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Overview of key climate change impacts, vulnerabilities and adaptation action in Europe

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SUMMARY This research paper offers an overview of expected climate change impacts, vulnerabilities, and the main policy actions undertaken in Europe to adapt to such changes. Regional and sectoral challenges that European countries expect to tackle with regard to climate change impacts and vulnerabilities are presented in the first section. The second section shows estimated costs of climate change impacts and costs to adapt, according to the available studies. The third section contains a synthesis of adaptation policy frameworks in place at international, European, national and regional level. The research paper is based on key technical and policy documents focusing on Europe.

Keywords: Europe, climate change, impacts, vulnerabilities, adaptation policies, National Adaptation Strategies, Regional Adaptation Strategies.

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Executive Summary

According to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) and the latest reports of the European Environment Agency (EEA), the effects of climate change have been already observed in many human and natural systems across European regions. **Such impacts will most likely be unevenly distributed**, **thus deepening the socio-economic imbalance across European regions and potentially endangering territorial cohesion**.

Under a regional perspective, a **clear trend towards more negative potential effects in the South of Europe has been detected while in many Northern, central and Eastern European countries "moderate levels of climate change" are expected to produce a mix of negative and positive effects.** The **Mediterranean basin, North-Western Europe, Central-Eastern Europe and the Arctic** are usually referred to as **the most vulnerable bio-geographical regions** to climate change. Also, many **coastal zones** characterised by high population concentrations and high dependence on summer tourism, **areas prone to river floods**, **mountain regions** with high dependency on winter and summer tourism and **densely populated agglomerations** are recognized as extremely vulnerable areas in Europe. Given the diversity of consequences that are expected across Europe, tackling climate change impacts through adaptation will be more effective if context and location specific. Therefore, adaptation strategies that are targeted according to territorial characteristics and challenges are of great importance, in particular those for the Mediterranean region and South-Eastern countries of Europe.

The issue of climate change impacts and vulnerabilities in Europe can be also framed under a sectoral perspective. **Key vulnerable socio-economic and environmental sectors** that will face challenges with respect to the projected impacts of climate change are **inland water management, marine and terrestrial biodiversity and ecosystems, agriculture and forestry, energy, tourism and recreation, and human health**. Those sectors will need to adjust in response to changing conditions and emerging risks.

Overall damage to the EU economy caused by climate change in terms of GDP loss per year by the end of the century is estimated to range between **€ 20 billion for a low temperature increase scenario (+2.5 °C) and € 65 billion for a high temperature increase scenario (+5.4 °C)**. Such aggregated economic damages are known to be underestimated due to various methodological issues. Variability across regions, sectors and different climate scenarios hide behind aggregate data. Although at present it is not possible to assess climate change damage related to extreme hydro-meteorological events, **it is acknowledged that the contribution of climate change in natural climate- and weather-related disasters is likely to grow in the future in terms of stronger physical impacts expected**.

Drawing from aggregated assessments carried out globally for developed countries, **costs of adapting to climate change in Europe is projected to be around € 2.5-16 billion per year by**

2030 for the interventions on infrastructure and coastal defence (UNFCCC estimates), or could **reach € 4-60 billion per year for infrastructure** (Stern Review). While the range of estimates widely varies across studies it is commonly acknowledged that the cost of addressing climate change today is lower than the costs of inaction. Sectoral assessments provide more detailed information across European countries: all highlight potentially **high adaptation costs both in the short-term** (in the order of billions of Euros per year) **and the long-period** (tens of billions of Euros). From a national perspective, **some European countries have attempted individual cost assessments of adaptation options**; in particular the Netherlands, Sweden and the United Kingdom can provide the most detailed national information. Many others are expected to release national studies on costs of adapting to climate change in the coming years.

With regard to international adaptation action, through the United Nations Framework Convention on Climate Change (UNFCCC) process, EU is committed to support developing countries that are particularly vulnerable to climate change impacts and have limited capacities to cope with them.

Within Europe, actual political action on adaptation has developed only over the last 5 years. The 2007 Green Paper on *"Adapting to Climate Change in Europe - Options for EU action"* released by the European Commission is regarded as the starting point of a more inclusive consideration of adaptation to climate change in Europe. It was followed in 2009 by a more formal policy document called the **White Paper on *"Adapting to climate change: Towards a European Framework for action"* that provided insights on adaptation measures and policies to reduce the EU's vulnerability to the impacts of climate change.** Importantly, with this document the Commission put forward the pillars and the framework of a comprehensive adaptation strategy to reduce EU's vulnerability and improve its resilience. The underlying concept is that given the different climate change impacts expected across regions in Europe, national, regional or local administrations will be primarily responsible for taking adaptation actions. The adaptive capacity of populations, economic sectors and regions within Europe is also unevenly distributed. **The added value to MSs of an overarching EU adaptation strategy lies in the possibility for greater coordination, information sharing and integration of adaptation considerations by MSs into EU policy sectors.** The EU would thus ensure that adaptation is addressed in a coherent manner between the national legislation and all relevant EU policies. **The EU Adaptation Strategy is expected be released in the Spring 2013** and will be accompanied by other relevant documentation such as an impact assessment study and guidelines to develop, implement and review national adaptation policies.

