	30200	20	4	83,42	18	4	1,77	17	4	0	4	1	4,0

Adaptive capacity indicators for CAP based on action

	Action														
	38%														
	Government effectiveness	Rank	Quintile* 1= very low 5= very high	Status of NAS (based on EU ClimateAdapt platform)	Low = 1 Medium = 3 High = 5	Farm Size in UAA, farms over 100 ha (2007)	Rank	Quintile* 1= very low 5= very high	Share of RDP funding to agric-envrionment measures, % of total Pillar 1+2 funding (2007-2013)	Rank	Quintile* 1= very low 5= very high	Share of UAA under agri-environment measures (%) (2009)	Rank	Quintile* 1= very low 5= very high	Average score ability
AT	1,9	24	5	Draft version of NAS available	3	764050	12	3	19,55%	27	5	0,69	24	5	4,2
BE	1,6	21	4	Available, without specific action plan	3	290610	6	2	3,16%	5	1	0,25	17	4	2,8
BG	0,0	3	1	No NAS available	1	2358230	18	4	7,37%	13	3	0,01	1	1	2
CY	1,5	18	3	No NAS available	1	24100	2	1	9,25%	19	4	0,08	7	2	2,2
CZ	1,0	12	3	No NAS available, but some information in	1	3098830	21	4	12,75%	23	5	0,18	13	3	3,2
DE	1,6	19	4	NAS available, Action Plan available	5	8852300	24	5	4,80%	9	2	0,35	20	4	4
DK	2,2	26	5	NAS available, with specific action plan	3	1628010	15	3	2,29%	2	1	0,12	10	2	2,8
EE	1,2	15	3	NAS under development in the frame of the Astra	1	626990	9	2	15,17%	25	5	0,47	22	4	3
EL	0,5	5	1	No NAS available	1	193080	5	1	3,18%	6	2	0,10	9	2	1,4
ES	1,0	11	2	NAS available, without specific aciton plan	3	13975170	26	5	2,78%	4	1	0,16	12	3	2,8
FI	2,2	27	5	NAS available, but no specific actions started	3	461160	8	2	10,80%	22	4	0,92	26	5	3,8
FR	1,4	17	4	NAS avaialbe, including specific sectoral action plans ("fiches actions")	5	15063250	27	5	2,70%	3	1	0,15	11	2	3,4
HU	0,7	6	2	NAS avaialbe	3	2768900	20	4	9,41%	21	4	0,25	18	4	3,4
IE	1,3	16	3	NAS still under development	1	681640	11	2	9,26%	20	4	0,19	14	3	2,6
IT	0,5	4	1	No NAS available	1	3176730	22	4	4,79%	8	2	0,20	15	3	2,2
LT	0,7	9	2	NAS under development in the frame of the Astra	1	947790	13	3	8,29%	17	4	0,07	5	1	2,2
LU	1,7	22	4	No NAS available	1	61230	4	1	7,71%	14	3	0,92	27	5	2,8
LV	0,7	7	2	NAS under development in the frame of the Astra	1	673260	10	2	9,23%	18	4	0,21	16	3	2,4
MT	-0,9	1	1	No NAS available	1	0	1	1	6,57%	11	2	0,07	6	2	1,4
NL	1,7	23	5	NAS avaialble ("Make room for climate") with specific action plans	5	300800	7	2	1,67%	1	1	0,05	3	1	2,8
PL	0,7	8	2	No NAS available	1	2707800	19	4	7,07%	12	3	0,03	2	1	2,2
PT	1,0	14	3	NAS available, but without specific action	3	1942900	17	4	4,65%	7	2	0,10	8	2	2,8
RO	-0,1	2	1	No NAS available	1	5172370	23	5	6,21%	10	2	0,07	4	1	2
SE	2,0	25	5	No specific NAS available, relevant legislation focuses on mitigation	1	1538340	14	3	13,20%	24	5	0,81	25	5	3,8
SI	1,0	13	3	No NAS available	1	34020	3	1	16,51%	26	5	0,42	21	4	2,8
SK	0,9	10	2	No NAS available	1	1747680	16	3	7,82%	15	3	0,33	19	4	2,6
UK	1,6	20	4	NAS available, Action Plan available	5	11296080	25	5	8,21%	16	3	0,48	23	5	4,4

Adaptive capacity indicators for CAP based on awareness

	Awareness								
	23%								
	Information platform (based on EU ClimateAdapt platform)	**Low = 1 Medium = 3 High = 5**	**Share of households with internet access in rural areas (2011)**	**Rank**	**Quintile* 1= very low 5= very high**	**Farmers trainings level (Full agricultural training) (2009)**	**Rank**	**Quintile* 1= very low 5= very high**	**Average score awareness**
AT	Website "Klimawandelanpassung.at" with	5	75	20	4	28	24	5	4,7
BE	Wesite available (www.climat.be) but focus on mitigation	3	74	19	4	23	22	4	3,7
BG	No platform available	1	31	2	1	1	8	2	1,3
CY	No platform available	1	49	6	1	0	4	1	1,0
CZ	No platform available	1	64	13	3	25	23	5	3,0
DE	KOMPASS, with case studies, implementation guides, etc.	5	79	22	4	45	27	5	4,7
DK	Webiste (klimatilpasning.dk) with comprehensive information	5	0	1	5	0	4	2	4,0
EE	Little adaptation activities ongoing (http://www.envir.ee/1180211)	1	66	14	3	22	21	4	2,7
EL	No platform available	1	38	4	1	0	4	1	1,0
ES	Very limited information available	1	54	8	2	1	8	2	1,7
FI	Website with some information under the Ministry of Agriculture	3	82	23	4	7	13	3	3,3
FR	Webiste with information on mitigation and adaptation but only medium information content	3	69	16	3	43	26	5	3,7
HU	Website available but with broader focus (http://klima.kvvm.hu)	3	57	10	2	8	14	3	2,7
IE	Specific webiste under EPA Ireland with medium information content	3	74	19	4	13	17	4	3,7
IT	No platform available	1	56	9	2	3	10	2	1,7
LT	Platform not yet available	1	53	7	2	11	15	3	2,0
LU	No specific platform available	1	93	27	5	42	25	5	3,7
LV	Adaptation acitivites just starting, no platform available	1	60	11	2	21	20	4	2,3
MT	No platform available	1	76	21	4	0	4	1	2,0
NL	Website (klimaatonder zoeknederland.nl) with detailed information on case studies and	5	93	27	5	4	11	2	4,0
PL	Need for platform recognized but not yet available	1	62	12	2	16	18	4	2,3
PT	Platform available (adaptacao.clima.pt) but rather	3	44	5	1	1	8	2	2,0
RO	No platform available	1	32	3	1	1	8	2	1,3
SE	Platform available (www.smhi.se/klimat anpassningsportalen) wiht	5	88	25	5	17	19	4	4,7
SI	Need for platform recognized but not yet available	1	71	17	3	6	12	3	2,3
SK	No platform available	1	69	16	3	3	10	2	2,0
UK	UKCIP with comprehensive information, case studies and	5	84	24	5	12	16	3	4,3

12 Annex 5: Baseline – Approach and results by Member State (Move to supplementary report)

12.1 Methodological approach

The baseline combines information on four main elements of the overall problem structure:

1. Illustration of climate change impacts per policy field/main receptor in a qualitative way: each field / receptor is classified and colour-coded (low, medium, high) based on the assessment of regional threats (as presented in Section 2.3).
2. Assessment of current EU spending under the different categories of Cohesion Policy and CAP identified in Section 2.3 per Member State: the matrix allows the comparison of the assessment of impacts with the amounts of EU investments spent in each policy field. Those fields that are characterised by large spending and that have been identified to face medium or high climate change impacts require particular action for climate-proofing.
3. Assessment of domestic adaptive capacities: Information on adaptive capacity, based on the assessment reported in Section 2.4, is important to contextualise the needs for EU attention and climate-proofing. Low or medium adaptive capacities imply risks that impacts and threats of climate change are insufficiently addressed by national authorities.
4. Taken together, these three dimensions allow for an indicative estimate of which policy fields/receptors in Member States will be severely affected under a business as usual scenario and hence should be regarded as priority areas for a strategy of climate-proofing CAP and Cohesion Policy. This information is then used to assess the value added of the different policy options discussed in chapter 3.

The evaluation criteria for each of these elements are presented in Table 49.

Table 49. Evaluation criteria for each of the four elements

Evaluation scheme for element 1: climate change impacts	Evaluation scheme for element 2: Significance of EU expenditures	Evaluation scheme for element 3: adaptive capacity	Evaluation scheme for element 4: Policy fields that require priority attention at EU level
Low (based on results from section 2.3)	Less than 5% of overall CP/CAP spending in the relevant category of expenditure is spent in relevant member state.	Adaptive capacity is high (based on a score in the project's adaptive capacity index above 3.5, see section 2.4)	Low need for action if maximum two classification "orange" or one "red"
Medium (based on results from section 2.3)	5-15% of overall CP/CAP spending in the relevant category of expenditure is spent in relevant member state.	Adaptive capacity is medium (with a score in the adaptive capacity index between 2.1 and 3.5, see section 2.4))	Medium need for action if: - 3 orange classifications, or - 2 orange and one red
High (based on results from section 2.3)	More than 10% of overall CP/CAP spending in the relevant category of expenditure is spent in relevant member state.	Adaptive capacity is low (with a score in the adaptive capacity index below 2, see section 2.4))	High need for action if: - 1 orange, two red classifications, or - 3 red classifications

Please note that this methodology aims at identifying the large-scale risks of climate change on EU investments and the need for climate proofing. As smaller member states generally receive a lower share of EU funding, step 2 of the methodology mostly leads to a rating of medium or low for these countries (e.g. the Baltic countries, Cyprus, Malta but also Slovenia, Bulgaria). For the smaller member states, step 4 of the methodology thus identifies few areas for EU action. It will however be important to consider threats in these countries as well, so a special consideration for these countries should be given in the interpretation.

Relevant categories of expenditure under Cohesion Policy and CAP have been identified per receptor in the relevant sub-chapters of chapter 2. For the baseline assessment, the categories as shown in Table 50 have been considered. For the receptors health and biodiversity, the expenditures include expenditures from some cross-cutting categories, for all other policy fields/receptors the categories can be directly linked.

For agriculture, biodiversity and forestry related CAP expenditures it needs to be recognized that the proposed categories could theoretically be used for adaptation to climate change in these sectors. Currently, only a small proportion of these expenditure categories are however channelled into activities which have a positive influence on adaptation to climate change. Unfortunately, a more focused assessment is not possible at the moment because we know only the funding amount of the categories and not the types and outcomes of the funded activities.

Table 50. Receptors and categories of expenditure

Sectors (receptor)	Relevant categories of expenditure considered for the baseline assessment
Health related expenditures	• 13: Services and applications for citizens (e-health, e-government, e-learning, e-inclusion, etc.) (50% of overall category) • 53: Risk prevention (20% of overall category) • 54: Other measures to preserve the environment and prevent risks (25% of overall category) • 76: Health infrastructure (100% of overall category)
Housing infrastructure	• 78: Housing infrastructure (100% of overall category)
Biodiversity (CP)	• 51: Promotion of biodiversity and nature protection (including Natura 2000), (100%) • 54: Other measures to preserve the environment and prevent risks (25%)
Biodiversity (CAP)	• 213, 214, 216, 224, 412, 323 (50%)
Agriculture (CAP)CP	• CAP measures 112, 113, 115, 121, 126, 131, 132, 133, 141, 142, 222, 215, 311, 411, 413 (50%)
Forestry (CAP)	• CAP measures 122, 123, 221, 222, 223,225, 226, 227
Forestry (CP)	• 53: Risk prevention (10% of overall category)
Industry&Commerce	• 6: Assistance to SMEs for the promotion of environmentally-friendly products and production processes (...) • 9: Other measures to stimulate research and innovation and entrepreneurship in SMEs • 14: Services and applications for SMEs (e-commerce, education and training, networking, etc.)
Tourism	• 55: Promotion of natural assets • 56: Protection and development of natural heritage • 57: Other assistance to improve tourist services
Transport Rail	• Categories 16-19 on rail infrastructures and assets
Transport Road	• Categories 20-23 on road infrastructures
Transport Aviation	• 29: Airports
Transport other	• 24: Cycle tracks • 25: Urban transport • 26: Multimodal transport • 27: Multimodal transport (TEN-T) • 28: Intelligent transport systems • 30: Ports • 31: Inland waterways (regional and local) • 32: Inland waterways (TEN-T) • 52: Promotion of clean urban transport
Energy conv	• Categories 33-38 on electricity, natural gas and petroleum products
Energy renewables	• Categories 39-43 on renewable energies and energy efficiency
Drinking water	• 45:Management and distribution of water (drink water)
Waste water	• 46: Water treatment (waste water)

Source: Own compilation

The following sub-chapters present Member State baselines being grouped according to the classification of climatic regions as done by the European Environment Agency.

12.2 Baseline assessment for the Mediterranean

The following chapter contains the information for the following Member States: Spain, Portugal, Italy, Cyprus, Malta and Greece. The assessment of climate change impacts is based on the analysis in chapter 2.

12.2.1 Baseline for Spain

The baseline table for Spain demonstrates medium or high short-term impacts from climate change for a range of relevant sectors (receptors) (detailed information can be found in chapter 2). Of particular relevance are the receptors health, agriculture, tourism, energy production and water infrastructures. For biodiversity, forestry as well as industry and commerce more moderate climate change impacts are expected. The analysis in chapter 2 makes clear that these impacts will remain relevant in the long-term as well, with an increase in damage costs up to 2080.

In these policy fields/receptors, climate change also affects EU investments under Cohesion Policy and CAP. Currently, the categories of expenditure that fall under the identified policy fields/receptors and are at risk from climate change impacts, receive funding in the magnitude of € 2.2 bn. per year under the Cohesion Funds and € 950 m per year from CAP.[123] The baseline table illustrates that Spain obtains a medium or even high share of overall funding in many of the relevant categories: medium shares in the categories health, agriculture, forestry (both under CP and CAP), industry and commerce, tourism, all transport related categories (except rail), conventional energy and waste water infrastructures; high shares in the categories biodiversity (under CP), forestry (under CAP), rail transport and drinking water. The baseline table shows that some of these areas are estimated to face medium to high impacts from climate change up until 2020.

The adaptive capacity of Spain with regard to policy fields that receive funding under Cohesion Policy and CAP has been classified as medium (with a score in the adaptive capacity index of 2.4 for Cohesion Policy related policy fields and 2.7 for agriculture). It is unclear if Spain's domestic capacities are enough to respond sufficiently to the apparent climate change induced threats to key investment areas for CAP and Cohesion Policy. EU funding should be utilised to support capacity-building in relevant policy areas, as well as ensuring that investments taken are sufficiently assessed and proved for climate change threats.

Based on our analysis the following priority areas can be identified, where particular risks for EU spending needs to be considered and where climate-proofing action will be relevant:

- With high priority: Drinking water infrastructures which faces threats from overall temperature increase and those related to changing precipitation patterns and drought.
- With medium priority: Health related expenditures as Spain will be one of the countries with highest increase in climate-change induced health problems in Europe. Agriculture and forestry will face threats from changing precipitation patterns and drought. The fields of biodiversity, which currently receives a large amount of funding in Spain, waste water infrastructures, industry and commerce and the conventional energy sector will be as well affected through the changing temperatures and precipitation.

[123] The relevant categories of expenditure and their link to the receptors/Policy fields analysed in the frame of this project are illustrated in the sub-chapters per receptor in chapter 2.

Baseline for Spain						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attantion**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	116,4	9%	medium	medium	medium
Housing infrastructure	low	0,0	0%	low	medium	
Biodiversity (CP)	medium	123,7	29%	high	medium	medium
Forestry (CP)	medium	7,4	9%	medium	medium	medium
Industry&Commerce	medium	128,6	8%	medium	medium	medium
Tourism	high	61,3	8%	medium	medium	medium
Transport - Rail	low	535,6	16%	high	medium	
Transport – Road, Aviation, other	low	583,2	30%	medium	medium	
Energy conv	high	19,9	8%	medium	medium	medium
Energy renewables	high	42,8	3%	low	medium	
Drinking water	high	295,7	26%	high	medium	high
Waste water	high	283,4	14%	medium	medium	medium
Common Agriculture Policy						
Biodiversity (CAP)	medium	120,7	6%	medium	medium	medium
Agriculture	high	429,9	7%	medium	medium	medium
Forestry (CAP)	medium	398,2	19%	high	medium	medium

12.2.2 Baseline for Portugal

Portugal will face similar threats from climate change as Spain. Only the housing sector and the transport sector will not face additional risks from climate change, all other policy fields will face medium or even high impacts. Of particular relevance are threats from heat which will affect health, agriculture, tourism, energy supply sector and water infrastructures. Biodiversity and forestry as well as industry and commerce will face medium climate change threats.

Most of the policy fields/receptors that will suffer from climate change also receive medium shares of funding from Cohesion Policy and CAP. Currently, Portugal receives about € 900 m per year from the Cohesion Policy funds and € 440 m per year from CAP in the categories considered in this analysis.[124] The baseline table illustrates that Portugal obtains a medium share of overall funding in many of the relevant categories: health, biodiversity (CAP), forestry (under CP and CAP), industry and commerce, rail transport and aviation as well as water infrastructures. Most of these fields (except transport) will be affected from medium to high impacts from climate change.

The adaptive capacity of Portugal has been classified as medium (with a score in the adaptive capacity index of 2.7 for Cohesion related policy fields and 2.6 for agriculture). It is
Thus unclear if Portugal's are sufficient to deal with the challenges posed by climate change and to climate-proof investments co-funded by CAP and Cohesion Policy. EU funding should be utilised to support capacity-building in relevant policy areas, as well as ensuring that investments taken are sufficiently assessed and proved for climate change threats.

[124] The relevant categories of expenditure and their link to the receptors/Policy fields analysed in the frame of this project are illustrated in the sub-chapters per receptor in chapter 2.

For Portugal the following priority areas can be identified, where particular risks for EU spending needs to be considered and where climate-proofing action will be relevant:

- With medium priority: Several sectors that are directly or indirectly affected from an increase in heat and changing precipitation patterns. Health will be highest necessity to act as Portugal will be one of the regions with highest temperature increases across Europe. Also, biodiversity (especially related to CAP funding) should receive medium priority. The same is true for industry and commerce as well as water related infrastructures where private and public stakeholders will face additional challenges.

Baseline for Portugal						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	82,3	6,3%	medium	medium	medium
Housing infrastructure	low	0,9	0,7%	low	medium	
Biodiversity (CP)	medium	11,5	2,7%	low	medium	
Forestry (CP)	medium	7,3	9,7%	medium	medium	medium
Industry&Commerce	medium	77,7	5,1%	medium	medium	medium
Tourism	high	33,1	4,1%	low	medium	
Transport - Rail	low	197,1	5,7%	medium	medium	
Transport – Road, other	low	204,9	5,6%	low	medium	
Transport Aviation	low	31,2	12,0%	medium	medium	
Energy – conv, renewables	high	38,5	3,8%	low	medium	
Drinking water – waste water	high	205,6	13,8%	medium	medium	medium
Common Agriculture Policy						
Biodiversity (CAP)	medium	29,9	1,5%	low	medium	
Agriculture	high	228,9	3,6%	low	medium	
Forestry (CAP)	medium	177,7	8,6%	medium	medium	medium

12.2.3 Baseline for Italy

For Italy, the baseline table provides a similar picture on climate change threats as for the other Mediterranean countries. Temperature increase, extreme weather events and changing precipitation patterns are the major threats. Many policy fields/receptors that are vulnerable to extreme heat and drought are classified at medium or high risk in Italy as well: health, agriculture, forestry, industry and commerce, tourism and the energy sector (see chapter 2 for detailed information on threats related to these receptors).

As Italy is still an important recipient of funds from Cohesion Policy, these impacts also affect EU investments. Italy receives medium shares of funding under several categories and even high shares on renewable energy sources and tourism. Overall funding from CP under the relevant categories of expenditure amount to € 1.4 bn. per year, CAP funding amounts to € 1.0 bn per year. The baseline

tables shows that some of the categories with medium or high funding shares have also been classified at medium or high risk from climate change. Climate-proofing CP and CAP will thus be highly relevant for Italy.

This need for climate-proofing is intensified through the rather low adaptive capacity of Italy. The project's adaptive capacity index has led to one of the lowest scores for Italy relating to Cohesion Policy (with a score of 1.8). For the CAP sectors, the score leads to a medium adaptive capacity (with a score of 2.3). It is thus highly questionable if Italy will have sufficient domestic resources to respond to climate change induced threats or if action on EU level is necessary to support the relevant activities.

Based on the different steps of the baseline development, several priority areas can be identified, where risks for EU spending needs to be considered and where climate-proofing action will be relevant:

- With high priority: Major threats related to extreme heat with relevance on health, and high threats on renewable energy. Also, tourism is identified as priority area with a double effect in Italy: heat reduces the attractiveness of the Mediterranean as summer destination and changing snow patterns lead to reduction of winter sport possibilities in the Alps.
- With medium priority: Further receptors that are affected from heat should be given medium attention on EU level. This including agriculture (where adaptive capacity is higher than for other policy fields), forestry and industry and commerce.

Baseline for Italy						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	69,4	5%	medium	low	high
Housing infrastructure	low	15,9	12%	medium	low	
Biodiversity (CP)	medium	12,7	3%	low	low	
Forestry (CP)	medium	5,6	7%	medium	low	medium
Industry &Commerce	medium	217,8	14%	medium	low	medium
Tourism	high	128,2	16%	high	low	high
Transport – Rail, Aviation, other	low	514,3	25%	medium	low	
Transport Road	low	92,4	2%	low	low	
Energy conv	high	4,6	2%	low	low	
Energy renewables	high	263,5	21%	high	low	high
Drinking water – waste water	high	82,1	6%	low	low	
Common Agriculture Policy						
Biodiversity (CAP) – Forestry (CAP)	medium	462,9	23%	medium	medium	medium
Agriculture	high	583,5	9%	medium	medium	medium

12.2.4 Baseline for Cyprus

The baseline for Cyprus demonstrates a list of medium and high short-term climate change impacts. Of particular relevance are the following receptors: agriculture will mainly suffer from extreme weather events and high temperatures, so will the health sector as well as water (drinking and waste water) infrastructures. Moreover, summer tourism will become less attractive due to extreme temperatures. Also, biodiversity, forestry and industry and commerce will be affected at a medium risk by climate change.

The baseline table shows that Cyprus receives only low shares of EU funding in all relevant fields. This is due to the small size of Cyprus with less than one million inhabitants. Overall funding from CP amounts to about € 18 m per year and fundings of the CAP to only € 18,4 m per year. Therefore, no large amounts of EU funding are at risk from climate change. However, in relation to overall investments and considering threats to economic development, it might still be relevant to consider climate-proofing of EU funds in Cyprus.

As Cyprus shows only a low adaptive capacity, a score index of 1.8 in CP fields and a score of 2.0 related to agriculture and forestry, it is highly questionable if its domestic recourses will be sufficient to respond to climate change threats. Thus action on EU level might become necessary in order to initiate the appropriate activities.

According to baseline development steps, no fields of priority for EU action could be identified under the methodological approach of this study. This result could emerge from the evaluation methods of the baseline because Cyprus is only a very small country receives relatively little EU funds compared to bigger countries. It might however be relevant, to consider over proportional threats for Cyprus, e.g. related to tourism or health. A more detailed analysis will be necessary in these cases.