In support of the preparation and future implementation of the 2013 EU Adaptation Strategy, a number of actions have been undertaken by the Commission with the aims of improving the knowledge base on adaptation and mainstreaming adaptation into key EU policies.

To improve the knowledge base on adaptation, an **"European Climate Adaptation Platform - CLIMATE-ADAPT" was officially launched on 23rd March 2012.** To date,

CLIMATE-ADAPT has developed into a platform that collects a wide range of information on climate change observed and expected impacts, vulnerabilities, adaptation measures and practices and provides useful interactive tools for understanding and planning adaptation.

Mainstreaming climate change adaptation into the EU budget and funding schemes is considered crucial for turning policy objectives into reality. **Concrete action to integrate adaptation into EU policies is being undertaken or explored in sector such as agriculture and forestry, infrastructure (energy and transport), health, water management, coastal areas, marine and fisheries, ecosystems and biodiversity, disaster risk reduction**.

Ahead of the 2013 EU adaptation strategy, **Member States are encouraged to act considering the possibility of mandatory requirements for MSs to develop their own adaptation strategy, or, more likely, mandatory reporting by MSs on adaptation actions being undertaken or planned**. To ensure compatibility of national and European actions on adaptation, the Commission is currently exploring a range of different options and tools. For example, the *EU Monitoring Mechanism Decision on greenhouse gas emissions and the implementation of the Kyoto Protocol* could be subject to revision and include reporting requirements on national adaptation actions.

At the national, regional and local scale a fragmented variety of autonomous and planned adaptation activities have been undertaken across Europe. **EU MSs are at different stages of designing, developing and implementing formal National Adaptation Strategies (NAS). Since 2005, 13 countries across Europe have formally adopted their NAS**, namely: Finland (2005), Spain (2006), France (2006), Hungary (2008), The Netherlands (2008), Denmark (2008), Germany (2008), United Kingdom (2008), Sweden (2009), Portugal (2010), Belgium (2010), Switzerland (2012), Malta (2012).

In addition, many other European countries have started assessing their adaptation needs and priorities in preparation for the development and adoption of their own NAS. In the NASs reviewed so far**, water management (especially flood protection), land use and agriculture, biodiversity and ecosystems were considered as priority sectors by the majority of MSs**. It can be pointed out that while biodiversity and ecosystems seemed to be more prominent in northern Europe, food production and security were the most critical matter in central European adaptation strategies.

National Adaptation Strategies often provide a framework for the development of regional strategies. In other cases, pre-existing regional adaptation strategies are legitimised and included in NASs. Regional adaptation strategies can be very different in spatial scope, ranging from EU macro-regions to sub-national regions. **Climate adaptation strategies and plans are increasingly being implemented at the level of EU regions through large cooperation programmes. In addition, specific concept of Macro-Regional Strategies has been created in order to address key trans-boundary issues**, including climate change in areas of special interest such as the Baltic Sea and the Danube regions. Furthermore, several so-called **"cross-boundary regional knowledge**

nodes" contribute to the development of adaptation measures at the sub-national scale. Within regions, **cities are taking the lead in planning for adaptation** due to their high concentration of socio-economic assets that make them particularly vulnerable to the risks posed by climate change. EU guidelines for the elaboration of regional adaptation strategies are already available.

1 Climate change impacts and key vulnerabilities in Europe

Climate change is acknowledged as one of the greatest environmental, social and economic threats facing the world and Europe in the XXI century. **Temperature warming has proved to be faster than the global average**[1] **in Europe, where mean surface temperatures have increased by almost 1˚C since pre-industrial times in the last 100 years.** According to the *Fourth Assessment Report* (AR4) of the Intergovernmental Panel on Climate Change (IPCC) and the latest reports of the European Environment Agency (EEA), **the effects of climate change have already been observed in many human and natural systems across European regions**.[2] Projections of changes in average climate state that by the end of this century, temperatures as estimated by different climate change scenarios, are projected to increase by 1.0-5.5˚C in Europe, thus potentially implying higher warming compared to global projections (1.8-4.0˚C).[3] Besides average changes in climate, climate-related extremes are also projected to show some degree of alteration. It is believed that global temperature increases above 2°C will bring about the risk of exceeding so-called "tipping points" that may generate sudden, large-scale, non-linear climatic events that would go beyond the capacity of human population and ecosystems to adapt to such new conditions.[4]

1.1 Expected regional challenges

Scientific evidence shows that **potential consequences of projected climate change will eventually impact all European regions in a negative way**. However, **such impacts will most likely be unevenly distributed**, **thus deepening the socio-economic imbalance across European regions and potentially endangering territorial cohesion**.[5] Generally speaking, a **clear trend towards more negative potential effects in the South of Europe has been detected while in many Northern, central and Eastern European countries "moderate levels of climate change" are expected to produce a mix of negative and positive effects.**[6] The Outermost Regions and overseas countries and territories of Europe are considered separately due to their geographical remoteness, but could be regarded as warnings of what might happen on the main land.[7]

Under a European perspective, IPCC climate change projections indicate a greater warming trend in winter in northern countries, and in summer in the southern and central