Baseline for Cyprus

	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	1,1	0,1%	low	low	
Housing infrastructure	low	0,0	0,0%	low	low	
Biodiversity (CP)	medium	0,0	0,0%	low	low	
Forestry (CP)	medium	0,0	0,0%	low	low	
Industry &Commerce	medium	1,7	0,1%	low	low	
Tourism	high	0,0	0,0%	low	low	
Transport – Rail, Road, Aviation, other	low	12,8	0,4%	low	low	
Energy – conv, renewables	high	0,9	0,1%	low	low	
Drinking water – waste water	high	1,2	0,1%	low	low	
Common Agriculture Policy						
Biodiversity (CAP) – Forestry (CAP)	medium	6,1	0,3%	low	low	
Agriculture	high	12,3	0,2%	low	low	

12.2.5 Baseline for Malta

The baseline for Malta provides a very similar picture as the one for Cyprus. Climate change threats have been identified in the same receptors. The health, agricultural and tourism sector will be mainly affected by heat and extreme weather events. Conventional and renewable energy supply and drinking and waste water treatments will face problems due to climate change in Malta as well.

Malta also receives only little EU funding; € 54 m of Cohesion Policy funds and even less, only € 9 m, of CAP funding. Concluding, no large amounts of EU funds are at high risk of climate change threats.

However, Malta reached even a lower score of adaptive capacity than Cyprus in the adaptive capacity index developed in the frame of this project. The adaptive capacity related to CP fields is one of the lowest (index 1.4), and it does not highly exceed this number in receptors related to agriculture and forestry at a rate of 1.7. EU actions, consequently, will probably become necessary because it is doubtful, whether Malta will be able to react sufficiently to climate change threats by its own capacities.

Based on the baseline development steps there were no fields of priority for EU action identified. For the same reason as mentioned in the case of Cyprus it is likely that our methodological approach underestimates the need of action in comparably small countries.

Baseline for Malta

	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	7,3	0,6%	low	low	
Housing infrastructure	low	0,1	0,1%	low	low	
Biodiversity (CP)	medium	0,0	0,0%	low	low	
Forestry (CP)	medium	0,7	0,9%	low	low	
Industry &Commerce	medium	1,5	0,1%	low	low	
Tourism	high	3,5	0,4%	low	low	
Transport – Rail, Road, Aviation, other	low	26,9	0,7%	low	low	
Energy – conv, renewables	high	5,0	0,4%	low	low	
Drinking water – waste water	high	8,8	0,5%	low	low	
Common Agriculture Policy						
Biodiversity (CAP) – Forestry (CAP)	medium	4,2	0,3%	low	low	
Agriculture	high	4,8	0,1%	low	low	

12.2.6 Baseline for Greece

The baseline of Greece demonstrates an image of medium to high short-term impacts from climate change in a range of relevant receptors. Of particular relevance are the receptors health, agriculture,

tourism, conventional and renewable energy as well as water infrastructures. The receptors biodiversity, forestry as well as industry and commerce will face medium risks.

In these fields EU investments under Cohesion Policy and CAP are endangered by climate change because Greece is still a recipient of shares for most relevant receptors. Except for transport, Greece still receives medium investments in categories of expenditure being affected by climate change at a classified medium or high risk. The Cohesion Policy shares reach an annual amount of € 1.5 bn. and CAP shares amount to approximately € 400 m. Hence, climate-proofing CP and CAP will be of high importance for Greece.

Greece shows only low adaptive capacity scores in all relevant fields. In agriculture and forestry it reaches a score index of 1.5 and even less with 1.4 in Cohesion Policy relevant receptors. Therefore, the need for EU Climate-Proofing is even highlighted by these figures and the fact that Greece will probably not be able to respond sufficiently to climate change threats by own domestic resources.

Based on our analysis the following priority areas can be identified, where particular risks for EU spending needs to be considered and where climate-proofing action will be relevant:

- With high priority: Major threats caused by extreme heat on health, drinking water supply and waste water treatment. Furthermore, high priority lies on conventional energy infrastructures.
- With medium priority: Biodiversity and forestry will be affected by extreme weather events, high temperatures and fires. Also, industry and commerce is classified as a field of medium priority.

Baseline for Greece

	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	130,6	10,0%	medium	low	high
Housing infrastructure	low	0,0	0,0%	low	low	
Biodiversity (CP)	medium	29,8	6,9%	medium	low	medium
Forestry (CP)	medium	6,8	9,1%	medium	low	medium
Industry &Commerce	medium	123,8	8,2%	medium	low	medium
Tourism	high	24,6	3,0%	low	low	
Transport Rail	low	115,8	3,4%	low	low	
Transport – Road, Aviation, other	low	778,5	29,7%	medium	low	
Energy conv	high	37,3	14,7%	medium	low	high
Energy renewables	high	52,0	4,1%	low	low	
Drinking water – waste water	high	199,7	12,5%	medium	low	high
Common Agriculture Policy						
Biodiversity (CAP)	medium	59,9	3,1	low	low	
Agriculture	high	224,8	3,5%	low	low	
Forestry (CAP)	medium	112,9	5,5%	medium	low	medium

12.3 Baselines for Central and Eastern Europe

The following chapter contains the information for the following Member States: Poland, Hungary, Czech Republic, Slovakia, Slovenia, Bulgaria, Romania, Austria, Germany, and Luxembourg.

12.3.1 Baseline for Poland

For Poland, the baseline table shows medium and high short-term climate change impacts in all policy fields/receptors with relevance for Cohesion Policy and CAP (see chapter 2 for detailed information). Particularly, the health sector and the drinking and waste water infrastructures will face major high threats related to increasing temperatures and changing precipitation patterns. Also, all transport infrastructures (road, rail and aviation) as well as conventional and renewable energy infrastructures will be highly affected. All other sectors, especially the ones relevant to CAP, will face medium risks. These impacts will maintain their relevance beyond 2020.

These impacts also affect EU investments under Cohesion Policy and CAP. Currently, the categories of expenditure that fall under the identified policy fields/receptors and are at risk from climate change impacts, receive funding in the magnitude of € 5.2 bn. per year under the Cohesion Policy funds and € 1.2 bn. per year from CAP. The baseline table illustrates that Poland receives medium or even high shares under all relevant categories of expenditure of which all will be affected from climate change until 2020 with medium or high impacts.

The adaptive capacity of Poland with regard to policy fields that receive funding under Cohesion Policy has been classified as low (score in adaptive capacity index 1.3) and the adaptive capacity related to agriculture and forestry as medium (score 2.1). It is thus unclear if Poland's capacities are developed sufficiently to deal with climate change induced threats to key investments under Cohesion Policy and CAP. There might be the need for supportive action from the EU.

Based on our analysis the following priority areas can be identified, where particular risks for EU spending needs to be considered and where climate-proofing action will be relevant:

- With high priority: All transport, water and energy infrastructures as well as buildings are affected mostly from extreme precipitation events and flooding. This poses challenging for the initial planning/layout of infrastructures and to make them more resilient to storms, high precipitation and river flooding. Also, health has to be considered as a major priority area for the EU as it shows only low adaptive capacity to the estimated climate changes.
- With medium priority: Agriculture, biodiversity and forestry have to be seen as a medium priority area for EU action. In this policy field, Poland is mostly affected from drought and changing precipitation patterns.

Baseline for Poland						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	High	229,8	18%	high	low	high
Housing infrastructure	medium	34,7	27%	high	low	high
Biodiversity (CP)	medium	21,9	5%	medium	low	medium
Forestry (CP)	medium	11,7	14%	medium	low	medium
Industry&Commerce	medium	228,6	15%	medium	low	medium
Tourism	medium	139,9	17%	high	low	high
Transport – Rail, Road, Aviation, other	high	3.662,7	121%	high	low	high
Energy conv	high	147,8	58%	high	low	high
Energy renewables	high	170,8	13%	medium	low	high
Drinking water	high	70,9	6%	medium	low	high
Waste water	high	452,5	23%	high	low	high
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	1.161,6	30%	medium	medium	medium

12.3.2 Baseline for Hungary

The baseline of Hungary shows a very similar picture compared to Poland. It contains major high and medium climate threats in the same areas: health, tourism, all transport infrastructures, conventional and renewable energy, drinking water supply and waste water treatment are identified to face high risk. The private property sector/housing infrastructures, biodiversity, agriculture, forestry and industry and commerce face medium risk.

These impacts by climate change also affect EU investments under CP and CAP because most of the relevant mentioned receptors receive medium or high shares. The total annual amount of CP adds up to € 1.8 bn. and CAP investments amount to € 440 m per year. Highly relevant for climate-proofing, will be investments in receptors like health, and forestry, of medium relevance will be shares in the housing infrastructure, tourism, all transport (except aviation) and drinking and waste water infrastructure fields.

Hungary shows only a medium adaptive capacity. Based on the adaptive capacity index, its scores reach a rate of 2.4 in Cohesion Policy relevant receptors and a slightly higher index of 3.0 in agriculture and forestry. Thus it remains questionable if Hungary's capacities are developed sufficiently in order to respond proportionately to threats induced by climate change. EU interventions and supportive actions might become necessary.

Based on our analysis the following priority areas can be identified, where particular risks for EU spending needs to be considered and where climate-proofing action will be relevant:

- With high priority: Threats from temperature increase will affect the health sector very strongly. Hospitals need to be prepared for increasing numbers of patients due to heat and they will have to improve their building infrastructure and cooling systems.
- With medium priority: Similar as the health sector, the private housing infrastructure needs to adapt to extreme weather events and increasing temperatures. Also classified with medium priority are the receptors biodiversity, forestry and tourism, all transport infrastructures (except aviation), drinking water supply and waste water treatment.

Baseline for Hungary						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	247,0	19%	high	medium	high
Housing infrastructure	medium	17,7	14%	medium	medium	medium
Biodiversity (CP)	medium	30,9	7%	medium	medium	medium
Forestry (CP)	medium	13,9	18%	high	medium	medium
Industry&Commerce	medium	59,9	4%	low	medium	
Tourism	high	64,0	8%	medium	medium	medium
Transport – Rail, Road, other	high	999,6	27%	medium	medium	medium
Transport Aviation	high	0,0	0%	low	medium	
Energy – conv, renewables	high	51,3	4%	low	medium	
Drinking water – waste water	high	279,8	17%	medium	medium	medium
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	440,8	12%	low	medium	

12.3.3 Baseline for Czech Republic

For the Czech Republic, the baseline table shows a moderate to high picture regarding threats from climate change. The major threats will arise in the health, energy and water fields. Furthermore, transportation and water infrastructures will face damages from climate change, mostly through flooding and weather extremes (see chapter 2 for detailed information on threats related to these receptors).

Though limited, these impacts also affect EU investments under Cohesion Policy and CAP. The Czech Republic currently receives medium shares of funding under most of the relevant categories. Overall funding from Cohesion Policy under the relevant categories of expenditure amount to € 1.9 bn. per year, CAP fundings are much less relevant with only € 340 m. per year. Most of the categories with medium funding shares are at medium or even high risk from climate change impacts. Therefore, a climate-proofing of EU funds will become highly relevant.

The adaptive capacity of the Czech Republic with regard to policy fields that receive funding under Cohesion Policy and CAP has been classified as medium (with a score in the adaptive capacity index of 2.0 for Cohesion related policy fields and 3.1 for agriculture). It is unclear if domestic capacities are enough to respond sufficiently to climate change induced threats as identified for transportation investments.

Based on our analysis, several medium priority areas can be identified, where risks for EU spending need to be considered and where climate-proofing action will be relevant:

- With medium priority: Transportation and water facilities which are affected through flooding and extreme weather events and where it needs to be ensured that they are constructed in the most resilient way to prevent lock-in effects of those long-lasting infrastructures. Health related expenditures will also face high damages by increasing temperatures thus improvement of buildings and cooling systems will be necessary. Also an effect of extreme temperatures will be the impacts on the energy and drinking and waste water systems.

Baseline for Czech Republic						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	112,0	9%	medium	medium	medium
Housing infrastructure	medium	0,0	0%	low	medium	
Biodiversity (CP)	medium	87,1	20%	high	medium	medium
Forestry (CP)	medium	4,7	6%	medium	medium	medium
Industry&Commerce	medium	67,7	4%	medium	medium	medium
Tourism	medium	96,1	12%	medium	medium	medium
Transport – Rail, Road, Aviation, other	high	1.109,9	33%	medium	medium	medium
Energy conv	high	0,0	0%	low	medium	
Energy renewables	high	187,7	15%	medium	medium	medium
Drinking water – waste water	high	249,4	15%	medium	medium	medium
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	336,3	9,3%	low	medium	

12.3.4 Baseline for Slovakia

Concerning the impacts of climate change for the relevant sectors, the baseline of Slovakia shows that the receptors health, transport, energy and water will suffer under high short-term impacts. Other receptors like housing, biodiversity, agriculture, forestry, industry and tourism are confronted with moderate impacts. Referring to chapter 2 it becomes clear that the relevant sectors will have to cope with these climate change impacts also in the future, as the damage costs will increase until 2080.

Regarding EU funding that is received by Slovakia the amount of funding being at risk through climate change amounts to nearly € 770 m under the Cohesion Policy funds. The amount of CAP funding that Slovakia obtains and that will be under risk concerning climate change impacts equals € 250 m. The baseline shows, that Slovakia therefore receives a relatively small amount of EU funding under Cohesion Policy or CAP. In the categories health, rail transport and waste water the amount received of EU funding is categorised as medium whereas all other relevant policy fields only receive a small share of EU funding. Although most of the relevant receptors derive rather little EU spending, the impacts that those areas face are medium to large. This dilemma should be kept in mind.

The adaptive capacity of Slovakia with regard to the policy fields that receive funding under Cohesion Policy are all categorised as low while the three CAP receptors biodiversity, forestry and agriculture are classified as medium regarding their adaptive capacity. As most relevant policy fields only show low adaptive capacity, EU funding should be utilised to increase Slovakia's adaptive capacity in the identified sectors.

The priority areas that are derived under this methodology are:

- With high priority: Health related expenditures, as Slovakia receives a medium amount of funding under the relevant categories and at the same time faces increasing temperatures. Also the important rail and waste water infrastructures are highly at risk and EU policy intervention should concentrate on this policy field.

Baseline for Slovakia

	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	83,5	6,4%	medium	low	high
Housing infrastructure	medium	2,5	2,0%	low	low	
Biodiversity (CP)	medium	9,0	2,1%	low	low	
Forestry (CP)	medium	2,0	2,6%	low	low	
Industry&Commerce	medium	15,8	1,0%	low	low	
Tourism	medium	11,3	1,4%	low	low	
Transport Rail	high	179,1	5,2%	medium	low	high
Transport – Road, Aviation, other	high	313,3	6,3%	low	low	
Energy – conv, renewables	high	24,1	1,9%	low	low	
Drinking water	high	12,9	1,1%	low	low	
Waste water	high	114,3	5,7%	medium	low	high
Common Agriculture Policy						
Biodiversity (CAP) Agriculture – Forestry (CAP)	medium	249,9	6,3%	low	medium	

12.3.5 Baseline for Slovenia

The baseline table of Slovenia demonstrates medium to high short-term impacts caused by climate change. Highly threatened receptors are the health, transportation infrastructure, energy and drinking and waste water infrastructure fields. Classified at medium risk are the private housing sector, biodiversity, agriculture, forestry, industry and commerce and tourism.

These impacts do not strongly affect EU funding under Cohesion Policy or CAP. Currently, Slovenia receives low shares of both investments, annually amounting to € 290 m under Cohesion Policy and € 83 m under CAP. This is due to the size of the country which can absorb only lower amounts of funding than the larger EU member states. However, it needs to be kept in mind that all categories analysed in the baseline are at medium or even high risk from climate change.

Slovenia shows a medium adaptive capacity with a score index of 2.3 related to Cohesion Policy relevant receptors and an index of 2.8 referring to agriculture and forestry. Thus Slovenia is probably rather capable of responding to climate change threats but, however, in the future supportive actions of the EU might become more relevant considering the high impacts from climate change.

Based on the baseline development steps there were no fields of priority for EU action identified. It is, however, likely that our methodological approach underestimates the need of action in comparably small countries like Slovenia.

Baseline for Slovenia

	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	10,5	0,8%	low	medium	
Housing infrastructure	medium	0,0	0,0%	low	medium	
Biodiversity (CP)	medium	7,1	1,6%	low	medium	
Forestry (CP)	medium	1,4	1,8%	low	medium	
Industry&Commerce	medium	31,9	2,1%	low	medium	
Tourism	medium	11,4	1,4%	low	medium	
Transport – Rail, Road, Aviation, other	high	141,4	5,1%	low	medium	
Energy – conv, renewables	high	22,8	1,8%	low	medium	
Drinking water – waste wtaer	high	64,3	4,4%	low	medium	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture, Forestry (CAP)	medium	103,1	2,8%	low	medium	

12.3.6 Baseline for Bulgaria

The baseline of Bulgaria makes clear that a high amount of policy fields and therefore EU funding receiving receptors are confronted with high climate change impacts. Concerning these impacts the following sectors will suffer from high climate change impacts: health, transport, energy and water (and therefore all their specified sub-sectors). The policy fields housing infrastructure, biodiversity, agriculture, forestry, industry and tourism will face climate change impacts on a medium level.

The overall Cohesion Policy funding for these categories of expenditure – which is therefore at risk from climate change - sums up to more than € 535 m. CAP funding that is endangered amounts to € 240 m. As these amounts are in e.g. comparison to Spain relatively low due to the much smaller size of Bulgaria, nearly all policy fields, except waste water are categorised low regarding EU funding share. Waste water receives a moderate share of EU funding. For the other policy fields, it has to be kept in mind that EU action might still be necessary to avoid over proportional threats.

Although the adaptive capacity in Bulgaria of all 16 receptors are categorised low there is only one policy field that will need some sort of EU intervention. The one priority that is identified for EU intervention is waste water. As waste water infrastructure is one essential basic infrastructure, this policy field is categorised as medium concerning EU policy need for action.

Baseline for Bulgaria						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	18,0	1,4%	low	low	
Housing infrastructure	medium	4,6	3,6%	low	low	
Biodiversity (CP)	medium	11,5	2,7%	low	low	
Forestry (CP)	medium	0,7	1,0%	low	low	
Industry&Commerce	medium	23,9	1,6%	low	low	
Tourism	medium	12,2	1,5%	low	low	
Transport – Rail, Road, Aviation, other	high	289,3	7,5%	low	low	
Energy – conv, renewables	high	42,9	5,6%	low	low	
Drinking water	high	23,8	2,1%	low	low	
Waste water	high	109,8	5,5%	medium	low	medium
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	238,8	6,1	low	low	

12.3.7 Baseline for Romania

The baseline for Romania shows a wide range for EU policy intervention. Nine out of 16 defined policy fields are threatened by high short-term climate change impacts. The receptors in this categorisation are health, transport, energy and water. Housing infrastructure, biodiversity, agriculture, forestry, industry and tourism are at medium risk. The analysis in chapter 2 makes clear

that these impacts will remain relevant in the long-term as well, with an increase in damage costs up to 2080.

In all these policy fields spending from EU Cohesion policy and from CAP will be affected by the climate change impacts. Overall, more than €1.4 bn Cohesion Policy funding and € 710 Mio. CAP funding is at risk as these are the amounts that are currently invested in Bulgaria. The baseline table demonstrates that Romania receives a high, medium or low share of overall EU funding. The areas of health, forestry (CP) and transport (aviation and other) obtain low amounts of EU funding, whereas housing infrastructure, biodiversity, agriculture, forestry (CAP), tourism, transport (rail and road), waste water and the whole energy sector gets a medium amount of overall EU spending. Drinking water receives even a high amount of overall EU spending. As these policy fields are identified to be at medium or high risk, climate-proofing of EU investments will become crucial in Romania.

Unfortunately, Romania can display only low adaptive capacity in all defined policy fields. It is therefore doubtful, if Romania is able to respond sufficiently to the apparent climate change induced threats to key investment areas of EU funding. This fact combined with the risks for current EU spending leads to an overall amount of eleven policy fields that will have need for EU action.

Based on this analysis, the following policy areas are derived as targeted policy fields that will need to undergo EU intervention:

- With high priority: The two transport areas rail and road will strongly suffer under climate change impacts such as river flooding. As these components are important parts of a well-functioning national infrastructure system special attention is required. Both energy and water infrastructures face the same high risk-level as these sectors represent also important parts of national infrastructure whereas especially water is highly important regarding minimum living standards.
- With medium priority: Concerning housing infrastructure, biodiversity, agriculture and forestry (CAP), Romania will not be able to stem the organisational and financial requirements to deal with the climate change impacts adequately. The EU should therefore be prepared to intervene in these policy fields.

Baseline for Romania						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	47,3	3,6%	low	low	
Housing infrastructure	medium	16,0	12,5%	medium	low	medium
Biodiversity (CP)	medium	29,1	6,7%	medium	low	medium
Forestry (CP)	medium	3,4	4,6%	low	low	
Industry&Commerce	medium	56,1	3,7%	low	low	
Tourism	medium	62,5	7,7%	medium	low	medium
Transport – Rail, Road	high	672,6	14,9%	medium	low	high
Transport – Aviation, other	high	94,7	5,9%	low	low	
Energy – conv, renewables	high	86,3	13,9%	medium	low	high
Drinking water	high	198,3	17,3%	high	low	high
Waste water	high	198,3	10,0%	medium	low	high
Common Agriculture Policy						
Biodiversity (CAP)	medium	69,6	3,5%	low	low	
Agriculture – Forestry (CAP)	medium	638,5	16,9%	medium	low	medium

12.3.8 Baseline for Austria

For Austria, the baseline table provides a similar picture regarding threats from climate change. The policy fields health, transport, energy and water infrastructures will face high impacts from climate change, already in the short-term up to 2020. Some medium impacts can be identified related to the receptors housing/private properties (affected from storms, extreme snowfall, landslides, etc.), agriculture, forestry, industry and commerce as well as tourism where especially winter tourism in the Alps will be affected (see chapter 2 for detailed information).

As Austria receives very little funding under Cohesion Policy and Cap there is also no risk that major EU investments are affected from climate change. Climate-proofing via Cohesion Policy and CAP thus has a low importance with regard to Austria. This estimate is reinforced when the adaptive capacity of Austria is considered. Adaptive capacity with respect to policy fields relevant for Cohesions Policy and in the field of agriculture has been classified as high due to major efforts on national level to deal with climate change.

Baseline for Austria						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	0,3	0,0%	low	high	
Housing infrastructure	medium	0,0	0,0%	low	high	
Biodiversity (CP)	medium	0,0	0,0%	low	high	
Forestry (CP)	medium	0,1	0,2%	low	high	
Industry&Commerce	medium	8,6	0,6%	low	high	
Tourism	medium	1,9	0,2%	low	high	
Transport – Rail, Road, Aviation, other	high	0,9	0,0%	low	high	
Energy – conv, renewables	high	4,5	0,3%	low	high	
Drinking water – waste water	high	0,0	0,0%	low	high	
Common Agriculture Policy						
Biodiversity (CAP) Agriculture	medium	488,6	12,8%	medium	high	
Forestry (CAP)	medium	27,0	1,3%	low	high	

12.3.9 Baseline for Germany

The baseline table for Germany shows several relevant impacts from climate change that have the potential to affect funding under Cohesion Policy and CAP. As Germany has a dense infrastructure network, this will be especially vulnerable to climate change impacts, with high impacts expected for road, rail and aviation infrastructures, conventional and renewable energy supply, medical healthcare and drinking and waste water infrastructures. Medium impacts are estimated for building properties, biodiversity, agriculture and forestry, industry and commerce and tourism (see chapter 2 for detailed information on threats related to these receptors).

These impacts also affect EU investments under Cohesion Policy and CAP. Although most of German regions are classified as more developed regions, the eastern part of Germany still receives a considerable amount of funding under Cohesion Policy. Overall funding from Cohesion Policy under the relevant categories of expenditure amount to about € 800 m per year, for CAP about € 1 bn per year. Germany receives medium shares of the relevant categories of expenditures in the categories biodiversity (CAP), agriculture, forestry (both Cohesion Policy and CAP), industry and commerce, tourism, road infrastructures as well as renewable energies. The baselines table makes clear that some of these categories will also face medium or even high threats from climate change.