[1] Recent observations confirm that the global mean temperature has increased by 0.8˚C compared with pre-industrial times for land and oceans, and by 1˚C for land alone; while Europe has warmed by 1˚C and 1.2˚C, respectively. Cf. EEA/JRC/WHO, 2008.
[2] Cf. EEA/JRC/WHO, 2008; EEA, 2010; EEA, 2012.
[3] IPCC, 2007 (a).
[4] A number of tipping points have been identified that may affect Europe (e.. the deglaciation of the West Anctarctic ice sheet and Greenland ice sheet). However, the understanding of these processes is still limited and the chance of them to occur is considered quite low in this century. Cf. UNEP, 2009; Alison et al., 2009.
[5] Greiving et al., 2011.
[6] Cf. IPCC, 2007 (a).
[7] Cf. CEC, 2009 (b) p.15.

countries. Likewise, future precipitation patterns suggest the tendency towards wetter winter conditions in the North and drier summer conditions in the South, with a stronger overall decrease in rainfall during the hot season. A more detailed territorial visualisation of potential physical, environmental, economic, social and cultural impacts over the pan-European area was recently provided by the ***ESPON CLIMATE project - Climate Change and Territorial Effects on Regions and Local Economies in Europe***[8] (see map in **Annex 1**). Aggregated impacts analysis confirms that potential impacts of climate change vary considerably across Europe. The project also developed maps illustrating the **overall adaptive capacity of European territories** (see **Annex 2**) calculated as a weighted combination of economic, infrastructural, technological, institutional capacities as well as knowledge and awareness about climate change. Scandinavian and Western-European regions appear to be characterized by higher adaptive capacity while in the Mediterranean region and in South-East Europe such capacity is relatively lower. Drawn from the coupling of climate change exposure and adaptive capacity, a **European vulnerability map** (see **Annex 3**) **suggests an even more prominent disparity between North**, where high adaptive capacity could quite make up for any expected impacts, **and South**, where little adaptive capacity does not sufficiently compensate the larger negative impacts foreseen thus resulting in medium to high levels of vulnerability.[9]

Therefore, **the Mediterranean basin, North-Western Europe, Central-Eastern Europe and the Arctic** are usually referred to as **the most vulnerable bio-geographical regions** to projected climate change in Europe. Also, many coastal zones characterised by high population concentrations and high dependence on summer tourism, areas prone to river floods, mountain regions with high dependence on winter and summer tourism, and densely populated agglomerations are recognized as extremely vulnerable areas in Europe.[10]

In particular, from a bio-geographical perspective, **key vulnerabilities and observed impacts that will be likely to persist in the future as classified by EEA** (see map in **Annex 4**) are listed below:[11]

- **Mountain areas** (especially the Alps):[12]
  - High temperature increase;
  - Substantial glacier retreat and expected disappearance of smaller Alpine ice-masses;
  - Permafrost degradation;
  - Reduced snow cover;
  - Changing precipitation patterns;
  - Potential water stress in summer;
  - Increased risk of hazardous geomorphologic processes such as floods and rock falls;
  - Ecological impacts on biodiversity like altitudinal shift in vegetation

[8] ESPON CLIMATE: http://www.espon.eu/main/Menu_Projects/Menu_AppliedResearch/climate.html.
[9] Greiving et al., 2011.
[10] Cf. IPCC, 2007 (a); EEA/JRC/WHO, 2008; EEA, 2010; Greiving et al., 2011.
[11] EEA/JRC/WHO, 2008; EEA, 2010.
[12] Alps, Appennines, Balkans-Rhodope Mountains, Carpathian, Fenonscandian, Pyrenees, Anatolian region, Dinaric Arc. Cf. EEA/JRC/WHO, 2008.

zones and animal habitats, invasion of alien species;

- Various socio-economic impacts among which reduced winter tourism; infrastructural problems; less energy supply from hydropower; reduced freshwater supply; consequences on river navigation; impacts on irrigation facilities.

- **Coastal zones and European seas** (especially the Baltic, Mediterranean and Black Seas):
  - Aggravation of low-lying coasts submersion and quicker erosion of beaches from sea-level rise and storm-related floods;
  - Possible local salinisation;
  - Higher water stress (scarcity and droughts) especially related to touristic peaks;
  - Deterioration of coastal habitats and ecosystems;
  - Changes in biodiversity due to northward shift of marine species and changes in the distribution of phytoplankton biomass;
  - Increasing share of population living at risk of floods by the end of the century. The most affected countries are expected to be France, Latvia, the Netherlands and the United Kingdom.[13]
- **Mediterranean basin** (including Black Sea region):
  - Exceptional decrease in annual mean precipitation especially in summer;
  - High temperature increase;
  - Water stress (decrease in water availability combined with increasing demand from agriculture and domestic sectors);
  - Higher risk of coastal floods due to sea level rise in combination with storm surges;
  - Lower crop yields;
  - Higher risk of biodiversity loss;
  - Increasing risk of forest fires and decrease in forest growth;
  - More likely heat waves, with an increased number of combined hot summer days and tropical nights;
  - Higher risk of droughts and desertification;
  - More vector-borne diseases;
  - Socio-economic impacts (e.g. hydropower sector facing water shortage and augmented demand; summer tourism showing less favourable conditions; public health).
- **The Arctic:**
  - Decrease in summer sea ice cover;
  - Greenland ice-sheet loss;[14]
  - Higher risk of biodiversity loss;
  - Socio-economic impacts both positive and negative (e.g. enhanced oil and gas exploration; opening of new shipping routes; infrastructural problems).
- **Cities and urban areas:**[15]

[13] Hinkel et al. 2009, 2010.