However, the need for action on EU level for climate-proofing the relevant investments has a lower priority with respect to Germany due to the high adaptive capacity to deal with climate change issues on national level. Germany has received one of the highest scores in the adaptive capacity index so the need for supportive action from the EU is less crucial.

Thus, no fields for priority attention at EU level have been identified.

Baseline for Germany						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	high	23,7	2%	low	high	
Housing infrastructure	medium	0,0	0%	low	high	
Biodiversity (CP)	medium	9,8	2%	low	high	
Forestry (CP)	medium	6,4	8%	medium	high	
Industry&Commerce	medium	103,2	7%	medium	high	
Tourism	medium	51,6	6%	medium	high	
Transport – Rail, Aviation, other	high	174,1	6%	low	high	
Transport Road	high	279,5	5%	medium	high	
Energy conv	high	0,1	0%	low	high	
Energy renewables	high	73,9	6%	medium	high	
Drinking water – waste water	high	53,9	3%	low	high	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture - Forestry (CAP)	medium	1.045, 0	30%	medium	high	

12.4 Baselines for North-Western Europe

The following chapter contains information on the baselines for the following countries: Denmark, Netherlands, France, Belgium, UK and Ireland

12.4.1 Baseline for Denmark

The baseline for Denmark gives very diverse information on threatened policy fields. Temperature increase will be less relevant in the short-term in the North and North-Western countries so that sectors mostly affected from this impact are not at risk. This leads to low climate change impacts for Denmark for health, industry, the energy and water sector; there are however ten receptors that are facing medium estimated climate change impacts. These relevant areas are: biodiversity, agriculture, forestry (both CAP and Cohesion Policy), industry and the whole transport sector. Of particular relevance is housing infrastructure as this sector faces high climate changes impacts, especially from storms and flooding.

As Denmark is one if the highest developed economies in Europe it receives only little support by the EU (about € 10 m per year from CP and € 70 m per year from CAP). EU funding is in all 17 relevant policy fields low.

The low relevance for EU climate-proofing is supported by a high adaptive capacity in Denmark concerning all relevant policy categories. Denmark seems to be able to respond adequately to the challenges of climate change impacts.

To summarize Denmark's baseline, it becomes clear that this EU member state does not have a singly policy field where EU intervention is required. This is because of the only small amount of EU funding going into this country and the country's high adaptive capacity which makes it able to cope well with climate threats.

Baseline for Denmark						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	0,0	0,0%	low	high	
Housing infrastructure	high	0,0	0,0%	low	high	
Biodiversity (CP)	medium	0,0	0,0%	low	high	
Forestry (CP)	medium	0,0	0,0%	low	high	
Industry&Commerce	medium	8,6	0,6%	low	high	
Tourism	low	1,8	0,2%	low	high	
Transport –Rail, Road, Aviation, other	medium	0,0	0,0%	low	high	
Energy – conv, renewables	low	0,0	0,0%	low	high	
Energy renewables	low	0,0	0,0%	low	high	
Drinking water – waste water	low	0,0	0,0%	low	high	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	68,2	2,2%	low	high	

12.4.2 Baseline for the Netherlands

The baseline for the Netherlands is similar to the baseline of Denmark. As well as above, this country also shows low, medium and high climate impacts threatened policy fields. The receptors health, tourism, energy and water all face low climate change impacts. In comparison to that, biodiversity, agriculture, industry, complete forestry sector and complete transport sector are confronted with estimated medium climate change impacts. Of particular relevance is again housing infrastructure: the sector is challenged by high climate change threats especially from flooding (both coastal and river) and storms.

The Netherlands receives only small amount of Cohesion Policy and CAP funding. There is no policy field that receives more than 1% of overall EU spending in the relevant category. Hence it becomes clear that in the Netherlands no high amounts of EU funding are at risk.

The adaptive capacity of the Netherlands with regard to policy fields that receive funding under Cohesion Policy and CAP has been classified as high. All 17 relevant receptors seem to be able to cope with climate change threats; at least they will be able to deal with climate challenges better than e.g. Poland as the Netherlands adaptive capacity index are with 4.7 for Cohesion policy related fields and 3.6 for agriculture one of the highest in Europe.

There is not policy field identified that would need EU funding intervention.

Baseline for the Netherlands						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	0,9	0,1%	low	high	
Housing infrastructure	high	0,0	0,0%	low	high	
Biodiversity (CP)	medium	0,7	0,2%	low	high	
Forestry (CP)	medium	0,0	0,0%	low	high	
Industry&Commerce	medium	15,6	1,0%	low	high	
Tourism	low	4,6	0,6%	low	high	
Transport – Rail, Road, Aviation, other	medium	7,2	0,3%	low	high	
Energy – conv, renewables	low	9,1	1,2%	low	high	
Drinking water – waste water	low	0,3	0,0%	low	high	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	64,9	1,9%	low	high	

12.4.3 Baseline for France

For France, the baseline table provides a range with all three categories (low, medium, high) regarding short-term climate change impacts. The sectors health, tourism, energy and water are expected to face low climate change impacts, while biodiversity, agriculture, forestry (CP and CAP) and transport are threatened by medium level climate change impacts. Again, the policy field housing infrastructure is suspected to face high short-term climate change impacts.

Looking now at the expenditures taken by the EU it becomes obvious that in most categories, no high amount of EU funding will be at risk in France. Under Cohesion Policy, France still receives quite a large amount of funding (€ 450 m), but these go mostly into categories that are identified ad low or medium risk. Under CAP, France obtains larger shares of funding and all three relevant categories (biodiversity, agriculture, forestry) are also identified to be at medium risk.

A need for climate-proofing by the EU seems however less pressing as the adaptive capacity index for France is high in all policy fields. The concrete measurements of the score are 4.0 regarding Cohesion Policy related fields and 3.7 regarding agriculture. The overall picture leads to the conclusion that no policy field in the baseline will need financial support by the EU to cope with the climate change threats in France.

Baseline for France						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	25,1	1,9%	low	high	
Housing infrastructure	high	0,0	0,0%	low	high	
Biodiversity (CP)	medium	26,7	6,2%	medium	high	
Forestry (CP)	medium	2,4	3,1%	low	high	
Industry&Commerce	medium	74,5	4,9%	low	high	
Tourism	low	36,5	4,5%	low	high	
Transport – Rail, Road, Aviation, other	medium	160,4	6,5%	low	high	
Energy conv	low	0,0	0,0%	low	high	
Energy renewables	low	88,4	6,9%	medium	high	
Drinking water - waste water	low	39,3	2,8%	low	high	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture	medium	700,2	16,4%	medium	high	
Forestry (CAP)	medium	94,0	4,6%	low	high	

12.4.4 Baseline for Belgium

The baseline for Belgium shows a very similar picture to the one of France. Again, the policy fields are classified after a qualitative model: health, tourism, energy and water sector will have to deal with low climate change threats. Biodiversity, agriculture, forestry (CP and CAP), industry and the complete transport sector will suffer under medium climate change impacts whereas - again – housing infrastructure faces the highest short-term climate change impacts.

As Belgium receives small amounts of EU funding, the need for climate-proofing these policy-fields is less relevant. The share of funding for each policy field is less than 1% in each category. Overall, Belgium obtains about € 30 m under CP and € 60 m from CAP.

At the same time, Belgium has a high adaptive capacity in all relevant policy fields (with a score of 3.6 both for Cohesion and CAP). This fact and the other results of the analysis lead to the conclusion that Belgium is not reliant upon EU financial intervention regarding short-term climate change threats.

Baseline for Belgium						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	0,0	0%	low	high	
Housing infrastructure	high	0,0	0%	low	high	
Biodiversity (CP)	medium	0,2	0%	low	high	
Forestry (CP)	medium	0,0	0%	low	high	
Industry&Commerce	medium	10,9	1%	low	high	
Tourism	low	4,6	1%	low	high	
Transport – Rail, Road, Aviation, other	medium	8,5	0,3%	low	high	
Energy – conv, renewables	low	4,4	0,3%	low	high	
Drinking water – waste water	low	0,0	0%	low	high	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	57,5	1,6%	low	high	

12.4.5 Baseline for the UK

For the UK the baseline provides a similar picture on climate change threats as for the rest of the North-Western countries. Receptors that are identified to suffer under medium level short-term climate change threats are biodiversity, agriculture, forestry (Cohesion Policy and CAP), industry and the complete transport sector. Private properties (housing infrastructures) will face high impacts from climate change due to river and coastal flooding as well as storm.

Looking at EU funding, it becomes apparent that the UK receives mostly low shares of funding in the relevant categories of expenditure. Under CAP funding with an overall amount of € 600 m going to the UK, the receptors biodiversity and agriculture receive medium shares of funding (with UK biodiversity obtaining more than 10% of overall EU funding). Concerning Cohesion Policy, only the industry and commerce policy-field obtains a medium amount. This shows a less pressing picture for climate-proofing EU investments and to a focus on CAP.

However, the UK has one of the best scores in our adaptive capacity index: for Cohesion Policy related fields with a score of 4.4, while the adaptive capacity scores for agriculture is 4.2. With both adaptive capacity scores being so high, there will be no need for EU action concerning climate change threats in the UK.

Baseline for the UK						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	2,7	0,2%	low	high	
Housing infrastructure	high	0,0	0,0%	low	high	
Biodiversity (CP)	medium	0,9	0,2%	low	high	
Forestry (CP)	medium	0,0	0,0%	low	high	
Industry&Commerce	medium	125,8	8,3%	medium	high	
Tourism	low	17,3	2,1%	low	high	
Transport – Rail, Road, Aviation, other	medium	69,9	3,5%	low	high	
Energy – conv, renewables	low	44,7	3,6%	low	high	
Drinking water – waste water	low	0,0	0,0%	low	high	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture	medium	531,2	15,5%	medium	high	
Forestry (CAP)	medium	72,0	3,5%	low	high	

12.4.6 Baseline for Ireland

For Ireland, the baseline offers a slightly different pattern regarding adaptive capacity, but still the result is the same as in the other North-Western European countries. Turning first to climate change impacts, six receptors are identified which face low climate change threats. These six are the sectors health, tourism, energy and water. In comparison to that, ten receptors are suspected to deal with medium level climate change impacts. These fields are: biodiversity (Cohesion Policy and CAP), agriculture, forestry (Cohesion Policy and CAP), industry and the complete transport sector. Housing infrastructure will face high climate change threats like in the rest of North-Western European countries.

Ireland receives only little amount of EU funding under the categories relevant for the baseline assessment (about € 20 m under Cohesion Policy and € 300 under CAP). The sector where it receives most of overall EU spending is agriculture, but still most of the 17 defined receptors are identified to receive only low amounts of EU funding. The exception is CAP funding going to biodiversity, where Ireland receives about 6% of total EU funds under the relevant categories.

What is now different in comparison to all other North-Western countries is the fact that Ireland is suspected to have only medium adaptive capacity. The score estimated for Cohesion Policy related policy fields is estimated at a score of 3.0 whereas the score for agriculture policy fields is with 3.4 a bit higher. But both scores are therefore lower than in UK, Belgium, France, Netherlands and Denmark and are hence classified as medium.

Summing up, the analysis leads us to the conclusion that although Ireland shows only medium adaptive capacity there is still no major need for EU intervention in Ireland. Only for biodiversity funding under CAP, a medium need for action is identified. Similar to other smaller member states,

there might however be the risk of over proportional impacts which need to be considered in a more detailed analysis.

Baseline for Ireland						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	0,0	0,0%	low	medium	
Housing infrastructure	high	0,0	0,0%	low	medium	
Biodiversity (CP)	medium	0,0	0,0%	low	medium	
Forestry (CP)	medium	0,0	0,0%	low	medium	
Industry&Commerce	medium	0,0	0,0%	low	medium	
Tourism	low	0,5	0,1%	low	medium	
Transport – Rail, Road, Aviation, other	medium	11,9	0,3%	low	medium	
Energy – conv, renewables	low	3,6	0,3%	low	medium	
Drinking water – waste water	low	1,9	0,1%	low	medium	
Common Agriculture Policy						
Biodiversity (CAP)	medium	112,4	5,7%	medium	medium	medium
Agriculture – Forestry (CAP)	medium	200,9	3,1%	low	medium	

12.5 Baselines for Northern Europe

The following chapter contains information on the baselines for the following countries: Finland, Sweden, Estonia, Latvia, Lithuania

12.5.1 Baseline for Finland

The baseline table for Finland provides comprehensive information on climate change impacts for the 17 defined receptors. Health, tourism, the energy and water infrastructures are expected to face low climate change threats due an under proportional temperature increase in the Northern countries. Biodiversity (CP and CAP), agriculture, forestry (CP and CAP), industry and the complete transport sector will suffer from medium short-term climate change impacts. Housing infrastructure stands out as this policy field will face high climate change threats. This policy field is vulnerable to extreme weather events as well as coastal and river flooding.

Fortunately, there is no high budget of EU funding at risk when we look at Finland. The highest share of overall EU funding that Finland shows is 3.2% in the agriculture sector. But still this share is categorised low and all other shares in the 17 policy fields are even lower. Currently, the categories of expenditure that fall under the identified policy fields receive funding in the magnitude of € 40 m per year under the Cohesion Funds and € 260 m from CAP.

The adaptive capacity of Finland with regard to policy fields that receive funding under Cohesion Policy and CAP has been classified as high (with a score in the adaptive capacity index of 4.0 for Cohesion related policy fields and 4.1 for agriculture). It thus seems highly probable that Finland will be able to respond sufficiently to climate change threats.

There are no policy fields identified where any EU financial support is required in the future.

Baseline for Finland						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	3,7	0,3%	low	high	
Housing infrastructure	high	0,0	0,0%	low	high	
Biodiversity (CP)	medium	0,8	0,2%	low	high	
Forestry (CP)	medium	0,1	0,1%	low	high	
Industry&Commerce	medium	16,5	1,1%	low	high	
Tourism	low	7,3	0,9%	low	high	
Transport –Rail, Road, Aviation, other	medium	5,2	0,2%	low	high	
Energy – conv, renewables	low	6,4	0,5%	low	high	
Drinking water – waste water	low	1,4	0,1%	low	high	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	263,1	6,2%	low	high	

12.5.2 Baseline for Sweden

The baseline for Sweden shows in a comprehensive way, that Sweden faces low climate change impacts in the policy fields health, tourism, energy and water. However, Sweden faces medium level short-term climate change threats in the fields biodiversity (Cohesion Policy and CAP), agriculture, forestry (Cohesion Policy and CAP), industry and the complete transport sector. A focus should especially be on housing infrastructure as this receptor is identified to suffer under high climate change threats.

Sweden as one of the highest developed economies in whole Europe receives only little amounts of EU funding. All 17 relevant categories are defined to receive only small shares of overall EU funding which sets therefore only little budget of EU investment at risk. The amount of Cohesion Policy related budget that Sweden receives from the EU equals €45.4 Mio. per year. The amount received under CAP conditions is € 240 m. Climate-proofing Cohesion Policy and CAP will thus have a lower relevance for Sweden.

The adaptive capacity scores measured for Sweden is 4.2 regarding Cohesion Policy related policy fields and also the CAP sectors display a score of 4.2. These scores are classified to be high. These

results as well as the rest of the analysis lead to the conclusion that no EU policy intervention is required for Sweden.

Baseline for Sweden						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	0,7	0,1%	low	high	
Housing infrastructure	high	0,0	0,0%	low	high	
Biodiversity (CP)	medium	0,0	0,0%	low	high	
Forestry (CP)	medium	0,0	0,0%	low	high	
Industry&Commerce	medium	21,1	1,4%	low	high	
Tourism	low	3,4	0,4%	low	high	
Transport – Rail, Road, Aviation, other	medium	11,5	0,6%	low	high	
Energy – conv, renewables	low	0,0	0,0%	low	high	
Energy renewables	low	8,8	0,7%	low	high	
Drinking water – waste water	low	0,0	0,0%	low	high	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	240,1	6,8%	low	high	

12.5.3 Baseline for Lithuania

For Lithuania, the baseline table provides the same picture regarding climate change threats as Sweden and Finland. Extreme weather events, flooding and changing precipitation patterns are the major threats. Some receptors that are vulnerable to these threats are classified as medium in Lithuania: biodiversity, agriculture, forestry (CP and CAP), industry and complete transport sector. The only sector facing high climate change threats is the housing infrastructure sector.

It is interesting now to see that Lithuania derives an as high classified amount of EU funding in the housing infrastructure policy field. With a share of 23.1% of overall EU budget under this category going to Lithuanian, a high amount of EU funding is therefore at risk. All other categories show a different picture, they receive only small shares of EU funding due to the small size of Lithuania. The CP funding received by Lithuania per year equals nearly € 502 Mio whereas the CAP funding sums up to € 180 m per year. Even is most policy-fields receive only small shares of EU funding, it will be important to consider over proportional impacts or hardship cases in Lithuania where EU climate-proofing might still become relevant.

Taking now into consideration that Lithuanian adaptive capacity score is measured to be low in all Cohesion Policy related policy fields whereas in CAP related policy fields adaptive capacity seems to be on a medium level this leads to the conclusion that in one policy EU support is required.

Based on this analysis, the following priority area can be identified, where particular risks for EU spending needs to be considered and where climate-proofing action will be relevant:

- With high priority: Major threats related to river flooding and heavy rainfalls will lead to a very vulnerable housing infrastructure sector. Climate-proofing of EU investments in this policy-field is definitely required.

Baseline for Lithuania						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	39,8	3,0%	low	low	
Housing infrastructure	high	29,4	23,1%	high	low	high
Biodiversity (CP)	medium	10,3	2,4%	low	low	
Forestry (CP)	medium	0,0	0,0%	low	low	
Industry&Commerce	medium	62,3	4,1%	low	low	
Tourism	low	16,6	2,0%	low	low	
Transport – Rail, Road, Aviation, other	medium	225,5	8,4%	low	low	
Energy – conv, renewables	low	68,3	8,5%	low	low	
Drinking water – waste water	low	49,1	3,2%	low	low	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	183,6	5,0%	low	medium	

12.5.4 Baseline for Latvia

For Latvia, the baseline table provides that climate change impacts on the 17 defined policy areas are exactly the same as in Lithuania (as all countries in the Northern European countries group suffer under the same climate change threats which lead to an identical climate change impacts column in all the relevant baseline tables).

The aggregated amount of CP budget for Latvia is nearly € 345 Mio per year. CAP funding sums up to only € 112 m per year. The drinking water sector is classified as the only sector receiving with 7% a medium amount of overall EU budget. All other relevant receptors obtain only small shares of EU funding and are therefore categorised as low. Due to the small size of Latvia, there are thus low absolute risks of climate change for EU investments. However, it is possible that some regions are over-proportionally affected and that climate-proofing with EU support would still be necessary. This is however not captured under our methodology and needs to be analysed in a more detailed approach.

Concerning adaptive capacity, Latvia shows one of the lowest scores for Cohesion Policy related policy fields (with a score of 1.3). For CAP, the score is a bit higher with 2.0. It is thus questionable if

Latvia will have sufficient domestic resources to respond to climate change induced threats or if action on EU level is necessary to support the relevant activities, even if no direct EU intervention is deemed necessary under this baseline methodology.

Baseline for Latvia						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	30,6	2,3%	low	low	
Housing infrastructure	high	4,3	3,4%	low	low	
Biodiversity (CP)	medium	3,7	0,9%	low	low	
Forestry (CP)	medium	0,4	0,5%	low	low	
Industry&Commerce	medium	26,7	1,8%	low	low	
Tourism	low	6,1	0,7%	low	low	
Transport –Rail, Road, Aviation, other	medium	174,2	9,0%	low	low	
Energy – conv, renewables	low	18,2	1,4%	low	low	
Drinking water	low	80,4	7,0%	medium	low	
Waste water	low	0,0	0,0%	low	low	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	medium	112,4	2,9%	low	medium	

12.5.5 Baseline for Estonia

The baseline table for Estonia demonstrates low, medium or high short-term impacts from climate change for a range of relevant sectors (for more information see table below as the climate change threats that Estonia is facing are identical with the ones in Finland, Sweden, Lithuania and Latvia).

Overall EU expenditures into Estonia show only small shares for all 17 receptors due to the small size of the country. Currently, the categories of expenditure that fall under the identified policy fields and are at risk from climate change impacts, receive funding in the magnitude of nearly €224 Mio. per year under the Cohesion Funds and € 80 m per year from CAP. Health related expenditures and drinking water infrastructures obtain funding shares of about 2%, all other policy fields are much lower. The absolute amount of funding being at risk of climate change in Estonia is that rather low. However, as for the other Baltic countries, there might be the risk of over proportional burdens or hardship cases which are not captured by our approach.

The adaptive capacity of Estonia with regard to policy fields that receive funding under Cohesion Policy and CAP has been classified as medium (with a score in the adaptive capacity index of 2.0 for Cohesion related policy fields and 2.8 for agriculture).

Based on the different steps of the baseline development, there is no receptor identified where risks for EU spending need to be considered and where climate-proofing action will be relevant.

Baseline for Estonia						
	Climate impacts	**Expenditures under CP and CAP**			**Adaptive capacity**	**Need for EU attention**
	Aggregated impacts (all threats)	In Mio. €/a	% of overall expenditure in category	Qualitative estimate	Capacity related to CP and CAP	Policy fields requiring priority attention at EU level
Cohesion Policy						
Health related expenditures	low	28,8	2,2%	low	medium	
Housing infrastructure	high	1,1	0,9%	low	medium	
Biodiversity (CP)	medium	5,5	1,3%	low	medium	
Forestry (CP)	medium	0,5	0,7%	low	medium	
Industry&Commerce	medium	9,6	0,6%	low	medium	
Tourism	low	14,9	1,8%	low	medium	
Transport – Rail, Road, Aviation, other	medium	100,6	3,5%	low	medium	
Energy – conv, renewables	low	4,1	0,3%	low	medium	
Drinking water – waste water	low	58,3	4,0%	low	medium	
Common Agriculture Policy						
Biodiversity (CAP) – Agriculture – Forestry (CAP)	Medium	79,5	2,2%	low	medium	

13 Annex 6 Detailed explanation of five steps on Decision tree for prioritising adaptation options

The five consecutive steps of the decision tree are explained in more detail below.

1. EU Relevance of adaptation options, especially for Cohesion Policy and CAP

To identify options with a strong EU relevance it is important to understand if their implementation lies in the responsibility of private stakeholders or public authorities and if EU funding provides additional value.

The following steps need to be considered in order to establish the relevance of options for CAP and Cohesion Policy:

- Who is responsible for implementing the option: public authorities or private stakeholders? For options that need to be implemented by public authorities the public funding logic needs to be clear. The need for EU intervention could be justified by the following factors: options that go beyond the existing regulatory baseline; in cases where the provision of funding for public goods addresses market failure; contributes to the development of new technologies and approaches that are seen to benefit society..
- If the option lies with the responsibility of private stakeholders: How likely is an autonomous implementation? Do market barriers, or the existence of broader impacts require public intervention?
  We assume that support through public intervention is necessary in the following instances:
  - If options have high upfront costs but only long-term benefits that go beyond the period needed to gain a return on investment by private stakeholders.
  - If options have benefits for the broader public and/or the environment that go beyond the benefits that are considered by the private sector.
  - If uncertainties around relevant climate impacts are high, and private stakeholders tend to take a higher risk than public authorities and thus to underestimate the need for action.
  - If options depend on the availability of new technologies that are not fully provided through private research & development activities.
  - If options reduce regional disparities and improve regional competitiveness.
  - If options address transboundary issues..
- If public intervention is necessary: is the option relevant for CP and CAP financing? Under which expenditure category does it fall for Cohesion Policy or pillar for CAP?
  An assessment of options, and the need for EU public finance, needs to consider whether such finance is more aptly provided by local, regional or national authorities and whether CP and CAP funding is necessary (and capable of) facilitating the implementation.