[14] Greenland does not belong to a bio-geographical region of Europe.

- Higher vulnerability of urban areas mainly in relation to extreme weather events such as heat waves, floods and water scarcity;
- Increased length, frequency and/or intensity of warm spells or heat waves, of which impacts on human health are aggravated by modern cities' fabric and design (artificial surfaces increasing night-time temperatures);
- Worse impacts of heat waves not expected exclusively in Southern countries, with increasing probability of "mega heat waves" over highly populated areas of Europe;
- Higher overall risk of flooding over European cities, including river floods (Western and Central-Eastern European areas), flash floods (Mediterranean and Alpine-Mediterranean to the Black Sea region), coastal floods (coasts in North-Western Europe, Northern Italy, and Rumania), urban drainage flooding (Western and Northern Europe), groundwater flooding;
- Cities on high risk of flooding usually do not cluster in a particular geographical region but risk depend more on local characteristics;
- Water resources projected to shrink in Europe as a result of disproportion between water demand and availability, causing increasing competition for water among sectors;
- Water stress during summer expected to worsen and extend towards northern cities;
- Droughts coupled with heat waves can aggravate the risk of forest fires especially in proximity to cities;
- Beyond direct impacts (e.g. health impacts and emergency assistance issues, material damages to buildings and infrastructure, erosion and landslides due to flooding), possible adverse indirect socio-economic impacts are expected (e.g. lower productivity, failure of services, high energy demand for cooling, high water prices, loss of jobs and income sources).

- **North-Western Europe** (Atlantic region):
  - Increase in winter precipitation;
  - Higher risk of flooding (coastal flooding; possible increasing frequency of winter and spring river flooding; further increase in urban drainage flooding)
  - Impacts on biodiversity due to northward movement of freshwater species.
- **Central and Eastern Europe:**[16]
  - More temperature extremes and more frequent and/or intense heat waves;
  - Reduced summer precipitation;
  - Increased risk of droughts;

[15] Cf. EEA, 2012.

[16] Continental region minus north/west Italy plus Pannonian region and Steppic region. Cf. EEA/JRC/WHO, 2008.

- Possible higher frequency of river floods in winter and spring;
- Higher crop-yield variability;
- Increased occurrence of forest fires.

- **Northern Europe** (Boreal region):
  - Reduced snow, lake and river ice cover;
  - Increased winter and spring river flows;
  - More frequent and intense extreme weather events (winter storms);
  - Increased crop suitability and yields;
  - Enhanced forest growth;
  - Impacts on biodiversity due to northward movement of species;
  - Some positive socio-economic impacts (more energy by hydropower, lower energy consumption for heating; possible increase in summer tourism).

As an outcome of the recently completed ESPON CLIMATE vulnerability assessment study that focused specifically on territorial dimension, a typology of European regions was developed based on projected climate changes.[17] The analysis identified 5 regions that show similarities in terms of a number of biophysical impact variables of climate change.[18] Those regions slightly differ from the EEA's bio-geographical areas. Nevertheless, the study has confirmed that climate change impacts are often not limited by national borders or precise geographical regions. On the contrary, one country may be faced by various and diverse challenges belonging to other "climate change regions" (see map in **Annex 5**). **Given the diversity of consequences that are expected across Europe, tackling climate change impacts through adaptation will be more effective if context and location specific . Therefore, adaptation strategies that are targeted according to territorial characteristics and challenges are of great importance, in particular those for the Mediterranean region and South-Eastern countries of Europe.**[19]

1.2 Expected sectoral challenges

The issue of climate change impacts and vulnerabilities in Europe can be also framed from a sectoral perspective. EEA 2010 thematic assessment report on adaptation[20] identified some **key vulnerable socio-economic and environmental sectors** that will face several challenges with respect to the projected impacts of climate change. Those are the following:

- **Inland water:**
  - Projected decrease in water availability in Southern and South-eastern Europe, as opposed to an increase in the Northern regions. The number of people living in water-stressed areas is expected to increase especially in the Iberian Peninsula, Italy and large parts of central Europe by the end of the century;[21]

[17] Greiving et al., 2011.
[18] Those regions are: Northern-Central Europe, Northern-Western Europe, Southern-Central Europe, Mediterranean Europe.
[19] Greiving et al., 2011.
[20] Cf. EEA, 2010.
[21] Cf. Schroter et al., 2004.

- More frequent river floods (fluvial floods including flash floods, as well as pluvial floods) due to the intensification of the hydrological cycle as a result of changes in temperature, precipitation, glaciers and show cover (coupled with unsustainable water management practices);
- Water shortages due to glacier melt likely to change the seasonal timing of river discharge in a number of key river basins (Danube, Po, Rhine and Rhone) and lower precipitation especially in summer;
- Increased water demand, due changes in demographic, economic, technological and lifestyle linked to climate change;
- Deterioration of water quality, both surface waters and groundwater resources due, inter alia, to higher temperatures and extreme events.