2. Urgency of options - Temporal characteristics of adaptation options

In the context of climate-proofing CP and CAP, the urgent implementation of certain adaptation options should be clearly indicated in the light of the next MFF. To identify urgent options, it is necessary to differentiate two key dimensions: the time-horizon in which the adaptation options have to be implemented; as well as the time-lag between the initial implementation of options and the occurrence of impacts to which they are likely to respond. Our assessment links the potential

implementation of options to the short-term planning horizon associated with the next MFF (2014-2020). The medium and long-term timeframe refers to the years beyond 2020.

The typology includes four different types of temporal characteristics, as shown in Table 51.

Table 51. Typology for temporal characteristics

		Timing for the implementation of measures	
		Short-term timing: To avoid existing and known impacts to 2020	**Medium and Long-term timing: based on impacts known beyond 2020.**
Effect of measures: time-lag between initiating the measure and its effect	**Short (< 10 years)**	Type I Adaptation options aimed at short- and medium term climate change impacts (climate change impacts that are already noticeable today or up until 2020) → These options have to be implemented today to maximize avoided costs or cost savings.	Type II Adaptation options can be more cost effectively implemented in the future when uncertainties concerning climate change impacts are reduced. → The need for action can be decided in the future. This is to avoid the unnecessary implementation of measures and expenditures.
	Medium and Long (> 10 years)	Type III Adaptation options with need for advance planning, with a medium time-lag between initialisation and responsiveness to impacts. → These options would have had to be initiated in the past to reach their full effect up to 2020. However, they can still be initiated but might not be able to reach their full benefits.	Type IV Adaptation options with the need for medium or long-term planning, medium or long time-lag between initialisation and responsiveness to projected impacts. → Can be initiated after 2020, when certainty of projected impacts occurring is greater.

Source: Tröltzsch, J., Görlach, B. Lückge, H., Peter, M. and C. Sartorius (2010): Ökonomische Aspekte der Anpassung an den Klimawandel.

The table shows that type I and III options are relevant for short-term adaptation activities that could be implemented prior to 2020. This could be explained using the following arguments:

- Type I: Options that address short-term climate change impacts (existing climate extremes and impacts up to 2020) and thus need to be initiated as soon as possible to be able to address unfolding impacts until 2020. Urgent action is especially required in case where options require a longer term implementation process. Furthermore, this can include no-regret options that provide good socio-economic or environmental benefits under any scenario.
- Type III: Options that aim at climate-proofing infrastructures with a long lifetime (e.g. waste water infrastructures has an 80 years lifetime), especially if a later technical adjustment to adaptation needs is technically impossible or costly. This is particularly true for green infrastructure given the difficulty for modifying spatial planning (securing room for green spaces in urban areas for example). The implementation of options that are the result of complex decision making, such as coastal and river flooding defences, could be considered urgent options given the delays often associated with infrastructure projects.

3. **Effectiveness of adaptation options: ability to respond to a range of impacts associated with varying climate change scenarios**

The third step is closely linked to effectiveness criterion of the EU Impact Assessment Guidelines. As there is still a high uncertainty around climate scenarios and expected impacts from climate change, public intervention through CP and CAP especially needs to consider the effectiveness of options in terms of responding to a range of impact scenarios. Decision makers may be more likely to fund options for which effectiveness under varying climate change scenarios can be assumed (e.g. the 2° and 4° scenarios that will be considered in the future EU adaptation strategy), and in cases where the implementation of options can result in business as usual benefits. As such, special priority should be given to no-regret options that can benefit other elements of society.

Our assessment of the effectiveness of options comprises three steps:

- **Perceived effectiveness under medium scenario:** Effectiveness concerns the extent to which an option is likely to achieve its objectives. Since the effectiveness of options differs under different climate change scenarios we first analyse the effectiveness of options against a 2 degree climate change scenario.
- **Effectiveness under existing climate variabilities and development under a BAU[125]-scenario (no-regret):** Some adaptation options may include benefits in addressing current climate variability as well as longer term climate change impacts and thus have the flexibility to respond to a varying degree of climate change impacts. These no-regret options should be pushed as they offer win-win opportunities in any case.
- **Robustness even under extreme scenarios:** For options with very high investment needs, their robustness under extreme climate scenarios (low probability, high impact) should be verified. This might be especially relevant for options that relate to sea-level rise.

The approach of evaluating the effectiveness of adaptation options is adapted for options in the land-based agricultural and forestry sectors. Determining the avoided damages associated with options for these sectors is very difficult to establish due to the many variables that affect the potential damage costs, the complexity of farm-level production and decision-making patterns as well as the uncertainties in the socio-economic environment. Due to the serious paucity of data for such a complex set of variables it was not possible to use the approach outlined above in the current project. Instead, for agricultural and forestry sectors, an alternative approach was applied. Adaptation options were evaluated in terms of their likely effect on provision of public goods (i.e. improving water quality, soil functionality, biodiversity, etc.) which are major objectives of CAP funding. However the approach also considers the resilience of farm-level, forestry production and income in rural areas in light of climate risk and climate change.

4. **Policy coherence: extent of synergies between options, and with other EU policies**

Climate change adaptation options address a wide range of potential economic, social and environmental needs, that may have considerable co-benefits in relation to other EU policies. Coherence can manifest itself in terms of coherence between options, and with respect to overarching objectives of EU policy as indicated below.

- **Identification of either co-benefits or conflicts with other EU policies:** The relevance of adaptation options to the different dimensions of higher level sustainable development policy and humanitarian goals is especially relevant for options that may not be implemented on an autonomous basis. These are likely to be options that address human interests,

[125] BAU: Business as usual - scenarios

biodiversity protection or safeguarding of ecosystem services and have co-benefits for other EU policy objectives. . Conversely there is potential for options to be in conflict with other EU policy objectives. The potential for adaptation options to undermine EU policy objectives and policies has also been taken into account.

- **Identification of co-benefits and conflicts with other adaptation options:** the analysis of coherence should also focus on the potential for synergies and conflicts between adaptation options.

5. Efficiency as a function of benefit-to-cost ratio

The efficiency of options can also be evaluated based on a comparison of benefit to cost ratios; although given the current analytical state of play, such comparisons need to be treated with caution. Based partly on the evaluation of options completed for this report, three categories of options have been proposed: options with higher costs than benefits (inefficient); options where costs are on par with benefits (efficient) and options with higher benefits compared to costs (very efficient). The estimates of costs and benefits should be based on a quantitative assessment. If quantification is not possible qualitative estimates can provide a first order indication. As the calculations are based on different data assumptions and uncertainties, these are indicated in the estimation of the cost and benefit components and should be taken into consideration when assuming further actions.

In our study, the assessment of efficiency was only possible for a limited number of options given data limitations.. The estimations of cost and benefits for these options is provided in the Supplementary Materail Report.

14 Annex 7 Overview of Selected Adaptation Options Assessed

Chapter 3 outlined the process to select concrete adaptation options for the cost-benefit and the analysis of impacts. As the project focuses on climate-proofing expenditure under Cohesion Policy and CAP, the selection focuses on options that require urgent implementation, or to be considered for implementation during the next MFF period. Options that can be implemented further along the "adaptation pathway" are less relevant for the decision-making processes related to the next period of CP and CAP.

This chapter is the summary of the detailed cost-benefit assessments undertaken for 12 options. The two more qualitative case studies are summarised in chapter the Supplementary Material Report. The detailed assessments aim at providing some indicative and illustrative results for the last step of the decision tree for selecting adaptation options: the criterion of efficiency. The detailed assessments of these options, including detailed information on assumptions regarding climate change scenarios, can be found in section 5 of the separate Supplementary Material Report distributed together with this final report and include a general impact assessment and an assessment of benefits and costs of adaptation options.

The summaries of these assessments provide the main results of the cost-benefit analysis and the general analysis of impacts but also show the role of the selected adaptation options for climate-proofing Cohesion Policy and CAP. The following topics are covered in the summaries:

Relevant climate threats

- What climate threats does the option address?
- Is there an immediate need for action (based on the risk of either short-term threats or long implementation time)?
- What kind of damages are prevented: i) direct economic damages, ii) environmental damages, iii) social impacts?

Role of public adaptation and EU relevance

- Is the option implemented by public authorities or by private stakeholders?
- Are there market failures and barriers that prevent autonomous implementation by private stakeholders or by farmers?
- Is the option fundable under the current Cohesion Policy and CAP frameworks? Or does it require a completely new funding envelope?

Cost-benefit analysis and general analysis of impacts

- Which cost and benefit components are considered and for which timeframe (based on economic lifetime)?
- What are the highest uncertainties associated with the cost-benefit assessment and their impacts on results? How robust is the assessment to assumptions on climate change scenarios?
- What is final benefit-to-cost ratio and does it lead to an unambiguous result?
- How can the variability (range) of results be interpreted and what are the major driving factors?
- What further benefits does the option have: in addressing broader impacts, co-benefits with other EU policies and synergies with other options?

14.1.1 Early warning systems

Overview of threats

Early warning systems have the ability to respond to all types of threats and under all climate change scenarios. They can alert national authorities of severe temperature increases, of increased precipitation leading to flooding and sea level rise, extreme wind, and of storm systems. If national authorities are able to respond to warnings in a timely manner, it can avoid damages to virtually all economic actors and the population. Given its potential to avoid such a broad range of threats, impacts and economic damages, its implementation is urgent particularly in vulnerable areas.

Role of Public Adaptation and EU Relevance

Early warning systems are typically implemented at the national level, although the data that helps prompt responses is made available through an EU level body, the European Centre for Medium Weather Forecasting. The failure to implement EWS is not a result of market failure, but is primarily due to a lack of capacity and human resources at the member state level. Additional funding could be made available through a number of existing Cohesion Policy expenditure categories related to adaptation, information and communication technologies (ICT), disaster management, and institutional capacity building. These include:

01 ICT backbone investment (>/=30 mbps)
02 ICT backbone investment (>/=100 mbps)
065 Adaptation to climate change and natural risk prevention
067 Civil protection and disaster management systems and infrastructures
077 Improving the delivery of policies and programmes
097 Investment in institutional capacity and in the efficiency of public administrations and public services with a view to reforms, better regulation and good governance
100 Information and communication

Cost Benefit Analysis and General Impact Assessment

The option "Early warning systems and implementing measures" comprises two components: the provision of meteorological data that indicates the probability of extreme weather events, and the response to those events. Our research indicated that Member States were able to mobilise the necessary resources to respond to events in cases where they were able to access data, to analyse data, and to communicate data as part of a coordinated government response. The measure was found to consist primarily of: ICT upgrades (by improving Broadband reliability); enhancing institutional capacity; and by undertaking education and training. The quantification of costs relates primarily to the human resources required to bolster response efforts at the national level, and to the provision of training.

Determining the variables comprising the cost of the measure was based on existing best practice. Calculating the total cost in the EU for these variables in each Member State, considered the extent to which all Member States were able to meet best practice. Costs were not calculated for those with existing response capacity. Costs were only calculated for a select grouping of Member States that do not have access to the right type of weather data, and who are unable to respond to extreme weather events based on general lack of institutional capacity. (This grouping was determined based on consultation with experts from the European Centre for Medium Range Weather Forecasting.) Referring to existing research on the benefits of meteorological forecasting, benefits have been calculated on the basis of societal "willingness to pay" (WTP) for the services of the UK Met Office, which is not only responsible for providing weather data, but for communicating severe weather

events to the public in collaboration with the national media. The UK system was found to represent best practice for the purposes of our analysis.

The WTP for EWS in the UK was transferred to other MS in order to determine benefits throughout the EU. Unlike the analysis completed for the land use options, where benefits are equivalent to avoided damage costs more easily identified from the bottom up, the benefits transfer approach was required given the top down nature of the option. For this reason, the results need to be treated with caution. The analysis is also based on a strong assumption; that all member states would be willing to pay the same amount per capita for EWS.

There are two other uncertainties that should be noted with respect to this survey: the WTP survey does not refer to the value of complementary government services falling outside the scope of the UK Met Office. We assume for the sake of analytical simplicity, that the cost of these additional services is not likely to outweigh societal perception of the benefits of weather warnings. Secondly, the value of the UK Met Office was not being considered in its capacity to cope with climate change as part of the WTP survey, but as a reliable provider of meteorological forecasting. We had to assume that the option is designed to cope with climate change in order to provide a starting point for the analysis of costs and benefits of adaptation options generally speaking. Here we emphasize the notion that our estimate represents an initial attempt to provide a rough overview of the *ratio* of benefits to costs, and the significance of this ratio in the context of first order estimates for other adaptation options.

Table 52 gives an overview of the minimum and maximum benefit-cost ratios (referring to a range of values at the member state level), in addition to the average value over the lifetime of the project. Values have been extracted from discounted benefits and from a discounted one-time cost estimated for 2014. The project lifetime for this measure has been limited to the duration of the next Multiannual Financial Framework (2014-2020); values have been discounted to 2020 for this reason.

Table 52. Minimum and maximum benefit-cost ratios

In Mio. € per year	Costs total	Benefits total	Benefit-cost ratio (average and variability)
Min	6	1	5
Max	12	96	(0.2 – 8)

The results of the analysis indicate that the benefit to cost ratio is highest for Poland. Benefits to cost ratios are also favourable for the Czech Republic, Romania, Estonia and Hungary. Due to the top-down approach of the benefit assessment with using the willingness to pay approach, it was not necessary to consider the variable magnitude of damage costs from the bottom up in the context of different climate change impact scenarios. We can therefore make the assumption that the benefit-to-cost ratio is robust under a broad range of climate scenarios.

14.1.2 Cooling of hospitals using passive cooling systems

Overview of threats

The different threats from climate change will not only affect economic activities but also lead to impacts on human health. While in the overall assessment, the threats from flooding (river and coastal) and storms are seen as major impacts, human health will be mostly affected by increasing temperature, especially an increase in the number heat waves (Watkiss et al. 2011, Ciscar 2009).

These health impacts will have economic consequences – either through direct medical costs (treatment and health protection), a lower work productivity or welfare changes (additional threats to health). Especially heat waves are already threatening human life under current climatic conditions, with a progressive increase expected up until 2100 (see for example, the results of the ClimateCost project, Watkiss et al. 2011).

As hospitals accommodate vulnerable sectors of society (people that are already sick, elderly citizens, etc.) and require their staff to possess their full physical and mental capacities, the implementation of adaptation options seems especially relevant in terms of avoiding loss of human life or prolonging existing illnesses. To prevent heat-related effects in hospitals for both patients and employees, the installation of cooling systems is a potential adaptation option. It prevents an increase of temperatures in hospitals beyond a certain threshold and thus protecting patients and ensuring good working conditions for hospital employees. Such cooling systems can either be installed during the construction of hospitals or ex-post as additional cooling devices. To avoid conflicts with mitigation policies, hospitals should make use of passive cooling systems based on environmental energies and on energy-efficient systems.

Role of Public Adaptation and EU Relevance

As most hospitals are run by public authorities, the cooling of hospitals needs to be considered a public adaptation option. EU action might be necessary if the effects of climate change are underestimated by member states. It may be necessary to provide incentives to install rather low-cost and energy-efficient cooling options in the construction process of new hospitals – rather than adding additional elements later on which are often based on conventional energy sources (as conventional air-conditioning systems). As health infrastructures (especially the construction and renovation of hospitals and low-energy consuming buildings) are currently funded under Cohesion Policy with about € 5 bn. (2007-2013 period), there is a direct link to climate-proofing of Cohesion Policy investments.

Cost Benefit Analysis and General Impact Assessment

As passive cooling systems have an economic lifetime of about 40 years, the analysis considers accumulating climate change impacts up to 2050. Even under consideration of these increasing benefits, the analysis clearly states that the option is only beneficial in highly affected regions and under consideration of broader benefits. The detailed assessment of costs and benefits focused on major elements that determine the overall efficiency of the option:

- For the cost calculation, the investment and operating costs for different types of passive cooling systems were calculated. These are applied to the existing number of hospitals in the EU that would need to be cooled in the context of climate change adaptation.
- Benefits are calculated for an average climate change scenario (A1B) in form of avoided productivity losses of hospital employees due to increasing temperatures as well as avoided heat-mortality costs for people that are already treated in hospitals. For the assessment of avoided productivity losses, the analysis is based on projections of the increasing number of summer days and several scientific studies on productivity losses due to heat. To determine the avoided heat-mortality costs, we used a top-down approach, with a bandwidth of heat-related damage costs that could be avoided by implementing the option. To show the range of potential benefits, both the Value of Life Year (VOLY) and the Value of Statistical Life (VSL) approaches have been considered (see section 5 of the Supporting Material report for more information on these concepts).The benefit assessment considers the average annual benefit over the entire economic lifetime of cooling system.

Annual costs and benefits can be directly compared without discounting as it can be assumed that the installation of passive cooling systems will lead to an immediate improvement of the temperature situation in hospitals – already under existing climate variability. Table 53 gives an overview on the range of costs and benefits as well as the average benefit-to-cost ratio for the EU. The detailed analysis on member state level (see section 5 of the Supporting Material report) makes clear that the highest share of costs will arise in more developed regions of the EU as they already have a denser hospital network.

Table 53. Minimum, average and maximum benefit-cost ratios

In Mio. €	**Costs**	Benefits productivity loss	Benefits health costs		**Benefits total**		**Benefit-cost ratio (average and variability**
			VOLY	VSL	**VOLY**	**VSL**	
Min	966	604	25	913	629	1'517	With VOLY approach: 0.5 (0.2 – 1.5) With VSL approach: 1.1 (0.5 – 3.0
Max	3'210	1'422	41	1'521	1'463	2'943	
Average	2'088	1'013	33	1'217	1'046	2'230	

The result crucially depends on the approach to assessment mortality costs. If the more conservative VOLY approach is used, the average benefit-to-cost ratio shows a result lower than one for the short timeframe (from now up until 2020). Under the VSL approach, the benefit-to-cost ratio however exceeds 1 resulting in efficiency of option implementation. In any case, this option should be further considered in the frame of climate-proofing adaptation. On member state level, the analysis provides positive results for some countries even under the VOLY approach (especially those with high earnings in the health care sector and thus high avoided productivity losses). The highest average benefit-to-cost ratio has been calculated for Spain In the medium-time frame, this option will become especially important in member states facing a high temperature increase. The maximum benefit-to-cost ratio already indicates a trend in the benefit to cost ratio moving in this direction. As hospital infrastructures have a long economic lifetime, it will be important to consider the long-term effects of this measure so that the upper boundary of the benefit-to-cost ratio seems relevant.

Also, it need to be acknowledged that the benefit assessment clearly represents a conservative estimate while the cost assessment, especially the upper bound, uses rather high unit cost estimates and higher end assumptions for hospital area requiring cooling. With respect to the EU relevance of the option, it will thus be necessary to focus on member states facing the highest risks of climate change in addition to having low adaptive capacity.

14.1.3 Storm retention reservoirs

Overview of threats

More intense precipitation events during storms and their impacts on private properties have been identified as relevant short-term threat, mostly for the northern, northwest and central & Eastern climate regions in chapter 2. The risk of storm and damage from intense precipitation is already relevant under current climate conditions (see current reports from the insurance industry, e.g. GDV 2011).

Extending the capacities of storm retention reservoirs enhances the ability to cope with more intense precipitation events and to prevent the damage associated with intra-urban flooding. To avoid sewage water leaks during high precipitation events, additional stormwater retention reservoirs

could be built to store greater volumes of water (Tröltzsch et al. 2011, Flörke et al. 2011, Mack et al. 2011, EUREAU n.d.). These include both combined sewer overflow (CSO) tanks and stormwater holding tanks (without overflow). Depending on their design, it should to be acknowledged that there is a remaining risk of impacts – especially if an extreme climate change scenario is considered.

Without adaptation, high precipitation events and intra-urban flooding will lead to an increase in property damages (see analysis for the UK in the Future Foresight Flooding report (Evans et al. 2004)) and thus potentially affecting both private households as well as industrial facilities and commercial buildings. Furthermore, public infrastructure can be impacted, including roads and rail tracks which could lead to problems for private and public transportation. Intra-urban flooding after high precipitation can also lead to environmental damages if untreated wastewater from combined stormwater and wastewater sewage systems is discharged into the environment. In extreme situations, intra-urban flooding can furthermore threaten human life and well-being.

Role of Public Adaptation and EU Relevance

As water management authorities are mostly governed by public bodies, adaptation options relating to water management need to be classified as "public adaptation". As investments into water infrastructures are currently funded under Cohesion Policy, additional investments into storm retention reservoirs could also be supported through EU funds, especially in those member states that are highly vulnerable to climate change (expected climate change damage is high, and low adaptive capacity as identified in the baseline assessment). Funding through Cohesion Policy will also be necessary to ensure that investments receive the appropriate "climate-proofing". To minimise overall transaction costs, it would be most beneficial to optimise the design of further retention reservoirs so that they will be able to cope with threats from climate change.

Cost Benefit Analysis and General Impact Assessment

The analysis of the benefit-to-cost ratio and potential co-benefits of the option support the assumption that EU action to support this option would be beneficial. The detailed assessment of costs and benefits considered the long project lifetime of water infrastructures and thus considers average annual costs and benefits up to 2050.

- For the cost calculation, the investment costs for additional capacities of retention basins have been calculated. It was assumed that the required capacity for enhanced storm retention reservoirs depends on the projected increase in rain intensity during high precipitation events in an A1B climate scenario (based on the approach used in Tröltzsch et al. 2012, forthcoming). Specific investment costs are available for Germany and the UK and have been adjusted for other member states.
- Benefits include avoided damages of residential and non-residential buildings in the period up to 2050 for which the benefit-transfer method has been applied (based on results for the UK). The assessment of avoided environmental benefits is based on the substitute cost method and analysis of the necessary water volumes required to reach a dilution of untreated sewage water so that it becomes environmentally harmless.

Table 54 provides an overview of the range of costs and benefits and calculates the average benefit-cost ratio for the EU (under consideration of variability). Detailed member state specific information is included in the accompanying report on adaptation options with a breakdown of all results on national level. In summary, it can be said that the new member states which receive the largest amount of funding under CP have to meet 22% of the overall investment needs (70 to 142 Mio. € per year). About 74% of the investment needs will have to be met in the four countries Germany, France, Poland and the UK.

Table 54. Minimum and maximum benefit-cost ratios

In Mio. € per year	Costs total	Benefits property	Benefits environment	Benefits total	Benefit-cost ratio average and variability
Min	324	254	71.5	325.5	3.5
Max	653	2;970	71.5	3,041.5	[0.5 – 9.4]

The benefit-to-cost ratio for storm retention reservoirs is clearly on the positive side for all affected countries. For the interpretation, it needs to be considered that uncertainties in the cost-benefit assessment relate more to the assessment of benefits as is evidenced for the large bandwidth of results related to benefits for properties. This uncertainty is driven by the range of available data and insurance data on property damages related to intra-urban flooding. It also needs to be considered that the benefit-to-cost ratio relates to an average climate change scenario and does not consider the potential impacts of an extreme scenario.

The qualitative assessment of the option also identifies some relevant co-benefits of storm retention reservoirs, particularly given their ability to improve environmental quality of rivers. This option has a strong interlinkage with both the Water Framework and the Floods Directive and thus overall EU water policy. The option is thus also relevant for biodiversity, albeit more indirectly. Considering interlinkages with other options, the co-benefits of storm retention reservoirs mostly have to be seen in a useful combination with the implementation of sustainable urban drainage systems which are described in the next section.

Overall, the assessment of the option indicates tht it is relevant in terms or receiving EU funding and will be cost-effective in all Member States.affected by increasing precipitation. As co-benefits of the option have not been considered in the quantitative assessment, it seems sensible to use at least the average benefit-cost ratio as the basis for further funding decisions.

14.1.4 Sustainable urban drainage systems (SUDS)

Overview of threats

Sustainable urban drainage systems (SUDS) are an alternative approach to address the problem of intense precipitation events and are thus closely linked to storm retention reservoirs. The SUDS approach reduces the exposure of urban areas to high precipitation events as it increases the infiltration rate of rainwater where it lands and thus reduces the speed of run-off (Gordon-Walker et al. 2007, Mack et al. 2011, ICF 2007, Flörke et al. 2011). Similar to storm retention reservoirs, SUDS are thus aimed at reducing impacts from intra-urban flooding which can affect private properties, industrial facilities, commercial buildings, public infrastructures and, in extreme cases, also health. SUDS also reduce impacts from urban run-off into the environment, thus improving water quality and safeguarding biodiversity.

SUDS do not comprise one specific adaptation option but include several grey and green elements that support rainwater management, e.g. permeable pavements, rainwater harvesting systems (in-house) and rainwater butts (garden), green roofs and green spaces as well as swales, infiltration ditches and filter drains.

SUDS also have positive effects in relation to other climate threats. In addition to extreme precipitation events, SUDS can prevent water scarcity through the decentralized storage of rainwater

that can be used for non-potable uses and thus reduce the demand for drinking water (Flörke et al. 2011). SUDS also reduce the heat-island effect by reducing the share of sealed surfaces.

Role of Public Adaptation and EU Relevance

The role of public adaptation differs for the different elements of SUDS. While permeable pavements and green spaces lie in the responsibility of local authorities, rainwater harvesting systems, rainwater butts and green roofs need to be implemented by private households. As the whole range of benefits is however not considered by private households (e.g. rainwater harvesting systems are installed to reduce costs of drinking water supply but not to prevent damages from intra-urban flooding for other families), there might be the need for public intervention to ensure optimal implementation rates. Relevant funding could be obtained via the category of expenditure of "risk prevention", but it might require a broader definition of this category to ensure that funds can be used for co-financing investments in the private domain.

Cost Benefit Analysis and General Impact Assessment

As green roofs have already been analysed in the ClimateProofing I study (Ecologic et al. 2011), our analysis has focused on the implementation of permeable pavements, rainwater harvesting systems and rainwater butts.

- The cost assessment is driven by the existing and limited potentials to implement the different elements (based on a CBA of the UK Environment Agency 2007). Specific investment costs for the different SUDS elements are based on market prices as well as literature sources with country-specific information.
- For the benefits, the results have been transferred from the analysis on stormwater retention reservoirs and thus consider average benefits up to 2050. Additional benefits of SUDS could not be quantified as the necessary background information (e.g. on the relationship between SUDS and the heat-island effect) does not yet seem to be available. The assessment on benefits thus needs to be seen as lower estimate only.

The results on costs and benefits and the average benefit-cost ratio are summarized in Table 55. The costs of permeable pavements make up the largest share of total costs at just over 80%. Rainwater butts have low specific investment costs and seem to be negligible in relation to the overall assessment. The analysis completed at the member state level shows a broader spread of costs between the member states than for storm retention reservoirs. Still, about 55% percent of overall costs will have to be faced in those countries facing the highest impacts from changing precipitation patterns and having significant urban infrastructures to protect: Germany, the UK, France, Finland and Poland.

Table 55. Minimum and maximum benefit-cost ratios

In Mio. € per year	**Costs total**	Benefits property	Benefits environment	**Benefits total**	**Benefit-cost ratio (average and variability)**
Min	4,131	254	71.5	325.5	0.4
Max	4,131	2;970	71.5	3,041.5	(0.1 – 0.7)

It can be seen that the option has a benefit-cost ratio lower than 1 for the whole estimated range and thus has to be classified as inefficient on an EU level overall. However, for some countries that face particular threats from increasing precipitation, the average benefit-to-cost ratio leads to a

positive result (UK and Ireland). If the maximum benefits are considered, the option is also efficient in further countries (DK, FR, LV, PL). When interpreting the benefit-to-cost ratio, it should be noted that the benefit assessment only considers avoided damages from intra-urban flooding. The co-benefits of the options, mainly a reduction of the heat-island effect and positive effects on biodiversity are not considered. Thus, the average benefit-to-cost ratio clearly underestimates the overall efficiency of the option.

The cost-benefit ratio of SUDS should be interpreted on the basis of the impact assessment for stormwater retention reservoirs. Although the enhancement of grey infrastructure is calculated to be less expensive than a full implementation of SUDS capacities, it does not exhibit the same range of co-benefits. With a full implementation of SUDS, the necessary capacity increase of storm retention reservoirs could be reduced and these avoided costs could also be included as a benefit for SUDS (substitute cost method). Also, it needs to be considered that SUDS could supplement storm retention reservoirs under extreme climate change scenarios where the extension of grey infrastructures alone might not be fully effective. The optimal mix of SUDS and storm retention reservoirs has, however, not yet been assessed so that we were not able to calculate them as a cluster.

14.1.5 Awareness raising for companies regarding adaptation to climate change

Overview of threats

The adaptation option "Awareness raising for companies regarding adaptation to climate change" in the context of Cohesion Policy takes the form of an additional service (an awareness raising programme) to business support services already funded by the programmes. The awareness raising programme is assumed to provide web-based information tools, training sessions on climate change impacts and adaptation, and printed materials.

Most of the threats identified in this cost assessment are either already existing or short-term in nature in some parts of the EU; and the damages addressed are predominantly economic and social (as shown for each business area). The means of implementing this measure are "soft" and should therefore not result in maladaptation.

For the adaptation option "Awareness raising for companies regarding adaptation to climate change", a total of six business areas[126] have been identified, where climate change presents threats and opportunities. These are: markets, finance, logistics, premises (assets), people and processes. For some of these business areas, case studies are used as examples of successful climate change adaptation.

Role of Public Adaptation and EU Relevance

The adaptation option "Awareness-raising for companies regarding adaptation to climate change", would be implemented by public authorities to correct for a market failure that impedes autonomous implementation by private stakeholders. There are two steps to the awareness process that have to be taken to avoid potential losses to the industry from climate change events. The first step is for private enterprises to be aware that climate change will have certain impacts specific to their activities beyond general impacts that are increasingly becoming common knowledge in the public domain. The second step is to carry out an assessment and be aware of what specific impacts are likely to occur to their enterprise. The market failure exists because of imperfect information regarding climate change, where business sector entities might not be aware of climate change

[126] Adapting to Climate Change: A Guide for Businesses in Scotland, p. 6

impacts particular to their activities (first step), and therefore choose not to allocate resources to find out how climate change will affect their business (second step). The awareness raising would give detailed enough information to private stakeholders (beyond common knowledge of overall climate events) as part of the first step to convince them that they need to take the second step (autonomous analysis of climate change impacts specific to their business) to ensure that their enterprise remains competitive and is not at risk from climate change events. As planning for climate change exceeds the usual timeframes for strategic management in companies, it is likely that need for action is not identified in advance, leading to "lock-in" effects (e.g. if new construction sites are built in vulnerable areas).

In particular, the main beneficiaries of these services will be small and medium-sized enterprises (SMEs)[127] that account for 99% of all businesses in the EU, for up to 66% of all private jobs and for 58% of the total value added by businesses in the EU. In contrast to other businesses, SMEs more often have difficulty in coping with market imperfections like accessing capital and knowledge, coping with structural changes in markets and frequently lack experience. SMEs also often lack the power to implement value chains on a large scale and therefore depend on creating direct links within and outside their region of origin[128], making SMEs less self-sufficient. EU Cohesion Policy is aimed at tackling these difficulties. Raising awareness on climate change impacts and adaptation is complementary for raising the competitiveness of SMEs, with potential positive effects to the growth and jobs for local economies, as SMEs often represent the highest source of employment at the regional level. The adaptation option is fundable under the current Cohesion Policy framework, especially under the expenditure category 060 EE in SMEs (ERDF Article 5(4)b in the draft regulations for the 2014-2020 period).

Cost Benefit Analysis and General Impact Assessment

There is limited quantified cost data available on existing awareness-raising programmes for enterprises, of the type that would be funded through Cohesion Policy. The costs have therefore been derived based on expert knowledge of the costs of running training programmes, and a number of assumptions about how the set-up of programmes could be implemented as part of Cohesion Policy-funded business support services across the EU. The costs are calculated by year, with Year 1 as the programme set-up year and implementation of training sessions + programme update taking place during Years 2 – 7.

There are no quantified benefit data available on awareness-raising benefits for companies that would consider the whole range of possible climate related damage costs specific to the industry. One indicative figure is the following—the damage costs reported for river flooding indicate that the damage to industrial and commercial activities accounts for around 12% of total damage costs, valued at some €2.5 billion per year (2010 prices) by the 2020s, based on the A1B climate scenario (Feyen and Watkiss, 2011).

This figure only considers river flooding in a medium climate-change scenario and indicates the high level of damage costs that can be expected for industry and commerce. Even in the absence of damage estimates from other climate change related events, the figure shows the potential that awareness programmes could have.

[127] SMEs employ fewer than 250 persons and have an annual turnover not exceeding €50 million/or have an annual balance sheet not exceeding €43 million. Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises 2003/361/EC http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:124:0036:0041:EN:PDF, Accessed 30 April 2012

[128] Elements for a Common Strategic Framework 2014 to 2020, SWD(2012) 61 final, Annex

The ratio calculated in Table 56 is an indication of the possible scope of benefits that could be considered for this option. Even if assuming minimal/low cost autonomous implementation amounting to 10% of the anticipated benefits, the costs of the "awareness raising for companies" are almost equal to the benefits across all Member States. If the total of €2.5 billion damages is avoided, the benefit-to-cost ratio increases to 9.7 to 1.

Table 56. Minimum and maximum benefit-cost ratios

In Mio.€ per year	Total costs	Total Benefits	**Benefit-cost ratio (average and variability)**
Min	257.4	250	5.3
Max	257.4	2,500	[0.97 – 9.7]

This analysis indicates that the soft option of awareness raising can be implemented efficiently in the frame of Cohesion Policy. The average benefit-to-cost ratio leads to result above 1 for nearly all Member States. Due to the approach based on damages from river flooding only, results for Denmark and Portugal (which will not face major threats from river flooding) lie below 1. This would however change if a broader range of climate change threats was included in the analysis.

For interpreting these results, it has to be clear that awareness raising alone does not effectively prevent climate impacts but that it is only the first step on an individual adaptation pathway in a SME. The benefits of the option only hold, if the awareness raising provides enough information and knowledge so that SMEs can identify and implement relevant adaptation option.

14.1.6 Setting up Anti-hail nets

Overview of threats

Hailstorms are extreme weather events of important significance in Europe. Most hailstorms occur during summer during thunderstorms. Different studies propose a considerable increase of hailstorm damages due to global warming, because they figured out a direct connection with the average summer temperature (Botzen et al. 2010, Dessens 1995, Willems 1995). Climate scenarios on hail storm damages show a high uncertainty, because convective extreme events show a high variability in space, time and intensity. Hail damages are most significant for agricultural production, but they also impact vehicles and buildings. A popular option to diminish the financial losses associated with hailstorms is to insure crops against hail damage. However, insurance does not solve all the problems; affected farmers often have to cover some costs and risk losing customers if they can't offer products and furthermore, the insurance companies establish a maximum price payable. Given the huge increase in the cost of insurance over the last few years, anti-hail nets have been increasingly used already under current climate conditions. Hail nets constitute an effective way to protect agricultural products against this threat (Iglesias & Alegre 2006, Dalezios n.d., Tasin et al 2008, Sinabell et al 2010). Via anti-hail nets it should be possible to avoid hail storm damages also under extreme climate scenarios. The avoided damages through anti-hails nets are mainly economic losses for farmers and further economic actors in the food industry. Furthermore, it is linked with social impacts of income losses, especially in regions where the economy and society is highly dependent on farm incomes.

Role of Public Adaptation and EU Relevance

The option has to be implemented by farmers, but the initial costs for anti-hail nets are very high. Furthermore, the benefits occur only on an irregular basis, only if hailstorm events happen. Anti-hail nets can receive funding under Rural Development Measure 121 Modernization of Agricultural

holdings. The funding rate can vary. In Slovenian RDP, for example, the funding rate is between 50 – 70% of the costs with the rate higher for your farmers and less favored areas, or Natura 2000 areas. The maximum recognized costs in Slovenian RDP are up to 23,500 Euro/ha.

Cost Benefit Analysis and General Impact Assessment

The cost and benefit estimation will be discussed in its application for fruits, like apples and peaches, olives and grapes. For these agricultural products, the damage caused by hailstorms can represent up to 100 per cent of the yearly harvest, depending on when they occur during the growing season, and the magnitude of the events. The most relevant studies are done for different fruits, especially apples (Tasin et al 2009, Iglesias & Alegre 2006, Dalezios n.d.).

In the cost and benefit estimation following components are included:

- Costs for this measure include: investment costs for installation of anti-hail nets, including nets, poles, poles anchorages, etc. To these costs must be added the yearly maintenance and handling. Furthermore, the potential impacts of hail nets on agricultural production are included.
- The major benefit parameter for setting up of anti-hail nets is the avoided agricultural damage costs due to hailstorm events, which is based on insured losses.

Uncertainties in the calculation are based on the weak data on the current installed anti-hail nets. As a result, the estimation of additional anti-hail nets is weak. For the cost parameter for installation and maintenance of nets different data sources show similar costs. Furthermore, assumptions had to be taken for the damage costs. A diversity of data on hailstorm damage costs is available, mostly for one time events (e.g. Betz 2009). But a systematic evaluation and monitoring of hailstorm damage costs in agriculture for a time period is very difficult to find, such damage costs could be only found for Greece. The link between temperature change and damage costs in agriculture is discussed in different studies and is proved. The spatial variability of hail storm damages cannot be projected but has a high impact on damages. The damage magnitude changes from study to study, but the bandwidth of Botzen et al (2009) includes different other results.

Table 57 contains the different estimated cost components and benefits and the cost-benefit ratio on EU level.

Table 57. Minimum and maximum benefit-cost ratios

In Mio. € per year	Investment + Maintenance Costs	Yield loss due to nets	**Costs total**	**Benefits total**	**Benefit-cost ratio average and variability**
Min	6,466.4	410.8	6,877.1	1,058.07	0.16
Max	9,257.5	410.8	9,668.3	1,608.45	[0.1 - 0.2]

The costs for the adaptation measure *additional anti-hail nets* are higher in all scenarios than the estimated benefits. The benefit-cost ratio is calculated between 0.2:1 and 0.1:1. The benefits could increase if the production value for fruits, olives and grapes from Europe rose by 2050. More than 80 % of the costs and therefore investment needs are linked with the more developed countries, focusing on Southern Europe (Spain, Italy, Greece and Portugal). From the less develop countries in Eastern and South-Eastern Europe Poland and Romania have the highest need for investments. Hailstorms are very local effects, so in regions which are especially vulnerable to hailstorms the option could show higher benefits. Furthermore, regions with a high dependency on farm income and on to hailstorms vulnerable crops the economic impacts of hailstorm damages could equal the

costs. Co-benefits are limited but can be seen for different aspects regarding economic income of farmers, e.g. less sunburn on fruits.

Due to benefit-cost ratio the option might be interesting for regions and farmers with a high vulnerability to hailstorms, e.g. in Southern Europe, especially some regions in Spain and Italy.

14.1.7 Buffer/vegetation strips

Overview of threats

Buffer strips include in the case study woodland, hedgerows, strips of grassland along water bodies, grass margins, field corners, etc. Vegetated and unfertilized buffer zones act as a shield against overland flow from agricultural fields and reduce run-off from reaching the watercourse, thus decreasing erosion and the movement of pollutants into watercourses. Soil erosion is a main climate change impact in the agriculture sector. High precipitation and droughts increase soil erosion – wind and water erosion. Both effects are projected in several European regions: extreme events, like high precipitation but also storms, are assumed to increase in magnitude and quantity. Also periods of droughts are likely to increase, especially in southern Europe (Floerke et al 2011). The climate change impacts: precipitation, storms and droughts interlinked with wind and water erosion is a main climate impact on agricultural production. The erosion problem is already a current and very urgent problem for agriculture. Furthermore, the options can reduce damages through flooding because the water infiltration rate of the soil is increasing. Buffer strips avoid reduced yield loss through soil erosion. Furthermore, a reduction of biodiversity loss and high environmental co-benefits are seen for biodiversity aspects. The benefits remain also under extreme climate scenarios.

Role of Public Adaptation and EU Relevance

Buffer strips on existing agricultural area are mainly implemented on private level from farmers. The implementation time of vegetation strips takes several years and the agricultural area of the farmer is minimized through the option. Since the CAP Health Check in 2009, buffer strips along watercourses are a compulsory GAEC standard under cross-compliance which had to be implemented at the latest by 1.1.2012. Member States had the flexibility to define the exact requirements taking into account national and regional conditions. Beyond this, MS can also introduce the measure as a voluntary measure whereby farmers are compensated for income foregone or additional costs accrued for requirements which go beyond the cross-compliance baseline. Normally, the voluntary measures are funded under the agri-environment measure (214) of Rural Development Programmes. Funding levels differ between MS and are based on the actual requirements for the farmers (width and length of the strip, management requirements). For example, in Finland the maximum payment level is 450 Euro/ha for strips up to 15-20 m in width along larger watercourses, in Norway payment for a 5 m grass strip include 0,79 Euro/m.

Cost Benefit Analysis and General Impact Assessment

The assessment of costs and benefits include:

- The cost assessment of the option includes establishing the vegetation strips at the beginning of the year, and their on-going annual maintenance. Furthermore, the reduced productivity of arable land is estimated.
- The major benefit for establishing additional vegetation strips is the avoided yield loss due to soil erosion, followed by run-off of nutrition. A second benefit is the use of fewer insecticides. Vegetation strips also support biodiversity and spread out beneficial organisms.Due to the long lifetime of buffer strips the average annual benefits and maintenance costs are estimated up to 2050 to consider the increasing benefits over time.

The highest uncertainty in this estimation can be seen in the future soil erosion risks of different countries. Here, only a small number of scenarios exist, which still have to be improved. In the basic costs parameters (investment, maintenance costs, also reduced productivity) some research was already done, but a strong band width exists. For the benefit estimation, assumptions were needed especially for the area which can benefit from lower yield losses and the reduced amount of needed insecticides. For these parameters the database is very weak and some own assumptions were necessary. The underlying values (production value and costs for insecticides) are reliable. They could be taken from Eurostat and exist for the different member states.

Table 58 contains the different estimated cost components and benefits and the cost-benefit ratio on EU level.

Table 58. Minimum and maximum benefit-cost ratios

In Mio. € per year	Investment + Maintenance Costs	Yield loss due to occupied land	**Costs total**	Reduced yield loss	Less used insecticides	**Benefits total**	**Benefit-cost ratio average and variability**
Min	25.0	13.2	**38.2**	274.5	25.7	**300.1**	20.1
Max	109.2	48.0	**157.3**	3695.2	42.7	**3,737.9**	(1.9 - 97)

The benefits for the adaptation measure *buffer/vegetation strips* are higher in all scenarios than the estimated costs. The benefit-cost ratio is calculated between 1.9:1 and 97:1. For Northern European countries the measure is less relevant because of their lower erosion risk. Furthermore, in the minimum scenario some Eastern European countries show slightly higher costs compared to estimated benefits.

The high bandwidth is mainly reasoned by the benefit estimation, so the benefits for reduced erosion and therefore higher yields due to vegetation strips vary very much. Also the assumptions on less used insecticides differ. The highest costs are shown for the countries: Spain, Italy, Romania, followed by Germany. The high values for these countries can be explained by a high amount of arable land and a high soil erosion risk. The highest benefits were estimated for France, Italy and Spain. The cost and benefit estimation shows a variation between the proportion for the new Member States in Eastern and Southeastern Europe (respective old Members States). We estimated 30 % of the costs for the new Member States, but only 17 % of the benefits. Due to the amount of co-benefits the estimated benefits are still at the lower range. The option shows high co-benefits with biodiversity and improving of water quality, including effords under the Water Framework Directive.

Overall the option shows higher benefits and costs in all scenarios. Further co-benefits for biodiversity and water quality are potentially increasing the benefits. Therefore a high EU relevance can be assumed.

14.1.8 On farm harvesting and storage of rainwater

Overview of threats

Rainwater harvesting is an effective adaptation strategy for areas with high rainfall variability. The systems can be divided between catchment of water and storage. Most catchment areas are rooftops with galvanized metal and non toxic paint; however, other options include concrete, terra cotta tiles, fiberglass, or polycarbonate. Additional system components usually include gutters, leaf screens and a storage tank, and filtration or treatment system. The measure helps to mitigate

flooding by reducing runoff at times of high rainfall and reduces pressures on water resources during times of water scarcity (UNEP, 2009). While the measures do not "save" water they alleviate the impact that water use has on the environment and other water users in the basin (EC, 2012). Water is needed for crop irrigation at specific times of year usually when water is most scarce. For this reason, alternative sources of water can alleviate pressure that would otherwise be extracted from vulnerable resources at critical points of the year. Especially in Southern Europe, but also in North-West and Central & Eastern Europe projections show an increase of drought periods (Floerke et al 2011). For extreme climate scenarios with a very strong reduction of rainfall also during winter, fall and spring the measure is less effective due to its dependency on winter rainfall.

Role of Public Adaptation and EU Relevance

On farm rainwater harvesting and storage are mainly implemented on private level from farmers. The option shows high co-benefits for the runoff and following flooding and erosion aspects. Especially, in regions with water scarcity in summer and enough rainfall in winter season the pressure on water resources can be reduced.

The measure can be funded as a rural development measure under CAP. Technical support and awareness raising activities can also be funded. In general, water harvesting systems have not received enough technical support which may be due to the fact that there is a lack of regional policy and strategy that aims to develop different rain water harvesting systems for crop production. There is a need to formulate a coherent policy or strategy towards strengthening extension and technical support of rainwater harvesting for crop production.

Cost Benefit Analysis and General Impact Assessment

The assessment of costs and benefits is done for up to 2050, because of the long lifetime of the harvesting and storage infrastructure. Following components are included:

- The cost assessment of the option includes establishing the infrastructure for rainwater in the initial phase for catchment and storage of water and the yearly maintenance and operating of these infrastructures.
- The major benefit for establishing additional rainwater harvesting and storage is that a change to non-irrigated crops but also less valuable crops can be avoided.

The highest uncertainty in this estimation can be seen in the future water availability under different climate scenarios including rainfall and droughts and therefore the need for irrigation of crops. For the cost parameter experiences from already installed infrastructure can be used, the parameter is relative certain. The benefit estimation is based on data from an UK case study and is transferred to the other countries on the basis of planting area for different relevant crops. Here, a more detailed analysis of market prices and also future projections of market prices and crop division could decrease the uncertainties.

Table 59 contains the different estimated cost components and benefits and the cost-benefit ratio on EU level.

Table 59. Minimum and maximum benefit-cost ratios

In Mio. € per year	Installation costs	Maintenance and Operating costs	**Costs total**	**Benefits total**	**Benefit-cost ratio average and variability**
Min	311.2	15.6	**326.7**	14.576.8	10.9
Max	4789.4	478.9	**5,268.4**	44.565.5	(2.8 - 136)

The adaptation measure *on-farm harvesting and storage of rainwater* shows in all scenarios on EU level and for all countries higher benefits than the estimated costs. The benefit-cost ratio is calculated between 2.8:1 and 136:1. The high bandwidth is mainly reasoned by the costs estimation and the different projections on needed irrigation under future climate change scenarios.
Italy, Spain, Greece, France and Portugal show the highest benefits and also the highest costs. The high results for these countries can be described by a high amount of irrigated area (today and under future projections) and a high percentage of high-valuable crops, like fruits, vegetables, etc.