- **Marine and terrestrial biodiversity and ecosystems**:
  - Increasing risk of ecosystems and biodiversity loss due to alterations to habitat conditions, especially for marine ecosystems and wetlands;
  - Northward and uphill distributional shifts of many European plant and animal species: main causes of vulnerability lies on the difficulties for many terrestrial species to move to new areas with suitable climate;
  - Changing phenology for marine and terrestrial plants and animals;
  - Higher risk of forest fires in Southern and continental Europe and related loss of habitats and species;
  - Projected decrease in sea ice coverage in Arctic ecosystems and related loss of habitat and species;
  - The share of species of Community Interest (breeding birds, reptiles and amphibians, butterflies and vascular plants) considered vulnerable to climate change is around 25% within the Natura 2000 network.[22]
- **Agriculture**:
  - Reduction of crop yields under drier conditions in Southern Europe and Mediterranean area are expected, while increases are projected in Northern regions. All EU regions would experience yield improvements for low levels of temperature increases;[23]
  - Changes in crop suitability, growing season and the timing of cycle of agricultural crops (agrophenology), especially endangering Central and Southern Europe productivity;
  - Increasing variability of crop yields in relation to more frequent and intense extreme weather events;
  - Increasing irrigation requirements for agricultural purposes and competition for water are projected to continue mainly in Southern and Southern and South-Eastern areas;
- **Forestry**:
  - Northward shifts of vegetation distribution could lead to enlargement of forested areas in the North and their shrinking in the South;

[22] Cf. Sajwaj et al., 2009.
[23] CEC, 2009(a).

- Changes in distribution and timing of seasonal events;
- Greatly increased risk of forest fires in Southern and Central European countries, with possible reduction in wood production and timber values;
- Adverse consequences of increased frequency and intensity of heavy windstorms;
- Possible negative impacts on logging and harvesting operations in the Boreal region.

- **Energy supply**:
  - Expected differences of impacts across Europe, with rising domestic summer cooling demand in Southern regions and reduced winter heating needs in Northern Europe;
  - Foreseen overall decline of hydropower potential for the whole Europe, with strong regional variations between North (about +5%) and South (about -25%);
  - Possible adverse impacts on thermal power plant efficiency due to reduced availability of cooling water.
- **Tourism and recreation**:
  - Winter sport industry is expected to experience economic losses due to snow cover reduction in the Alpine region and Northern Europe;
  - Artificial snow-making implies sustainability and environmental issues related to the use of water resources and energy;
  - Summer tourism is likely to shift in distribution and time due to decreased suitability of the South-Eastern Mediterranean region for touristic and improved comfort and attractiveness of the North and West European regions. Possible increases of tourism flows could occur in the spring and fall.
- **Human health:**
  - Human health may be affected by climate change in a number of ways through the alteration of weather patterns, changes in water, air, food quality and quantity, ecosystems, livelihoods and infrastructure;[24]
  - The elderly, people with some diseases, young children, those on low income and ethnic minorities are considered the most vulnerable groups to the projected health-related effects of climate change;[25]
  - A rise in the number of heat-related deaths can be expected, especially around urban areas where climate change is coupled with trends of increased urbanisation and population ageing;[26]
  - An increasing heat-related annual mortality occurring mainly in central and southern European regions is expected to substantially balance a decrease in annual cold-related mortality;[27]
  - A higher number of potential casualties can result from more frequent and intense extreme weather-related events in some regions;

[24] Cf. Confalonieri and Menne, 2007.
[25] Cf. CEC, 2008; Kirch et al., 2005.
[26] Cf. EEA, 2012.
[27] Cf. Watkiss et al., 2009.

- Expected changes in the spread of water-, food- and vector-borne diseases;
- Possible changes in distribution in the environment and toxicity of some chemical pollutants.[28]

- **Society:**[29]
  - The most vulnerable parts of society, those who have to spend a higher proportion of their incomes on basic needs such as housing, energy and food, are expected to experience the hardest social impacts of climate change;
  - Environmental pressures (especially the search for water) may drive migration into Europe from areas hit by drought; migrants then become part of the vulnerable groups most at risk once inside Europe.

[28] Cf. Noyes et al., 2009.
[29] Cf. CEC, 2009 (b) p.16.

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Next updates

EEA, Report on climate change, impacts and vulnerability (expected in Nov 2012)

EEA, "Adaptation in Europe" Report (expected in Feb 2013)

2 Costs of climate change impacts and adaptation in Europe

As currently practiced, political action on climate change has been especially triggered by considerations of economic nature, such as monetary estimates of climate change impacts and evaluation of costs to adapt to the new climatic conditions. However, assessing economic costs and potential benefits of climate change impacts in Europe has been proven to be a quite complex exercise, since the proportion of those impacts that is attributable to climate change is not easily distinguishable from those caused by other factors of change.[30] Furthermore, the costs of adaptation actions have not been sufficiently investigated for either the present time or the future. According to the EEA[31], the Organization for Economic Cooperation and Development (OECD)[32] and other reviews, costs and benefits of adaptation have been poorly addressed in earlier economic assessment studies, where analyses were mostly constrained to a few sectors or limited to a sub-set of climate change effects. In recent literature, more comprehensive, although still limited, cost estimates covering Europe and its Member States have emerged, mainly drawing from outcomes of key EU projects such as **PESETA - *Projection of Economic impacts of climate change in Sectors of the European Union based on boTtom-up Analysis***[33], **ADAM - *ADaptation And Mitigation Strategies: supporting European climate policy***[34] and **ClimateCost - *Full Costs of Climate Change***.[35]

2.1 Costs of climate change impacts

2.1.1 Integrated economic assessments

The **project PESETA** has delivered significant information on the impacts and economic costs of climate change in Europe and adaptation responses. PESETA multi-sector analysis encompassed impacts related to coastal systems, human health, agriculture, tourism, and floods considering four different climate change scenarios for the medium (2011-2040) and long-term (2071-2100) horizons. One of the most interesting findings of PESETA project is the evaluation of the **overall damage to the EU economy caused by climate change in terms of GDP loss per year**: this is estimated by 2080 to range between **€ 20 billion for a low temperature increase scenario (+2.5 °C) and € 65 billion for the high temperature scenario considered (+5.4 °C)** characterized by strong sea level rise. The annual relative aggregate welfare loss is estimated at between 0.2% and 1% for different scenarios.[36] However, aggregated figures of economic impacts in Europe hide **high variability across regions, sectors and climate scenarios.** The following are some more detailed pictures of aggregated estimates of economic impacts for each macro-region:

[30] Cf. EEA/JRC/WHO, 2008.
[31] Cf. EEA, 2007.
[32] Cf. OECD, 2008.
[33] PESETA: http://peseta.jrc.ec.europa.eu/index.html.
[34] ADAM: www.adamproject.eu.
[35] ClimateCost: http://www.climatecost.cc/.
[36] Cf. Ciscar et al., 2011.

- **Southern Europe** would be the area most severely affected by climate change, with annual welfare losses ranging between 0.3% and 1.6%, particularly due to damage to agricultural sector and tourism;
- **Central Europe** would show mixed impacts. **The Southern part of central Europe** would experience a decline in welfare ranging between 0.1% and 0.6%, mainly due to impacts of river floods. Under the highest emission scenario considered, agricultural sector would suffer major losses. **The northern part of central Europe** would be primarily affected by damages to coastal ecosystems; a slightly higher decrease in welfare of between 0.3% and 0.7% is estimated, with most economic costs resulting from river floods. Conditions for the tourism industry could to some extent become more favourable across whole central Europe;
- **Northern Europe** would be the only region with welfare improvements under all scenarios considered with estimates ranging from 0.5-0.8% per year, largely driven by enhancements in conditions for agricultural activities, higher tourism revenues and smaller costs from river floods damages.

Despite the importance of this study, being one of the first multi-sector assessments at the EU level, authors explicitly recognize that **aggregated damages may be underestimated** since the impact categories do not cover potentially relevant ones such as forestry, transport, energy systems, migrations and biodiversity losses. Also, the effects caused by climate extremes, and potential major economic damages caused by low-probability high-impact events (passing "tipping points") are neglected. An additional limitation is that possible inter-sectoral effects **were not** considered.

2.1.2 Sectoral assessments: economic costs of extreme events

Over the last 20 years there has been an **increasing trend of occurrence of floods, land movements, storms and heat/cold waves, droughts and forest fires across European countries**. Also, the consequences of natural disasters have been growing in Europe, with the majority of the economic losses attributed to hydro-meteorological events.[37] However, the rising trend in the observed losses from climate- and weather-related extremes may be attributable to a range of factors, primarily socio-economic changes and increasing exposure (e.g. higher economic value of assets, changes in population, and more activities taking place in hazardous areas). An unequivocal climate change signal is difficult to identify over the total economic damages from such extreme events. Nevertheless, it can be stated that **the contribution of climate change to climate- and weather-related disasters is likely to grow in the future in terms of stronger physical impacts expected**.[38]

[37] Since 1998 the total amount of quantified losses from natural disasters has reached about 118 billion € in the whole Europe, of which about half due to large floods and storm events (data from Munich Re, 2009 and 2010). Cf. EEA, 2010.
[38] EEA, 2010.