Furthermore, the option shows co-benefits against flooding and erosion. The measure shows positive benefit-cost ratios and can be recommended to all member states, which have problems of water availability during summer season and enough rainfall in winter. But the measure does require careful consideration in areas of water scarcity where the implications for hydrological balance at the river basin level can be greater.

Overall the option shows higher benefits and costs in all scenarios. And there is further potential to increase the benefits, due to further co-benefits. A high EU relevance can be assumed.

14.1.9 Enhance floodplain management

Overview of threats
Flood meadows are a green measure utilizing natural landscape functions and thereby embracing the concept of ecosystem based adaptation. The measure reduces the impacts of and exposure to extreme flooding events and increases the adaptability of ecosystems to climate change. River and Coastal flooding is one major problem which will be increased in quantity and intensity by climate change. (See also chapter 2 and the main sources: Brown et al 2011, Richard & Nicholls, 2009, Feyen & Watkiss 2011, EEA 2010). Regions with already high precipitation may become even wetter in future. For some dry regions such as Mediterranean and Eastern Europe also more extreme precipitation events are projected (unevenly distributed though EU). The British Islands and Central, East and south Europe are the most vulnerable regions (Christensen and Christensen 2007). Flood meadows are an environmental friendly and green measure against flooding, compared to heightening dikes. Furthermore, also in contrast to dikes the measure is still efficient under extreme climate scenarios. The measure shows many co-benefits for biodiversity and water quality.

Role of Public Adaptation and EU Relevance
For flood meadows mainly public actors and interventions are needed. In some cases they are supported by private donators, i.e. environmental associations. The co-benefits for biodiversity and water quality of rivers are very high. The implementation time for flood meadows is very long due to growth of habitat typical vegetation.

The measure is currently and can continue to be funded under the agri-environmental measures of the CAP under the Rural Development Plans. The average payment rate for the conversion of arable land to grassland as an environmental land use change is currently €313 per ha with the minimum rate of €101 per ha in Hungary and a maximum of €733 per ha in the UK (European Commission, 2011).

Cost Benefit Analysis and General Impact Assessment
The assessment of costs and benefits up to 2050 (considering the long timeframe of effects) include:

- The cost assessment of the option includes establishing and maintenance costs for the flood meadows. Furthermore, the crop yield loss due to land use change has been included.

- The benefits for flood meadows are avoided damage costs concerning river flooding (up to 2050), mitigation of greenhouse gases, nutrient retention (especially nitrogen, phosphor) and biodiversity conservation.

The value for biodiversity conservation shows a high uncertainty. The parameter is taken from a regional case study in Germany and was transferred to the different other EU members states. Furthermore, it can be discussed if this value will be changed due to climate change (in the calculation no change is included.) Further, there are uncertainties which percentage of damage costs can be avoided by flood meadows. These effects differ very much regarding local circumstances.

For establishing and maintenance of flood meadows historical data exists, but it is always different according to local circumstances. The crop yield loss is based on the average crop output for every Member States with data from Eurostat. The database is relative certain, but future changes of used crops and market prices for agricultural products could not be included.

Table 60 contains the different estimated cost components and benefits and the cost-benefit ratio on EU level.

Table 60. Minimum and maximum benefit-cost ratios

In Mio. € per year	Establishing and maintenance costs	Crop yield loss	**Costs total**	**Benefits total**	**Benefit-cost ratio average and variability**
Min	26,694	47,217	73,912	86.137	1.4
Max	32,075	47,217	79,292	124.724	(1.1 – 1.7)

The adaptation measure *enhance floodplain management especially establishing of flood meadows* shows in all scenarios at least slightly higher benefits than the estimated costs. The benefit-cost ratio is calculated between 1.1:1 and 1.7:1. The benefits are higher than the costs in almost all countries, except some Southern countries like Italy and Greece and some countries with a high agricultural production value per ha like Netherlands. The highest costs and benefits are estimated for Hungary, Finland and Sweden. It remains mainly to their high amount of possible additional wet-grassland. Furthermore, the option shows co-benefits for the increasing of water quality and against soil erosion.

As summary: The option shows higher benefits and costs in all scenarios and because of different environmental and social co-benefits a high EU relevance can be assumed.

14.1.10 Plant winter cover

Overview of threats

Planting winter crops builds up soil quality, reduces nutrient leaching, surface run-off and soil erosion, and has positive effects for carbon sequestration. Soil erosion is a main climate change impact in the agriculture sector and nutrient runoff is a major cause of contaminated freshwater, groundwater and coastal water sources. It is very relevant given the expected increase in extreme precipitation events, and changing precipitation patterns (milder and wetter winters). By slowing down wind speeds at ground level plant cover thus also reduces wind erosion.

Wind and water erosion are main already existent problem in European agriculture, which will be increased due to climate change impacts. Especially relevant are the increase of quantity and intensity of extreme events such as precipitation (and flooding), storms, heatwaves, droughts. The combination of different climate change effects can even increase the impacts on soil erosion.

The measures plant cover and catch crops consist of fast-growing crops that are grown between successive plantings of a main crop. Although cover crops can also be under-sown below the crop in spring, they are generally sown in late summer or autumn, immediately following harvest with the purpose of providing soil cover during the winter. The measure is particularly applied in areas with excess precipitation and runoff during autumn, winter and early spring. The measure is effective under different climate scenarios, including extreme scenarios.

The choice of cover crop depends on the purpose, the method of seeding, and the time of year. Cover crops are usually classified as cool season, warm season, winter annual, biennial, or perennial and as grass, legume, brassica, or other. Crops may include: green rye, hairy vetch, winter turnip rape, cereal, oil-seed crop, seed spice, phacelia, barley, mustard. In northern states, the plant selected needs to possess enough cold tolerance to survive hard winters.

Role of Public Adaptation and EU Relevance

Planting winter cover is an option which has to be implemented by farmers. The option shows further co-benefits with biodiversity conservation regarding species in rivers and lakes, due to reduced runoff water containing N, P and particularly pesticides winter plant cover can also provide a habitat space for species (Flynn et al. 2007).

The EU Common Agriculture Policy (CAP) identifies agri-environmental measures in its Rural Development Program (RDP) to reduce losses of nutrients which include promoting catch crops. The cross-compliance mechanism of CAP also requires farmers to meet environmental requirements to receive subsidies, of which winter plant cover are measures.

Cost Benefit Analysis and General Impact Assessment

The assessment of costs and benefits include:

- The cost assessment of the option includes investment and operation costs for additional seed and costs include seedbed preparation, seed, planting and killing the vegetation.
- The benefits for planting winter cover are avoided damage of nitrate leaching (to health, eutrophication, etc.), reduced fertiliser spending, mitigated greenhouse gases through increase of soil organic carbon.

The highest uncertainty in this calculation can be seen in the estimation of the current situation and the additional needed area with plant winter cover. Furthermore, we did not recommend the option for Southern European countries, due to their water scarcity problems and the uncertainty if enough water is available for another crop planting period. For costs experiences of the farmers can be used and the data is reliable. Some beneficial effects differ according to different regions and local circumstances, such as avoided damages through nitrogen fertilizer depends on population density, etc.

Table 61 contains the different estimated cost components and benefits and the cost-benefit ratio on EU level.

Table 61. Minimum and maximum benefit-cost ratio

In Mio. € per year	Costs total	Mitigation of GHG	Avoided damage costs nitrogen fertilizers	Reduced fertilizer spending's	Benefits total	Benefit-cost ratio average and variability
Min	**954.1**	222.0	139.8	512.8	**874.6**	1.0
Max	**1,214.3**	577.5	215.1	512.8	**130.5**	(0.7 – 1.4)

The adaptation measure *plant winter cover* shows a balanced benefit-cost ratio. It varies between slighty higher costs to benefits to slightly higher benefits to costs. Anyway, the option shows for all scenarios higher benefits than the estimated costs. The benefit-cost ratio is calculated between 0.7:1 and 1.4:1, with an average: 1:1.

The highest costs are estimated for Poland, France and Germany, concerning there high amount of arable area. Highest benefits are shown for Poland, France and Germany.
Like mentioned, Southern European countries are not included due to problems with water availability. Positive benefit-cost ratios are estimated for different countries, especially Belgium and Netherlands show a very good ratio due to their high costs for fertilisers. Also Germany, France, UK and the Northern countries (with Finland, Sweden, and Denmark) have a good ratio (with higher benefits than costs).

Even if in some scenarios the costs are slightly higher than the benefits the measure has further co-benefits like biodiversity conservation, which could not be included in the estimation. A high EU relevance can be assumed, especially for the North-West and Northern countries. It needs to be careful in countries where water scarcity is already a problem, like in the southern European countries such as Spain, Italy and Greece.

14.1.11 Improvement of animal rearing conditions under increasing temperature

Overview of threats
Increasing average temperature and maximum summer temperature are one main climate change impact which is one of the most certain effects. All European countries will face the temperature problem with highest temperature projections in the Southern European countries. Apart from the consequences for human health effects occur for animals in agricultural production. Rising temperatures can result in increased heat stress, disease and parasites, which in turn, reduce animal productivity, and possibly increase mortality. Given the rise in temperature due to climate change and the intensive production of contemporary farming methods, the agricultural industry should address these concerns to increase the long-term viability of European farming systems and improve animal welfare.

The objective of the measure is to decrease the stress that animals experience during hot weather and thus maintain their productive capacities. Many different options are possible for cooling of animals. The measure includes the use of sprinklers and shading structures (trees or building shade structures). Cooling options, such as indoor ventilation systems with fans, or cooling pads, are not considered (they are part of the 'cooling of stables' option). Passive cooling through the design of stables is also not considered here. Usually, the best option is a combination of components that can be used throughout the day in various locations to maintain the animals' normal temperature. The measures are effective under all scenarios, but the effect is limited to a certain degree of heat reduction, so under extreme climate scenarios with very high summer temperatures the effect of the measures would decrease.

Role of Public Adaptation and EU Relevance

Improvement of animal rearing conditions is mainly implemented on private level by farmers. Due to the direct connection to product margin for the farmers' autonomous adaptation can be assumed, at least partly. In particular, measures with a short implementation time will be preferred by farmers. If the energy and water efficient measures were encouraged through government support or subsidies, farmers would be more likely to implement these measures.

CAP sets its objective at productive and sustainable agricultural production to which animal rearing is relevant in terms of both productivity and sustainability of the industry to adapt to climate change and specifically rising temperatures. Improved animal welfare through cooling and shade systems not only improves welfare but also the quality of agricultural products for human use and consumption, particularly milk and eggs. Funding is provided by
RDP Article 18 – Investments in physical assets, providing support for investments in 'tangible and/or intangible investments which can improve the competitiveness of the business or be non-productive in nature, linked to achieving requirements under the agri-environment-climate or forest-environment measures. Further important are: RDP Article 34 – Animal welfare, RDP Article 23 – Afforestation and creation of woodland (for trees) and RDP Article 29 – Agri-environment-climate.

Cost Benefit Analysis and General Impact Assessment

The assessment of costs and benefits concentrates on shade structures for dairy cows:

- The cost assessment of the option includes investment costs for artificial shade structures.
- The major benefit for establishing is the avoided reduction of milk production due to increasing temperature.

The highest uncertainty in this estimation can be seen in the future market prices for milk production in Europe. The projections on increasing temperature are one climate change impacts which can be projected with higher certainty. For the costs to build shade structures experience parameters exist.

Table 62 contains the different estimated cost components and benefits and the cost-benefit ratio on EU level.

Table 62. Minimum and maximum benefit-cost ratio

In Mio. € per year	Costs total	Benefits total	Benefit-cost ratio average
	757.0	988,2	1.3

The adaptation measure *improvement of animal rearing conditions under increasing temperature* shows for shade structure for dairy cows higher benefits than the estimated costs. The benefit-cost ratio is calculated 1.3:1.

The highest costs are estimated for Germany and France, followed with a lot lower result by Poland and Romania. Benefits are highest in France and Germany followed by Spain and Netherlands. France and Germany have the highest amount of milk production in the EU. For both and for Netherlands is also projected the highest increase (change) in the number of heat and summer days. Higher benefit-cost ratio has been estimated for countries with a high milk production, high increase of temperature – especially Southern European and Central & Eastern countries.

Further benefits can be seen for better animal health and decrease of the spread of harmful diseases among animals by reducing ammonia, dust, and carbon monoxide levels which are also important for farmer health and public health.

Overall the option shows higher benefits and costs. Furthermore further benefits can be seen. A high EU relevance can be assumed, especially for countries with a high projected temperature change and a high milk production.

14.1.12 Improved forest management: Forest Thinning Practices

Overview of threats

Good forest management will help counter the impacts of climate change. Forest management is based on the combination of a number of practices including forest monitoring, maintaining species diversity, pest and disease management, conservation of biodiversity, and fire management (FAO, 2012). Reducing the likelihood of forest fires in particular, will involve continuous monitoring of fuel conditions, fire behaviour and climate, in addition to fuel removal (FAO, 2012). The removal of fuel or "forest thinning" is one of the most commonly used methods to prevent fires. It involves the mechanical and manual removal of shrubby species and tree thinning, both of which prevent the spread of fire across the ground and up to the tree canopy (IEEP, 2008).

Some areas of the EU are more prone to forest fires than others. Reports of forest fires in France, Greece, Italy, Portugal and Spain show that, in these areas, between 2000 and 2006, more than 450,000 ha burned on average each year. In 2007 the phenomenon got even worse, especially in the South-Eastern countries (Greece and Italy in particular), and the total area burned was approximately 500,000 ha. Fires have caused extensive damage in recent years, leading to a loss of human life, impacts on human health due to dispersed particulates, fire damage to property, infrastructure and businesses, and extensive environmental damage in forests and agricultural areas (IEEP, 2008).

Role of Public Adaptation and EU Relevance

Forest management is a public responsibility. EU interventions under Cohesion Policy to fund forest thinning could be addressed through the following investment categories:

064 Protection and enhancement of biodiversity, nature protection (including Natura 2000) and green infrastructure

065 Adaptation to climate change and natural risk prevention

Efficient utilisation of funds however could be constrained by the lack of an overarching policy on fire prevention in the EU, the lack of guidelines regarding practices, and the application of traditional forest management practices that in certain cases may increase the vulnerability of forests to fire.[129] This could include deliberate forest burning for example.

Cost Benefit Analysis and General Impact Assessment

The costs and benefits of forest thinning were calculated based on the most current data obtained from the European Forest Institute (EFI). Benefits were calculated based on the recreational value of forests, determined through willingness to pay (WTP) studies undertaken throughout the EU as part of the FP6 Exiopol project (Exiopol, 2008). The WTP values chosen for this analysis are based on survey results that consider the greatest number of local variables at the Member State level in order to capture the greatest range in variability of societal value from across the EU. Societal value attributed to forests varies on the basis of national income, forest size, the value of forests at higher altitudes (people often prefer visiting forests in mountainous regions) and density. and density. These WTP values however refer to protecting the overall forest areas, whereas only a part of it will

[129]. See: www.firesmart-project.eu

be affected from climate change and especially forest fires. However, given that these WTP values relate to the protection of total forest areas, the benefit to cost ratio presented in table below needs to be treated with some caution. For simplicity, we summed that only a share of 15-30% of these WTP values can be seen as benefit from forest thinning. This assumption is based on the judgement that not all forests in the EU will be at threat from forest fires and, on the other hand, will be affected from other climate change impacts as well. In a sensitivity analysis, we consider the full WTP value as benefit.

The data used to estimate the cost of forest thinning is based on outputs from the EFISCEN model (Wilkes, 2007). Analysts at the EFI modelled thinning cost over the 2000-2030 year period, in the context of three different wood supply scenarios: a business as usual productivity scenario, a scenario where forests are being used to harvest biomass for the bioenergy sector and under a scenario where the biodiversity of forests is being maintained through conservation practices. The highest cost value from the conservation scenario (over the thirty time period), was used in our analysis. The highest €/m^3 removal cost for each member state in the 2000-2030 time period was multiplied by the total volume of wood removed from forests based on data available from Eurostat in 2010 to obtain a total cost value.[130]

The frequency of thinning varies based on the age of the forest, the species, density and height of trees. Based on the total costs for the 2000-2030 period, annual costs for forest thinning have been compared to annual benefits values.

Table 63 indicates the different estimated cost components, benefits (considering the 15-30% share of WTP values), and the benefit-to-cost ratio, using an annual average for the EU.

Table 63. Minimum and maximum benefit-cost ratio

In Mio. € per year	Costs	Benefis	Benefit-to-cost ratio average and variability
Min	3‘516	1‘275	0.5
Max	3‘516	2,550	[0.4 – 0.8]

As some of the European regions will face only low impacts from rising temperatures and heat waves and thus the risk of forest fires, implementation of the option will only be required in certain areas of the EU. The benefit to cost ratios are higher for countries facing a higher risk of forest fires, and in countries with small forest areas possessing thus high WTP values). The benefit-to-cost ratios are about 2 for Spain, Greece and Cyprus, and 9 for Italy. If the full WTP values for forests are considered as benefits, the benefit-to-cost ratio on EU level comes up to 2.4. This however clearly indicates an upper estimate on the potential efficiency of this option.

14.2 Overview of Options with Qualitative Estimation of Costs and Benefits

A detailed cost-benefit assessment has not been possible for two case studies. These case studies are illustrated in a more qualitative way in this chapter:

14.2.1 Hydropower stations

[130]. http://bit.ly/KbkIUa

Overview of threats

Enhancing the capacity of hydropower reservoirs by increasing dam height could be a way of managing increased river flooding. It is difficult however, to standardize the costs and benefits of hydropower given the variability in hydro technology, and river basin hydrology. Hydropower can include installations of ranging power generating capacity, with widely different impacts on and benefits for natural and social environments (Egré & Milewski, 2002). Meaningful analysis must consider the specific kind of hydropower technology in question. In the case of small hydro, technology is likely to harness river runs only, without involving the creation of reservoirs. Furthermore, social and environmental impact assessments of hydropower schemes only make good sense in reference to complex local scenarios of water basins.

Medium and large hydropower (classified by the International Energy Agency (2010) as 100-300 MW and > 300 MW respectively) involves the construction of dams and reservoirs, a practice which has become increasingly unpopular in Europe because of the substantial environmental impacts entailed. Nevertheless, reservoirs offer the benefits of flood protection (which may be increasingly relevant under the intensified hydrological cycles of a warmer world) and the ability to follow rapid changes in electricity demand to ensure security of supply (which is increasingly important with an expanding but intermittent renewable energy sector), possibly using pumped-storage (World Energy Council, 2004, p. 201-3).

These advantages of flood protection and security of supply are not offered by small 'run-of-river' hydro schemes, typically less than 100 MW in size (IEA 2010). Furthermore, unlike reservoirs, run-of-river power generation stations are unable to harness high water discharge levels associated with intense rainfall events and high levels of precipitation that might be experienced in regions of Europe in the future. This is because they are usually not able to take advantage of overflow volumes that exceed the cut-off maximum productivity level (see below).

Role of Public Adaptation and EU Relevance

EU interventions under Cohesion Policy to fund the enhancement of hydro reservoirs could be addressed through the following investment categories:

057 Renewable energy: hydroelectric, geothermal, marine energy and other

Cost Benefit Analysis and General Impact Assessment

Our research indicates that it is virtually impossible to standardize the benefit to cost ratio for this type of measure given the hydrological variability associated with different river basins. Research undertaken through the Climate Cost project also indicated that it was virtually impossible to provide cost estimates for measures addressing flooding with a bottom-up approach.

Overall damage costs from river flooding can be used to estimate the potential maximum benefits of this option. The total damage costs in the different member states have been calculated in the frame of the ClimateCost project and amount to about 8 bn. € for the EU total. For the five countries where a very rough cost-estimation has been possible, damage costs amount to 4.6 bn. €.

Obtaining cost data has also been extremely challenging. Consultation with experts from the International Hydropower Association revealed that there is virtually no data available to determine the cost of reservoir construction or enhancement. We have used data pertaining to one project in the United States, where reservoir construction is designed to cope with increased flooding.[131] At the

[131]. The potential to build new reservoirs to manage water on the Temperance Flat in the Upper San Joaquin River Basin in California is currently being investigated. See:

current time, the precise dimensions and construction costs of the reservoirs themselves are unknown. A unit cost is available to determine the ability to cope with an average water yield of 183,000 acre feet per year. Developers of this project estimate that reservoir construction will cost $350 per acre foot of volumetric water flow.

Referring to the Californian example, we estimate the cost of the measure to be approximately €0.21/m^3. To obtain a marginal cost for reservoir enhancement at the member state level, this number is multiplied by the average annual water yield used in the Californian example, and the number of reservoirs in each member state. Two cost numbers are obtained: one for water volume in the baseline, and a second for projected water volume. The baseline cost is subtracted from the projected cost to give the total marginal cost of enhancing reservoirs to cope with increased flooding.

Two other data limitations have required us to present the analysis in a particular way. Firstly, it is not possible based on the data available to determine how many reservoirs have been implemented in the context of each hydropower station throughout the EU. The EEA has provided estimates of the total number of reservoirs in Spain, the UK, Italy, France and Sweden. Given that these numbers include all reservoirs, including those built to store water for standard water supply, and assuming that other types of reservoirs also have the potential to cope with flooding, we have included them in the analysis.[132] Referring to total estimates of hydropower generation in each Member State, it is impossible to tell what percentage of generation pertains to larger scale hydro, and hence to those installations including reservoirs. Using this very rough cost estimation, necessary investment costs (annualised values) in the five relevant countries have been estimated at 15.9 bn. €.

Comparing this rough cost estimate with the potential maximum benefits makes clear that this options is rather inefficient. Even if the maximum potential benefits are considered, costs are still nearly three times higher. This option should thus not receive a high prioritisation on the overall EU level. Other options targeted at river-flooding might be more efficient. Still, the option might be efficient in very local circumstances with limited alternatives for other options (e.g. in the Alpine Space).

14.2.2 Adaptation of tourism services and infrastructures

Overview of threats

Given changing temperature and precipitation patterns, climate change will radically change the attractiveness of European tourism destinations and thus lead to changes in destinations and the seasonal demand structure (Ciscar et al. 2009, Scott et al., 2008). European tourism destinations will be affected differently, according to their current characteristics and target groups: mountain destination in the Alps and lower mountain ranges (e.g. Black Forest in Germany) will suffer from less reliable snow conditions and thus a decline in traditional winter sports tourism; while the Mediterranean region will suffer from extreme heat during peak tourism season, other regions like the North Sea Coast will benefit from more favourable climatic conditions (OECD 2007, CLISP 2012).

Due to these very different challenges, characteristics and market niches of European tourism destinations, it is not possible to provide a generic adaptation approach for all regions and member states. In addition, adaptation options need to be customized and fine-tuned for each tourism destination and could include combined elements of grey, green and soft options:

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http://www.water.ca.gov/storage/docs/USJ%20Project%20Docs/Temperance_FAQ.pdf

[132]. See: http://www.eea.europa.eu/themes/water/european-waters/reservoirs-and-dams

- Grey options could include the adaptation of tourism infrastructures to changing climate conditions. This may include the adaptation of skiing infrastructures or the construction of new protective infrastructures against natural hazards in mountain areas. In coastal areas, grey options may include protective infrastructures on the coastline such as dikes. Also, this element can include a diversification of infrastructures, e.g. with the construction of bike trails, new indoor and outdoor activity centers, etc.
- Green infrastructures focuses directly on tourism (for example the extension of natural parks) or can have indirect impacts on tourism (for example making use of floodplains, mountain forests etc. to better cope with natural hazards and extreme events).
- Soft options that focus on both tourism stakeholders (for example awareness raising campaigns, information and exchange platforms, support to develop private adaptation strategies) and guests (information platforms with activity tips for varying weather conditions). Targeted early-warning systems could profit both groups. Soft options furthermore include strategic options such as sustainable regional planning practices which, in combination with grey options, can considerably reduce the vulnerability to climate change impacts.