2.2 Costs of adapting to climate change

Available information on the costs and benefits of adaptation in Europe was recently reviewed by the **EU project ClimateCost**.[39] A general convergence of cost estimates was found. However, figures resulting from the studies considered are acknowledged to hide high levels of aggregation and a number of simplifying assumptions. Furthermore, the most relevant global aggregated studies revealed significant underestimation of figures related to potential adaptation options.[40]At the European level, it was found that sectoral, regional and national studies are challenging to compare due to different methods and metrics used, diverse time-spans and assumptions. Also, coverage of sectors seems not sufficiently wide and information on adaptation costs at the regional scale was found to be limited in key sectors (e.g. water supply, tourism, industry, biodiversity and ecosystems). **It appears therefore difficult to obtain a coherent figure for adaptation costs in Europe.**

2.2.1 Global assessments

Drawing from aggregated assessments carried out globally for developed countries, **costs of adapting to climate change in Europe have been estimated to be around € 2.5-16 billion per year by 2030 for interventions on infrastructure and coastal defence** (UNFCCC estimates). Others claim that costs could **reach € 4-60 billion per year for infrastructure** (Stern Review). While the range of estimates varies widely across studies[41] it is commonly acknowledged that the cost of addressing climate change today is lower than the costs of inaction.[42]

2.2.2 Sectoral and regional assessments

Sectoral assessments reviewed by ClimateCost provide more detailed information across European countries, all highlighting potentially **high adaptation costs both in the short-term** (in the order of billions of Euros per year) **and the long-period** (tens of billion of Euros). Some integrated sector studies, like the ones carried out within PESETA project, concluded that adaptation options entail economic benefits that eventually prevail over the investment in adaptation itself. At present the **sector most often considered by adaptation cost-benefit assessment studies in Europe is coastal zones**.[43] Other socio-economic sectors of a certain significance in terms of number of studies are: energy demand for heating and cooling, health (heat alert and food-borne diseases in particular)[44] and agriculture (especially farm-level adaptation benefits). Also, economic assessments have investigated costs of local measures of adaptation to climate change in some vulnerable regions such as studies on adaptation to sea-level rise in Western Europe; adapting tourism in the Alps; adjustments in health, energy and water sectors over the Mediterranean and the Baltic regions.

[39] Cf. Watkiss (ed.), 2011; ClimateCost, Policy Brief no.2.
[40] Parry et al. 2009.
[41] Many other estimates are available, e.g. from OECD, ADAM project and other economic Integrated Assessment Model (IAM) studies. Cf. EEA. 2010.
[42] Stern, 2007.
[43] See e.g. Richards and Nicholls, 2009; Hinkel et al, 2009, 2010.
[44] See e.g. Ebi, 2008; Markandya and Chiabai, 2009.

2.2.3 National assessments

From a national perspective, **some countries have carried out cost assessments of adaptation options**; in particular the Netherlands, Sweden and the United Kingdom present the most detailed national information. Many others are expected to release national assessments in the coming years. It is reported that if findings of such national studies were scaled up to the European level, they would imply adaptation costs far higher than the ones drawn from aggregated sectoral assessments and especially global studies.[45]

[45] EEA, 2010.

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Next updates

EEA, Report on climate change, impacts and vulnerability (expected in Nov 2012)

EEA, "Adaptation in Europe" Report (expected in Feb 2013)

EC, Report on "Climate-proofing" (expected July 2012)

3 Policies for adaptation in Europe

3.1 The international commitment to adaptation

The Lisbon Treaty[46], recently entered into force, reaffirms that combating climate change on an international level is a specific EU objective. The EU and all its Member States (MSs) are parties to the United Nations Framework Convention on Climate Change (UNFCCC) that has at its goal stabilizing greenhouse gas concentrations at a level that would prevent dangerous human interference with the climate system.[47] The EU, responsible for around 14% of global greenhouse gas emissions as of 2012[48], has always taken the lead of international efforts to tackle climate change playing a key role in the development and effective implementation of the UNFCCC and its 1997 Kyoto Protocol. According to science, emissions would need to peak and decline thereafter in order to reach stabilization of the concentration of greenhouse gases in the atmosphere. The lower the stabilization level, the more quickly this peak and decline would need to occur.[49] UNFCCC negotiations have been debating on a shared vision for long-term cooperative action with the aim of "identifying a global goal for substantially reducing global emissions by 2050 and a time frame for a global peaking of greenhouse gas emissions".[50] Stabilization of GHGs at around 350-400 ppm[51] reached prior to the end of the century would, in principle, limit global mean temperature increase to less than 2°C with respect to pre-industrial levels. However, due to the scientific and methodological uncertainties surrounding climate change projections, **the "2°C target", which the EU and its Member States have politically committed to since 1996, provides no guarantee for avoiding all adverse climate change impacts, and residual impacts will have to be addressed.**[52] It is widely acknowledged that **strategies to adapt to current and future climate change impacts are necessary, even if successful mitigation actions would be agreed and implemented by all countries.** When a full understanding of the risk posed by climate change is not possible, policy makers should be held to the precautionary principle to avert any possible harm to human or natural systems through their decisions.