Role of Public Adaptation and EU Relevance

Although economic stakeholders in tourism will adapt autonomously to climate change (or are already doing so), there are several reasons for a potential government intervention. This is especially the case when private, market-driven and autonomous implemented adaptation options will lead to environmental and social external effects and are thus not in line with the overall principle of sustainable development (e.g. in the case of excessive artificial-snow production) or even lead to maldaptation. Gaining acceptability for these types of options, will require significant consultation with local stakeholders, especially for small scale resorts that generate significant income for the local economy. (OECD 2007). Transboundary issues may require broader consultation efforts. to prevent unwanted distributional impacts within confined natural areas such as the Alpine Space area or the Baltic sea for example.

Using this logic, EU action might become necessary if effects from climate change are underestimated by member states, if the assessment of threats by private stakeholders or public authorities at the regional and national levels leads to unsustainable solutions (or even maladaptation) or if uncertainties around climate change are deemed too high for private stakeholders to become active. The EU can provide incentives and take on a support function concerning the construction of tourism infrastructures, improvement of tourist services as well as training options and awareness-raising. The Structural Fund and the Cohesion Fund already provide essential support to improve the quality and the competitiveness of tourism at regional and local levels. Between 2007 and 2013 directly targeted EU support for tourism under Cohesion policy has amounted to more than €6bn which represents 1.8% of the total EU budget. With respect to sustainable regional planning, it will also be crucial to consider the role of projects for European Territorial Cooperation that receive ERDF funding.

Cost Benefit Analysis and General Impact Assessment

Due to the general approach of the cost-benefit assessment and the fact that no generic adaptation option can be identified for all EU tourism destinations, a benefit-to-cost ratio has not been determined for this sector.15 regional case studies (with both qualitative and quantitative information) however provide an initial estimate for different types of tourism adaptation options. The following table provides a rough overview of these case studies, detailed information can be found in the Supplementary Material Report that includes supplementary material.

Table 64. Overview of tourism adaptation optons and cost-benefit assessment

Region	Specific adaptation option	Type of option	Cost-benefit evaluation or assessment of efficiency
Bavaria (DE) Alpine region	Winter tourism, preparation of skiing slopes. The cost-benefit analysis focuses on the provision of artificial snow.	Infrastructure	Average benefit-to-cost ratio: 70 : 1
Winter sport region in Germany	Addresses summer tourism: "Diversification of offers in summer and every-day life tourism" The cost-benefit analysis focuses on the expansion of cycle path networks.	Infrastructures for sustainable mobility	Average benefit-to-cost ratio: 1.5 : 1
German North Sea region	Building of storm-proofed tourism infrastructure and facilities (e.g. window shutters), abandonment of coast-near buildings of tourism-infrastructure, adapted tourism attraction by a mixture of outdoor and weather-independent indoor activities, awareness-raising of the extreme weather events in tourist-offerings by e.g. "bad-weather hints" with alternative activities	Infrastructure and awareness-raising measure	No information
Todtnau, southern Black Forest Region, Germany	Addresses low mountain ranges tourism: artificial snowmaking, "four-seasons-tourism", concerning ski tourism: concentration on few but therefore suitable skiing centres, ski-independent winter sport offers (e.g. ice-skating, winter hiking trails, etc.), flexible price policy concerning ski passes, alternative sports offers.	Infrastructure and awareness-raising measure	No information
German North Sea region	Sustainable beach management concepts (e.g. beach purification, development of new concepts regarding funding of the different measurements, information spreading concerning climate change impacts, capacity building through the implementation of a focus-network.	Infrastructure and awareness-raising measure	Information is not yet available. A cost-benefit analysis is foreseen in the frame of the project.
Northwest of England	Making use of innovative funding measures e.g. visitor payback schemes; exploring new marketing strategies that consider explicitly the potential vulnerability of locations which face increasing visitor levels	Awareness-raising measure	No information
Municipality of Cascais, Portugal	Adaptation measures were divided in three groups: natural seasonality of the demand; satisfaction of tourists; and tourism products. Some examples of these measures include the increased use of air conditioners, the development of information programs aimed at the general public and tourists, as well as tourism officials in order to create awareness on the issues related to heat stress.	Infrastructure and awareness-raising measure	No information

Region	Specific adaptation option	Type of option	Cost-benefit evaluation or assessment of efficiency
Skåne with the largest city Malmö, Sweden	Identifies challenges and opportunities regarding climate change in Skåne: Opportunities: Large inflow of tourists from Southern Europe summertime evading heat and drought. Challenges: beach erosion will challenge coastal development as will red tide, heavy rains and wind may impede canoeing and trecking, elderly people may need medical care during heat waves Trade-offs: Indoor activities as alternative during hot and rainy days will increase energy use, increased water demand for golfing and gardens may impact agriculture, nature conservation does not allow for nature protection of e.g. the coast line	Infrastructure	No information
Harz-Mountains in Germany	Strengthening of the approach “all year tourism”, instead of focus on winter tourism Specific events during off-peak seasons, e.g. music festivals.	Infrastructure, information and awareness raising	No information available
Alpine Space	Strategy focuses on the following elements: Enhancing planning systems and instruments, cooperation across sectors, levels and borders, building and transferring knowledge, awareness raising, resilient settlement systems and infrastructure, natural hazard prevention, diversification of services	Grey, green and soft options	No information on costs and benefits is available, case studies focus on organizational processes.
Alpine Space	Due to short innovation cycles in tourism, long-term development strategies often do not exist. Based on the concept of sustainability, master plans for regional tourism should be created within the framework of participative processes. These tourism plans should be linked with the regional spatial plans.	Strategic spatial planning, combined with infrastructure options.	Sustainable land-use methods and precaution measures have better benefit-to-cost ratios than technical protective measures.
Saastal, Switzerland	High need for action: diversification of touristic services Medium need for action: adaptation of alpine infrastructures, adaptation of settlements, consideration of indirect impacts (e.g. from changes in water management or biodiversity)	Mostly infrastructure options	No information avaiable

On the basis of these 15 regional case studies and the assessments of other adaptation options, it was however possible to estimate the efficiency of several types of adaptation options:

- **High efficiency adaptation options in the tourism sector:** All strategic options focusing on sustainable regional and spatial planning will have a high efficiency (as stated in the ClimChAlp project). This can be highlighted by an analysis of preventive spatial planning options analyzed by Tröltzsch et al. (forthcoming) with a positive benefit-to-cost ratio. Also, all soft options regarding awareness raising and training show a high efficiency.
  → These options should thus lie in the focus of climate-proofing EU funds, e.g. through using the territorial cooperation frameworks under the ERDF.
- **Medium efficiency adaptation options:** Options that focus on the diversification of tourism services and infrastructures with long-term dynamic effects should at least have a balanced cost-benefit ratio. Some case studies made clear that benefits can exceed costs (e.g. the analysis for cycle trails in Germany). This is especially the case for options with large co-benefits, which are for example also beneficial for the local population.
  → Especially options focusing on sustainable tourism (mobility) can be funded under Cohesion Policy (directly under the categories related to tourism or via relevant sustainable transport funding).
- **Low efficiency adaptation options:** some short-term adaptation options with high upfront investment costs and high operating costs and negative environmental impacts will have a low efficiency and should be left in the responsibility of private stakeholders. This includes the installation of artificial snow production infrastructures which might be very beneficial in the short-term but can also lead to a "lock-in" effect and even to maladaptation if the region fully focuses on this option. Also, this could include some large-scale indoor tourism facilities with high-energy needs like indoor-skiing halls or large indoor-swimming pools or and spas.

15 Annex 8 Methodology Applied by the ClimateCost Project

River flooding and sea-level rise are recognized as the most significant climate threats at the EU level. This can be seen in the relevant crosscutting baseline illustrated in chapter 4. We have not analysed any specific adaptation options related to river flooding or sea level rise in this project as the FP 7 ClimateCost project is just finalising detailed assessments for those threats including estimates on economic damages (without additional adaptation) as well as costs and benefits of adaptation options. Chapter 5.15 of the Supplementary Material Report provides a short summary of results from the ClimateCost project, including country-specific information that is not included in the Technical Policy Briefing Notes (Brown et al. 2011 and Feyen & Watkiss 2011).

With respect to the cost and benefit assessment, the ClimateCost project has used different approaches. For sea-level rise, the approach is similar to our bottom-up methodology but is based on modelling undertaken using the DIVA model. This model allows for implementation of two specific adaptation options; i) dikes and ii) beach nourishment. The model then shows the specific benefits of these options (Brown et al. 2011). For river flooding, the study has applied a top-down approach analysing the benefits of a more holistic regional adaptation strategy. A level of acceptable risk has been defined and the benefits related to introducing and maintaining the corresponding flood protection in future time calculated. The potential costs of protection for obtaining these standards were then assessed (Feyen & Watkiss 2011).

The calculation provides clear results for the benefit-to-cost ratios for both river flooding and sea-level rise adaptation options (see Chapter 2). In all cases the benefits of adaptation to river flooding and sea level rise exceed the costs that increase over time.

Table 65 contains the different estimated cost components and benefits and the cost-benefit ratio at the EU level.

Table 65 Benefit-to-cost ratios for adaptation to river flooding and sea-level rise (A1B)

	Benefit-to-cost ratio of adaptation to river flooding		Benefit-to-cost ratio of adaptation to sea-level rise	
	2020	2080	2020	2080
Costs (in bn. €)	1.9	9.0	1.2	1.8
Benefits (in bn. €)	7.2	49.2	3.92	25.5
Benefit-to-cost ratio	3.8 : 1	5.5 : 1	3.3 : 1	14.2 : 1

16 Annex 9 Summary Assessment of Instruments

Summary assessment of relevance of instruments to be used in the climate proofing (from the perspective of adaptation) of Cohesion Policy and the Common Agricultural Policy

Instruments	Type of instrument	Aim of instrument	Current requirements for climate change adaptation	Relevance		Assessment in relation to the potential for climate proofing CP and CAP from the perspective of adaptation
				Relevance for CAP	Relevance for CP	
Environmental assessment or other cross-cutting instruments						
Environmental Impact Assessment (as required by Directive 2011/92/EU)	Regulatory	Assess the potential environmental impacts of public and private projects with a view to minimising these in the project design	Requires the consideration of the impact of the project on the climate, but **not** the potential effect of climate change on the project	EIA is required for agriculture projects of a certain size (those listed in Annex II), including afforestation and deforestation when converting to another type of land use, as well as infrastructure projects	EIA required for a number of types of project (list in Annex II) of a certain size that could be funded under CP	Currently, the EIA is not suited to ensure climate proofing of projects under CP/CAP; as it is widely used in CAP and CP, **it should be considered further in this assessment**.
Strategic Environmental Assessment (as required by Directive 2001/42/EC)	Regulatory	Require an environmental assessment of selected public plans and programmes to ensure a higher consideration of environmental concerns	Requires to consider the impact of the plan/programme on the climate, but **not** the potential effect of climate change on the plan /programme	An environmental assessment is required for all plans and programmes prepared for agriculture and forestry, including Rural development programmes and the proposed Partnership contracts	SEA is required for Operational Programmes	Currently, the SEA is not suited to ensure climate proofing of projects under CP/CAP; as it is widely used in CAP and CP, **it should be considered further in this assessment**.

Instruments	Type of instrument	Aim of instrument	Current requirements for climate change adaptation	Relevance		Assessment in relation to the potential for climate proofing CP and CAP from the perspective of adaptation
				Relevance for CAP	Relevance for CP	
Public procurement, as covered by Directives 2004/17/EC and 2004/18/EC	Regulatory	Set the framework for the public procurement of supplies, works and services in the EU	**No explicit** mention of climate change (mitigation or adaptation), but environmental characteristics can be used as a procurement requirement	Public works contracts involving earth moving, including the drainage of agricultural or forestry land, are covered by the Directives, as are state or public owned farms	Procurements under CP, which are likely to include works projects, would need to be consistent with the Directives	Currently, EU public procurement is not suited to ensure climate proofing of CP/CAP because it does not set out specific requirements for the procurement of supplies, works and services that are more resilient to climate change impacts; as procurement would need to be undertaken within CAP and CP investments, **it should be considered further in this assessment**.
Eco-label, as set out in Regulation (EC) 66/2010	Voluntary	Establish a common eco-label scheme to promote products with a reduced environmental impact	The impacts to be included in the establishment of eco-labels include the impact on climate change, but there is **no** mention of adaptation	No. There is no mention of agriculture or forestry in the Regulation. While it could be applied to agricultural products (food and feed, raw materials), organic farming labels try to cover that more thoroughly.	Cohesion Policy can stimulate the development of new market opportunities for climate-proof building techniques, materials and products	Difficult to see how instrument might be relevant for climate proofing CAP and CP from the perspective of adaptation beyond procurement (see above); hence it is not analysed further

Instruments	Type of instrument	Aim of instrument	Current requirements for climate change adaptation	Relevance		Assessment in relation to the potential for climate proofing CP and CAP from the perspective of adaptation
				Relevance for CAP	Relevance for CP	
EMAS, as set out in Regulation (EC) 1221/2009	Voluntary	Establish an EU-wide eco-management and audit scheme to promote continuous improvements in environmental performance	Emissions to be covered by EMAS include the six greenhouse gases covered by the Kyoto Protocol, but there is **no** explicit mention of adaptation	No, as EMAS focuses on the environmental performance of an organisation, not on the impact of the environment on the organisation	Cohesion Policy can promote EMAS as an instrument for SMEs that reduce their vulnerability to climate change impacts	Difficult to see how instrument could be used to climate proof CAP and CP from the perspective of adaptation; hence it is not analysed further
Instruments targeting the environment, resource efficiency and health						
Assessment in accordance with Article 6(3) of the Habitats Directive (92/43/EEC)	Regulatory	Promote the maintenance of biodiversity, including through the designation of special areas of conservation	Potentially taken into account as the assessment requires the consideration of the impact of plans and projects on the conservation objectives of the site, which should be long-term and so may have considered climate change adaptation.	Yes, as there is the potential for actions under the CAP to impact on biodiversity. The Directive requires management plans and sets constraints to the use of designated areas. Measures may be funded under the 2nd Pillar in the CAP	Yes, as could be applicable to all Operational Programmes and projects	Habitats can be significantly affected by both CAP and CP; habitats can be important for climate change adaptation. In both instances, it is the detail of the intervention that matters and so **it would be useful to assess this instrument in more detail**.

Instruments	Type of instrument	Aim of instrument	Current requirements for climate change adaptation	Relevance		Assessment in relation to the potential for climate proofing CP and CAP from the perspective of adaptation
				Relevance for CAP	Relevance for CP	
Biodiversity Strategy, as set out in COM (2011) 244	Strategic framework	Aims at reversing biodiversity loss	Notes that ecosystem-based approaches to adaptation can offer cost effective solutions and deliver benefits beyond biodiversity conservation. Also notes the importance that afforestation is carried out in accordance with the needs of adaptation	Yes, as the CAP could be used to enhance the positive contribution of agriculture and forestry to biodiversity	Yes, as CP funded projects could assist with the use of biodiversity for the purposes of climate change adaptation	Not considered appropriate for further assessment as main issues in relation to biodiversity would be best captured under the Article 6(3) assessment noted above.
River Basin Management Plans as required by Article 13 of the Water framework Directive (2000/60/EC)	Regulatory	Plans are designed to manage river basins in order to ensure the attainment and maintenance of water of good ecological status and to maintain the sustainable supply of water.	Potentially taken into account as should include a summary of significant pressures and human activity on the status of surface water and groundwater	Yes. Management plans may have an impact on agriculture (fertilizer use, minimizing erosion, water abstraction); measures may be funded under pillar 2.	Yes, particularly when CP provides water infrastructure or funds other projects that potentially have significant impacts on water supply or quality.	While such plans are relevant for both CAP and CP, it is difficult to see how the instrument might be used further to climate proof CAP and CAP from the perspective of adaptation; hence it is not considered further in this assessment.

Instruments	Type of instrument	Aim of instrument	Current requirements for climate change adaptation	Relevance		Assessment in relation to the potential for climate proofing CP and CAP from the perspective of adaptation
				Relevance for CAP	Relevance for CP	
Water pricing as required by Article 9 of the Water framework Directive (2000/60/EC)	Regulatory/ economic instrument	Water pricing aims to ensure the efficient use of water, and this the efficient development of the necessary infrastructure by, *inter alia*, recovering the costs of infrastructure development.	Implicitly water pricing would lead to levels of water use that would be efficient from a range of perspectives, including climate change adaptation.	Yes. Relevant for the CAP as would have implications for the price, and therefore level of water use, faced by farmers. This could have implications on their farming methods, including the crops they plant.	Yes. Relevant for CP as would have implications for the price, and therefore level of water use, faced by wider society and therefore on the amount of water infrastructure that might need to be funded by CP.	While water pricing would potentially have implications for both CAP and CP, it is difficult to see how it could be further used to climate proof these two funds, once the costs associated with climate change adaptation have been included in the price faced by consumers.
Flood Risk Management Plans as required by Article 7 of the Floods Directive (2007/60/EC)	Regulatory	Plans are designed to manage flood risks in order to reduce the adverse consequences for health, cultural heritage, the environment and economic activity.	There are many explicit references to the need to take account of the likely impacts of climate change on the occurrence of floods.	Yes. Flood risk management needs to include agricultural areas for water retention and flood-prone agricultural management in those areas.	Yes, as CP funds could be used to fund projects that reduce the risks of the potential adverse consequences of flooding	While the Directive is of potential relevance for CP and CAP, it is not clear how it might be used further to climate proof investments from the perspective of climate change adaptation; hence, this instrument was not assessed further
Air Quality Plans as required by Article 23 of the Ambient Air Directive (2008/50/EC)	Regulatory	Plans are required where Member States exceed air quality limit values for air pollutants	No mention of climate change adaptation or mitigation.	None, as difficult to see a general relevance in the context of climate change adaptation.	None, as difficult to see a general relevance in the context of climate change adaptation.	Not relevant for further assessment, as no relevance in the context of CP and CAP.

Instruments	Type of instrument	Aim of instrument	Current requirements for climate change adaptation	Relevance		Assessment in relation to the potential for climate proofing CP and CAP from the perspective of adaptation
				Relevance for CAP	Relevance for CP	
Waste Management Plans as required by Article 28 of the Waste Framework Directive (2008/98/EC)	Regulatory	Plans are designed to ensure that waste is managed and that the environmental impacts associated with its re-use, recycling, recovery and disposal are improved.	**No** mention of climate change adaptation or mitigation, although there are many references in the provisions of the Directive to reducing the environmental impacts of the treatment of waste	Little relevance given the scope of CAP	The instrument is relevant as these plans underpin the scope, nature and prioritisation of waste investments promoted under Cohesion Policy.	In spite of Waste Management Plans having an implication for waste investments under CP, it is not clear how the instrument might be used in order to climate proof such investments from the perspective of climate change. Hence, these plans were not assessed further.
Integrated environmental management of the urban environment, guidance developed as a result of strategy on the urban environment (COM (2005) 718)	Voluntary	Summarised the state of the art with respect to best practice on integrated environmental management of urban areas	Notes that solutions to environmental the existing problems of urban areas need to be forward looking, and explicitly mentions the need to mitigate against the risks of climate change such as increased flooding	Not relevant, as focus is on urban areas.	The instrument is relevant as CP promotes investment in urban areas; however, only guidance and so has little real impact.	While CP can lead to investment in urban areas, it is difficult to see, in the context of this assessment, the added value of further assessment, given that relevant issues should be addressed in the course of the respective EIAs and SEAs, which are assessed further (see above).
Action plan on urban mobility (COM (2009 490)	Plan of actions	Sets out EU actions to promote sustainable urban mobility	Mentions climate change in relation to mitigation, but **not** explicitly adaptation	Not relevant, as focus is on urban areas.	The instrument is relevant as CP promotes investment in urban areas; however, only guidance and so has little real impact.	As with integrated urban management plans, there appears to be little added value in further assessing this instrument, as the relevant issues would probably be addressed by the respective EIAs and SEAs

Instruments	Type of instrument	Aim of instrument	Current requirements for climate change adaptation	Relevance		Assessment in relation to the potential for climate proofing CP and CAP from the perspective of adaptation
				Relevance for CAP	Relevance for CP	
National plans for increasing amount of low energy building in Energy performance of Buildings Directive (2010/31/EU)	Regulatory	Plans aimed to set out Member States' approaches to increasing the number of "nearly zero-energy buildings"	None, as focus is on reducing buildings' contribution to climate change, not an adapting to climate change.	Not relevant, as focus of the legislation is on mitigation.	Not relevant, as focus of the legislation is on mitigation.	The instrument is irrelevant for climate proofing CP/CAP
Integrated Coastal Zone Management, Recommendation 2002/413	Voluntary	Recommends an approach that Member States could take to manage their coastal zones in an integrated, sustainable manner	States that the integrated management of coastal zones should be based on *inter alia* a recognition of the threat to these areas from climate change, particularly sea level rise and increased frequency and violence of storms	Yes, as with the floods Directive, agricultural areas may be used as buffer areas, thus requiring an adapted management	Yes, as CP could fund projects that contribute to the objectives of the ICZM Recommendation from the perspective of adaptation, e.g. green infrastructure	In spite of potential relevance of the Directive for CP and CAP, it is difficult to see how the instrument could be used further to climate proof these investments from the perspective of adaptation beyond what would be covered by further assessment of EIA and SEA (see above).
Health White paper, COM (2007) 630	Strategic framework	To provide a common framework to address challenges, including threats to health	Communication notes that there is a need for action on the health aspects of climate change adaptation	Not relevant to adaptation in agriculture	Yes, as health is mentioned under a number of the ERDF/ESF priorities.	Even though health is mentioned under some of the priorities it is not of direct relevance from the perspective of adaptation. Hence, the instrument should not be assessed further.
Instruments for trans-European energy and transport infrastructures						

Instruments	Type of instrument	Aim of instrument	Current requirements for climate change adaptation	Relevance		Assessment in relation to the potential for climate proofing CP and CAP from the perspective of adaptation
				Relevance for CAP	Relevance for CP	
Union guidelines for the development of the trans-European transport network (TEN-T), as proposed in COM(2011) 650/2	Regulatory	Sets the framework for the development of the TEN-T, including the priorities, implementation measures and the projects of common and mutual interest	Proposals require Member States to give consideration to risk assessments and adaptation measures to improve the resilience of infrastructure to climate change	None, as focus is on transport infrastructure	The instrument is relevant as CP supports the development of TEN-T	The instrument has the potential to support climate proofing CP/CAP in a significant manner, as many relevant projects are funded. Hence, **it should be assessed further**.
Union guidelines for the development of the trans-European energy network (TEN-E), as proposed in COM(2011) 658	Regulatory	Sets the framework for the development of the TEN-E, including the rules to identify and facilitate the implementation of projects of common interest	Proposal specifies that criteria for identifying projects of common interest in relation to electricity and oil transport, should take account of climate risks.	None, as focus is on energy infrastructure	The instrument is relevant as CP supports the development of TEN-E	The instrument has the potential to support climate proofing CP/CAP in a significant manner, as many relevant projects are funded. Hence, **it should be assessed further**.

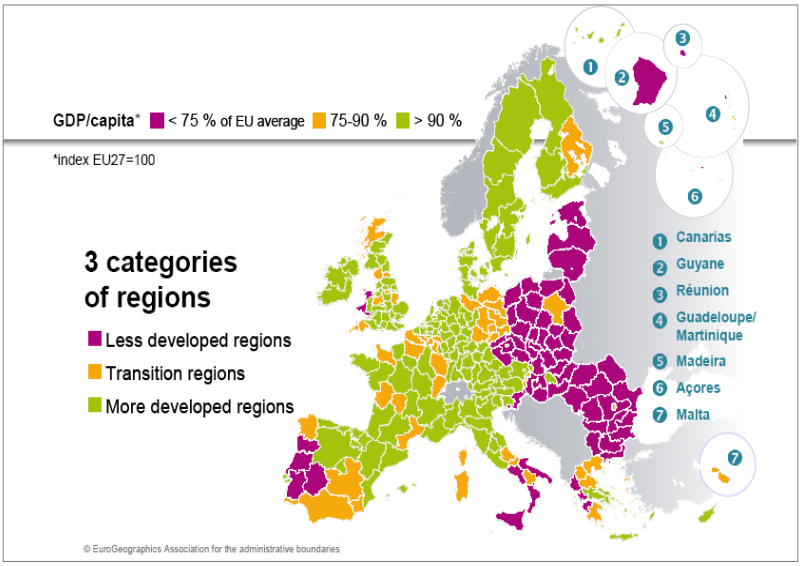
Instruments	Type of instrument	Aim of instrument	Current requirements for climate change adaptation	Relevance		Assessment in relation to the potential for climate proofing CP and CAP from the perspective of adaptation
				Relevance for CAP	Relevance for CP	
Union guidelines for the development of the trans-European telecommunications network, as proposed in COM(2011) 657	Regulatory	Sets the framework for the development of trans-European telecommunication networks, including setting objectives and priorities	Actions under the horizontal priorities may include actions that assess climate related risks and improve climate resilience. Reports on major projects should take account of *inter alia* climate change adaptation.	None, as focus is on ICT infrastructure	The instrument is relevant as CP supports the development of TEN-ICT	The instrument has the potential to support climate proofing CP/CAP in a significant manner, as many relevant projects are funded. Hence, **it should be assessed further**.

17 Annex 10 Overview of Commission proposals on the 2014-2020 EU Cohesion Policy

On 6 October 2011, the European Commission unveiled a legislative package on the 2014-2020 EU Cohesion Policy.[133] The total proposed budget for the 2014-2020 EU Cohesion Policy is €336 billion[134] (or €11 billion less than the 2007-2013 budget). Funds will underpin two new goals: 1) '*Investment in growth and jobs*' and (2) '*European territorial cooperation*' with majority of funds concentrated in poorer regions. These replace the current three objectives for convergence, competitiveness and employment, and territorial cooperation. Regions under the '**Investment in growth and jobs'** goal are differentiated on the basis of GDP per capita as follows (see also Figure 7):

- **More developed regions** (GDP per capita is more than 90 per cent of EU average). The total budget for this category of regions is €53.1bn;
- **Transition regions** (GDP per capita is between 75-90 per cent of EU average). This is a new category which captures the current system of phasing in and phasing out regions. The total budget for this category of regions is €38.9bn; and
- **Less developed regions** (GDP per capita is less that 75 per cent of EU average). The total budget for this category of regions is €162.6bn.

Figure 8. New categories of regions 2014-2020 EU Cohesion Policy



Source: DG REGIO

[133] A Regulation laying down provisions governing all five funds under shared management which fall under a Common Strategic Framework (CSF). These include the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund, the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF). The second part of the proposed Regulation lays down general provisions for the European ERDF, the ESF and the Cohesion Fund (i.e. replacing the current General Regulation 1083/2006/EC); Three specific Regulations for the ERDF, the ESF and the Cohesion Fund; and Two Regulations dealing with the European territorial cooperation goal and the European grouping of territorial cooperation (EGTC).

[134] European Commission (EC) (2011) *A budget for Europe 2020*, Commission Communication, COM(2011)500, 29.6.2011, Brussels

The Common Provisions Regulation establishes the main **principles** governing all five funds, including partnership; multi-level governance; compliance with EU and national law; equality between men and women; and sustainable development and climate change. The Commission proposals also include provisions aimed to strengthen the **thematic concentration** of funds. A menu of eleven new thematic objectives, in line with the Europe 2020 Strategy, is introduced, which include:

Commission proposal for thematic objectives

1) Strengthening research, technological development and innovation;
2) Enhancing access to, and use and quality of, information and communication technologies;
3) Enhancing the competitiveness of small and medium-sized enterprises;
4) Supporting the shift towards the low-carbon economy in all sectors;
5) Promoting climate change adaptation and risk prevention and management;
6) Protecting the environment and promoting resource efficiency;
7) Promoting sustainable transport and removing bottlenecks in key network infrastructures;
8) Promoting employment and supporting labour mobility;
9) Promoting social inclusion and combating poverty;
10) Investing in education, skills and lifelong learning; and
11) Enhancing institutional capacity and efficient public administration.

Another novelty in the Commission proposals is the **Common Strategic Framework (CSF)**[135]**.** It is intended to improve the coordination and strategic orientation of planned investments for the five funds under shared management.[136] The Commission proposes that the CSF is a document that translates the objectives and targets of the Europe 2020 Strategy into key actions for the CSF Funds, establishes key areas of priority support, territorial challenges to be addressed, policy objectives as well as coordination mechanisms among CSF Funds and other EU funding instruments and mechanisms for coherence and consistency with the economic policies of Member States and the Union. The Commission unveiled elements of the 2014-2020 CSF in March 2012, which are now going to be negotiated between the Council and the European Parliament. It is envisaged that part of the CSF will be adopted as an Annex to the Common Provisions Regulation while other parts will be presented as a no-binding guidance document.

A considerable attempt is made to strengthen the legislative basis for improving the effectiveness and overall performance of the future policy. In this regard, a number of provisions are foreseen to establish **conditionalities** and performance checks. Conditionality, for example, will be used both ex ante (i.e. certain conditions must be in place before funds are disbursed) but also ex post (i.e. conditions that will render the award of a performance reserve funds or lead to the suspension of funds contingent on the achievement of results).

The Commission will undertake two consecutive performance reviews, in 2017 and 2019 respectively, against the preliminary established milestones in a **performance framework**. Based on the 2019 review, the performance reserve (5 per cent of the national allocation of each fund) will be

[135] European Commission (2012) Elements for a Common Strategic Framework 2014-2020, Part I and II, Commission staff working document, SWD(2012)61, 14.3.2012, Brussels

[136] These include European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund

awarded to the best performing Member States or funds may be suspended in the case of failing to achieve the established milestones.

In addition, the Commission has proposed to establish a stronger link between Cohesion Policy and the EU economic governance (through the so called **macro-economic conditionality**) where the EU may suspend funding in case Member States fail to take effective actions in the context of the economic governance process.

The **simplification** of implementation procedures is another key feature in the Commission proposals. A number of provisions are put forward with the aim to streamline procedures and reduce administrative burden. In this regard, the establishment of *inter alia* common principles for management and control, common eligibility and financial rules, simplified cost options and the possibility for a multi-fund programming process are envisaged.

A new element is the **Partnership Agreement** (PA), which will be negotiated between the Member States and the Commission, establishing a link between the Europe 2020 Strategy and National Reform Programmes. It will also set out an integrated strategy for territorial development, which will ensure the coordination of priority interventions supported by all funds under shared management and include arrangements to ensure effective implementation. **Operational Programmes** are retained as the main document that spells out concrete priority axes and sub-priorities in conjunction with the PC. These will be accompanied by financial, output and result indicators as required by the performance framework. They will be submitted to the Commission together with the PC.

Funding instruments

The future EU Cohesion Policy retains the three main funding instruments namely the **ERDF**, the **ESF** and the **Cohesion Fund.** A number of changes are introduced to each of them. In addition, the role of **innovative financial instruments** is reinforced with the aim to increase the leverage effect of EU Structural Funds and mobilise additional private financing.

The Commission strengthens the concentrations of ERDF funds through a proposal for a **quantified earmarking** of funds. It is proposed that 80 per cent of the ERDF expenditure in more developed and transition regions under the 'Investment in growth and jobs' objective is concentrated on activities promoting research and innovation, competitiveness of SMEs and energy efficiency and renewable energy, of which at least 20 per cent should target the latter. Less developed regions will be allowed to devote their allocation to a wider range of measures. Still, it is proposed that 50 per cent of the ERDF allocations in less developed regions should be earmarked to these priorities out of which at least 6 per cent should target energy efficiency and renewable energy.

Territorial cohesion is defined by emphasising the role of cities, functional geographies and sub-regional areas facing specific geographical or demographical problems in Cohesion Policy. Community-led initiatives and **sustainable urban development** are therefore going to be stepped up. At least 5 per cent of ERDF are to be earmarked for sustainable urban development actions including actions to tackle economic, environmental, climate and social challenges affecting urban areas. Importantly, 0.2 per cent of the ERDF will be used to support innovative actions in urban settings.

The ERDF will be the main instrument to support the goal for **European territorial cooperation.** The total budget for it proposed to be €11.7bn. The main areas of intervention, similar to past periods, will include cross-border actions, transnational and interregional cooperation. The thematic concentration requirement applies here as well, meaning that programmes can choose to allocate resources on a limited thematic menu of priorities.

The **ESF** will continue to support measures for promoting employment and labour mobility; education, skills and lifelong learning; promoting social inclusion and combating poverty; and enhancing institutional and administrative capacity. Minimum shares for the ESF shall be established for each category of region (25 per cent for less developed regions; 40 per cent for transition regions; and 52 per cent for more developed regions) resulting in a minimum overall share for the ESF of 25 per cent of the budget allocated to Cohesion Policy, i.e. EUR 84 billion. In line with the Europe 2020 Strategy, a quantified earmarking is envisioned for the ESF according to which at least 20 per cent of the ESF should be allocated to promoting social inclusion and combating poverty.

The **Cohesion Fund** will support Member States where Gross National Income (GNI) per capita is less than 90 per cent of the average EU27. It will promote interventions under the 'Investment in growth and jobs' objective with a total budget of €68bn. The Cohesion Fund will continue to support mainly interventions in the field of transport and environment. In transport, the fund will focus on TEN-T projects with €10bn envisioned to be 'ring-fenced' for support to large scale transport infrastructure under the new Connecting Europe Facility. In addition, the scope of intervention in the environmental field is broadened to include not only investment needs stemming from the implementation of EU water and waste *acquis*, but also climate change adaptation, energy efficiency, renewables, air pollution, urban regeneration, biodiversity and green infrastructure.

18 Annex 11: Overview of potential barriers, success factors and enabling conditions

• Type of possible barriers	• Examples
• **Gaps in strategic tools**	• Lack of national/regional adaptation strategies in a number of Member States
• **Institutional factors**	• Environment/climate authorities are not involved in infrastructure planning and sectoral decision-making • Managing authorities/administrations tend to think in narrow sectoral frames and have difficulty dealing with cross-cutting issues such as CC • Small scale adaptation projects are perceive to entail higher administrative costs
• **Planning gaps**	• Activities have been mainly reactive to extreme events and natural disasters, but not preventive • Procedural delays are common and cause slow implementation (usually linked to setting up call for proposals, etc.) • There is no categorisation of adaptation projects in the context of Cohesion Policy, so even if there are some adaptation related measures, they are not categorise as 'adaptation to climate change' • No operational guidance available • 'Not in my backyard' (NIMBY) effect • Bias towards familiar technology based options (grey options)
• **Financial barriers**	• Most allocations tend to favour certain sectors, e.g. floods and no/little support is provided for other sectors • Funding favours large scale infrastructure projects
• **Gaps in knowledge base**	• Knowledge base about potential impacts of climate change and risks to economic sectors is different across countries • Knowledge how to link adaptation to Cohesion Policy in terms of priorities, types of projects and categories of expenditure • Lack of awareness of managing authorities how to design call for proposals in relation to CC adaptation • Lack of awareness of beneficiaries how to make use of the available funds • Lack of trained practitioners/consultants to carry out evaluations of risk

	assessments in relation to Cohesion Policy programmes/projects
• **Monitoring gaps**	• No available indicators on adaptation, indicators exists with regards to impacts • More data is available at EU level, less data is available at regional levels • Even if there is data at lower levels, the data is not analysed and systematically presented
• **Success factors**	• Identify and promote synergies between adaptation and mitigation • Identify and promote co-benefits of adaptation measures for economic and social cohesion • Undertake a place-based approach, focus on specific issue with clear targets (e.g. water) • Ensure cross-sectoral coordination among different Ministries (climate change, environment, regional development, finance) • Set up institutional structures to work with stakeholders, develop guidelines and provide advice to beneficiaries • Involve all affected stakeholders in a structured process of discussing potential climate impacts and agreeing on adaptation options • Establish a cooperation with Universities and research institutes in order to strengthen the knowledge base • Establish Inter-sectoral working groups on climate change mainstreaming • Run pilot projects

19 Annex 12: Boxes with examples of climate proofing

Box 1: SIC adapt! - Strategic Initiative Cluster 'Adaptation to the spatial impacts of climate change', ERDF – INTERREG IVB

SIC adapt! is a grouping of networks that brings together eight projects to jointly tackle adaptation to the impacts of climate change in different spatial settings. All projects deal with the effects of climate change, possible adaptation strategies and look for sustainable, cost-efficient, good-practice solutions in four main sectors: urban areas, water / river / coasts, nature / forest / agriculture and social aspects. The cluster, was launched in October 2010 with the aim of:

- increasing the resilience of built, water, natural and social environments towards climate change;
- building a stronger knowledge base;
- inputting climate change impacts into key EU policies; and
- supporting wider international efforts at adaptation.

The initial conclusions from the project indicate that climate change adaptation will only be successful and effective if the development of technical adaptation tools and measures include stakeholders as part of the process. It is evident from the early work that the main challenges in this process lie in improving communication, facilitating organisational change, and increasing institutional capacity. The concerted actions of the cluster will result in extensively tested assessment tools and good-practice adaptation measures that can be easily transferred throughout other European regions.

Source:
SIC Adapt! http://www.sic-adapt.eu/

Box 2: GRABS - Green and Blue Space Adaptation for Urban Areas and Eco Towns, ERDF – INTERREG IVB

The GRaBS project is a network of 14 leading pan-European organisations involved in integrating climate change adaptation into regional planning and development. The GRaBS project is financed under the Interregional Cooperation Programme INTERREG IVC, financed by the European Union's Regional Development Fund. The GRaBS Project has four main objectives:

- To raise awareness and increase the expertise of key bodies responsible for spatial planning and development as to how green and blue infrastructure can help new and existing mixed use urban development adapt to projected climate scenarios.
- To assess the delivery mechanisms that exist for new urban mixed use development and urban regeneration in each partner country and to develop good practice adaptation action plans to co-ordinate the delivery of urban greening and adaptation strategies, as well as cooperation amongst planner, policy-makers, stakeholders, and local communities.
- To develop an innovative, cost effective and user friendly risk and vulnerability assessment tool, to aid the strategic planning of climate change adaptation responses
- To improve stakeholder and community understanding and involvement in planning, delivering and managing green infrastructure in new and existing urban mixed use development, based on positive community involvement techniques.

Sources:
Interview with DG REGIO official
GRsBS website: http://grabs-eu.org/

Box 3: The DELTA Programme in the Netherlands

The Delta Programme is a national programme with the objective to protect the Netherlands from flooding and ensure a sufficient supply of freshwater. It involves collaboration between the national government, provincial authorities and municipal authorities and water boards. Civil society organisations also participate in the programme. The Delta Programme adopts an integrated approach to tackling the issues of safety, water supply and spatial planning. It is implemented by the so called implementation programmes which currently include:

- Flood protection programme-2
- The Enclosing Dyke
- Weak Links on the Coast
- Room for the River
- Meuse works
- Repair of stone cladding eastern and western Scheldt
- Sand replenishment and the sand motor (Delta dune)

These implementation programmes focus on flood protection management- now but also for the future. Completion is scheduled for between 2015 and 2020.To finance all the measures a Delta Fund is established. The fund can cover the costs incurred by the government in building, improving, managing, maintaining and operating water management works as well as the costs of related basic information provision and research.

Sources:

Interview with a representative of a Member State

DELTA Programme website: http://www.deltacommissaris.nl/english/topics/#alinea3

Box 4: AMICA: Matrix of Measures Integrating Mitigation and Adaptation, ERDF – INTERREG III

AMICA project developed a new approach to environmental policy designed to combine long-term climate protection with short- and midterm adaptation measures on the local level as a means to improve coherence of decisions and allocation of financial means. The project focused on three specific areas, including energy, construction and spatial planning.

In the energy sector, mitigation benefits such as improving energy efficiency, enhancing CO2-neutral energy consumption and CO2 fixation in vegetation can be merged with adaptation benefits such as risk prevention and energy supply security during extreme weather events, for example storms and droughts, comfort in buildings during heat waves and reduction of environmental damage in flooded areas (e.g. water pollution). The project findings further indicate that the optimisation of the energy consumption of buildings offers the largest potential for long-term CO2 reduction strategies. Buildings are also important for adaptation measures against climate extremes such as floods, storms and overheating in summer. Risk prevention for buildings and cooling comfort during heatwaves are two areas in which synergy effects for climate change mitigation can be achieved.

So***urce:***

AMICA website: http://www.amica-climate.net/

Box 5: Climate change in SEA, Regions for Sustainable Change, ERDF – INTERREG IV

Regions for Sustainable Change (RSC) is a partnership of 12 organisations. Through regional cooperation, the project aims at promoting an EU-wide shift to climate-friendly economies and seeks to identify opportunities for – as well as the costs and effects of – moving to a low-carbon economy. The guidance paper '*Opportunities for integrating climate change into regional planning through the use of strategic environmental assessment'* developed by the RSC partnership aims to expand knowledge of the role of assessment tools, and strategic environmental assessment in particular, in integrating climate change mitigation and adaptation considerations into policy planning. It also offers practical advice for future improvements. It:

- Outlines key considerations related to climate change mitigation and adaptation that should be addressed at local and regional level.
- Provides an overview of SEA and other assessment tools that can contribute to the consideration of climate change concerns during decision making.
- Presents the main challenges in addressing climate change in SEA and recommends useful approaches.
- Provides guidance on integrating climate change into SEA aimed at authorities and practitioners.

In the Piedmont region (Italy) for example the SEA process in relation to the Regional Operational Programme co-funded by the European Regional Development Fund (ROP ERDF) allowed for the mapping of areas vulnerable to climate change risks associated with the programme's implementation, and for carrying out a qualitative estimation of the environmental (climate change) effects of the programme in relation to future environmental (climate) conditions. The assessment has been used to improve the integration of environmental and climate change issues within the process. A set of indicators has been developed to define appropriate measures for environmental monitoring.

Sources:

RSC website: http://www.rscproject.org/index.php

RSC (2011) Opportunities for integrating climate change into regional planning through the use of strategic environmental assessment, INTERREG IVC Programme http://www.rscproject.org/docs/SEA_Report_Dec2011.pdf

Box 6: Climate Change and Railroads - Environmental Impact Assessment as an Instrument to Improve Planning and Climate Proofing, Germany

The German Strategy for Adaptation to Climate Change collaborated with the Federal Railway Authority (EBA) on the task to consider effects of climatic change in decision-making on future railways projects. Instead of developing an independent new instrument, the assessment was integrated into the existing EIA procedures. From 2011 on, vulnerability to climate change has to be analysed and alternatives need to be considered when railroad lines are being planned. Furthermore, the planning of compensation measures has to adapt to the changing environment. The relevant administrative regulations of the EBA (Umweltleitfaden, environmental guidance) were adapted. However, until now there is no common practice for climatic assessment in EIA. Due to uncertainties inherent in the forecasting models such a common practice is likely to be difficult to develop sufficiently fast in the short term.

Sources:

Interview with national representative

E. Roll, J. Ludeke, R Neises, S. Rommel, ROLL I UVO – report 25 (5): 265 – 269 1 2011

Box 8: Indicators relevant to Climate Change Adaptation, Regions for Sustainable Change, ERDF – INTERREG IV

The guidance paper '*Opportunities for integrating climate change into regional planning through the use of strategic environmental assessment'* developed by the RSC partnership identifies a set of indicators relevant to climate change adaptation. These include:

- Number of developments built to high sustainability standards, and increase in this number in a given period.
- Number of properties affected by fluvial flood events and reduction in this number in a given period.
- Number of properties affected by coastal flood events and reduction in this number in a given period.
- Number of instances of planning permission granted contrary to the advice of the Environmental Agency on flood defence grounds.
- Household water use and water use reduction in a given period.
- Enhancement of ecological networks through habitat creation/restoration schemes.

Sources:

RSC website: http://www.rscproject.org/index.php

RSC (2011), Opportunities for integrating climate change into regional planning through the use of strategic environmental assessment, INTERREG IVC Programme http://www.rscproject.org/docs/SEA_Report_Dec2011.pdf

20 Annex 13 Overview of barriers to integrating climate adaptation within the CAP and solutions identified

Main Barriers	Solution identified
Political barriers	
Lack of political commitment	- Identification of reasons for lack of commitment - Key decision makers involved from the start - Development of continuous support
Emphasis on climate mitigation to the exclusion of climate adaptation	- Providing briefings on the importance of action for climate adaptation
Acting and planning within short timeframes	- Development of long-term adaptation plans including for individual sectors - Increase public awareness about the importance of taking action for climate adaptation
Institutional barriers	
Lack of coordination, cooperation and even conflict between responsible political actors (leading to missing synergies, duplication of work and ineffective policies)	- Giving responsibility to one person or team for leading the adaptation process. - Developing a common knowledge base - Putting in place an information network for targeted communication. - Use of existing cross sector cooperation to mainstream adaptation.
Lack of suitably trained staff	- Initial assessment of the resources needed to deliver the adaptation policy at an early stage. - Create synergies with other areas of work by integrating adaptation into existing work plans - Setting clear objectives and targets towards implementation
Absence of appropriate institutional structures	- Encourage flexibility for new institutional structures (temporary or permanent) to evolve, such as advisory boards on climate change
Financial Barriers	
Funding required for knowledge transfer, guidance, capacity building and innovation	- Establishment of long term funding structures
Planning and Integrated Delivery	
Planning in silos, heightening the risk of maladaptation	- Developing a common knowledge base - Improved communications between government departments.
Short term planning leading to insufficient prioritisation of climate adaptation	- Identification of priorities for short, medium and long term action and highlight areas where long term strategic planning is essential (i.e. for forestry, biodiversity and infrastructure with a long term span).
Information availability	

Lack of basic information on climate impacts and associated economic costs and cost effectiveness of actions Lack of applicable research results and regional approaches Absence of guidance on the most effective measures to implement Lack of methodologies or indicators for evaluating measures for CC-Adaptation	- Establishment of a robust evidence base based on sound science and best practice including developing appropriate methods, such as for assessing costs and benefits. - Development of scenarios to guide decisions under uncertainties - Recognition that decisions may need to be made on the basis of 'best available' scientific evidence - Provide guidance on measures for increasing resilience to climate change - Establishing adaptation indicator-sets to measure progress. - Periodical evaluation to incorporate new information and to re-assess priorities and objectives.
Knowledge transfer Low levels of interaction and knowledge transfer between research expertise and practical experience Need for knowledge transfer and capacity building for farmers	- Make the most of the ENRD and the EU Platform on climate change as well as improve the dissemination of research findings, for example from FP7 and LIFE+ projects - Use the opportunities offered by the EIP on agricultural productivity and sustainability to improve information exchange between scientists and policy makers and fostering collaborative work between governments and researchers - Training of local delivery and farm advisory services and provision of pro-active advice for farmers.