With regard to international adaptation action, through the UNFCCC process EU is committed to support developing countries that are particularly vulnerable to climate change impacts and have limited capacities to cope with them. The UNFCCC "Copenhagen Accord" of December 2009 launched a **Fast Start programme** to fund enhanced adaptation and mitigation actions in developing countries at a level of USD 30 billion (€ 25 billion) for the

[46] Lisbon Treaty: http://europa.eu/lisbon_treaty/index_en.htm.
[47] UNFCCC: http://unfccc.int/.
[48] From UNFCCC: "UNFCCC Greenhouse Gas Inventory Data - Detailed data by Party". Retrieved 2012-04-21.
[49] IPCC, 2007 (b).
[50] UNFCCC, 2012.
[51] Parts Per Million.
[52] For example, IPCC AR4's projections show that reducing global GHGs emissions by 50% by 2050 would provide a 50% probability of not exceeding the 2°C increase in global temperature above pre-industrial levels.

period 2010-2012 and USD 100 billion (€ 85 billion) as a long-term goal by 2020, which will come from a variety of sources, public and private, bilateral and multilateral.[53] **The EU pledged to contribute € 2.4 billion per year in 2010-2012 and it is committed to provide its share of the agreed global public support in the longer term.**[54] Furthermore, the 2010 "Cancun Agreements" established the **Cancun Adaptation Framework (CAF)**, aimed at supporting action for adaptation within and outside the UNFCCC with the same level of priority as mitigation.[55]Under the CAF, EU and all developed countries support the National Adaptation Plans (NAPs)[56] process that has the objective to help developing countries to design and implement plans that will integrate medium and long-term climate change adaptation in their paths of socio-economic growth. The NAPs are intended to build on the National Adaptation Programmes of Action (NAPAs) that have identified the urgent adaptation needs of Least Developed Countries (LDCs) and are now moving towards the implementation phase. Another important stream of the CAF consists of the work programme on "loss and damages"[57] aimed at ensuring that developing countries achieve the capability to deal with the impacts of climate change-related extreme events and slow-onset consequences such as sea level rise and drought. To advance scientific and practical understanding of adaptation, the EU strongly supports the Nairobi Work Programme on Impacts, Vulnerability and Adaptation. In December 2011 in Durban, the UNFCCC COP17 (Conference of the Parties) made the CAF operational and, in particular, adopted decisions on the shape and role of the **Adaptation Committee** serving as an overall advisory body on adaptation-related issues to the COP.[58]

The UNFCCC requires, besides the obligation to cooperate in preparing to adapt to the impacts of the changing climate, that national and regional programmes containing measures for climate change mitigation and adaptation be formulated and implemented. **EU and its MSs have widely engaged in action on adaptation at national level and the latest information on their progress was presented in their 5th Communication to UNFCCC due in 2010.**

In addition, the EU supports the United Nations International Strategy for Disaster Reduction (UNISDR), and its goal of harmonising existing institutional and governance arrangements for linking disaster risk reduction and adaptation communities and practices.[59] Other international conventions and initiatives to which EU is party also contribute to further developing adaptation knowledge, policies and practices, such as the United Nations Convention on Biological Diversity (UNCBD)[60], the Convention to Combat Desertification

[53] UNFCCC, 2010.
[54] EUROPEAN COUNCIL, 2009.
[55] Adopted at the 16th Conference of the Parties held in Cancun in December 2010. Cf. UNFCCC, 2011: http://unfccc.int/adaptation/cancun_adaptation_framework/items/5852.php.
[56] National Adaptation Plans: http://unfccc.int/adaptation/cancun_adaptation_framework/national_adaptation_plans/items/6057.php.
[57] Loss and damage: http://unfccc.int/adaptation/cancun_adaptation_framework/loss_and_damage/items/6056.php.
[58] Adaptation Committee: http://unfccc.int/adaptation/cancun_adaptation_framework/adaptation_committee/items/6053.php.
[59] UNISDR: http://www.unisdr.org/.
[60] UNCBD: http://www.cbd.int/.

(UNCCCD)[61], and the UNEP (United Nations Environment Programme) PROVIA - Programme of Research on Climate Change Vulnerability, Impacts and Adaptation.[62]

3.2 The European framework on adaptation

Initial EU focus on measures to mitigate climate change and cut greenhouse gas emissions at the beginning of the '90s, was progressively broadened to include adaptation. This was mainly driven by the occurrence of events such as mega heat waves and major floods in Europe, that have raised concern about the need to define strategies and measures to adapt to the effects of climate change that are already taking place. **Therefore, actual political action on adaptation has developed within the EU over the last 5 years.** The 2007 **Green Paper on *"Adapting to Climate Change in Europe - Options for EU action"*** released by the European Commission is regarded as the starting point of a more inclusive consideration of adaptation to climate change in Europe.[63]It was followed in 2009 by a more formal policy document called the **White Paper on *"Adapting to climate change: Towards a European Framework for action"* that provided insights on adaptation measures and policies to reduce the EU's vulnerability to the impacts of climate change.**[64]The report outlined over 30 actions that EU should begin to put into practice across its various policies. Importantly, with this document the Commission put forward **the pillars and the framework of a comprehensive adaptation strategy to reduce EU's vulnerability and improve its resilience.**

The underlying concept is that given the different climate change impacts expected across regions in Europe, national, regional or local administrations will be primarily responsible for taking adaptation actions. The adaptive capacity of populations, economic sectors and regions within Europe is also unevenly distributed. The added value to MSs of an overarching EU adaptation strategy lies in the possibility for MSs to receive support to their adaptation initiatives through greater coordination, information sharing and integration of adaptation considerations by MSs into EU policy sectors. The EU would thus ensure that adaptation is addressed in a coherent manner between the national legislation and all relevant EU policies.

The main elements that would prepare the ground for the EU adaptation strategy are the following:

1. **Knowledge:** strengthening the evidence base on adaptation;
2. **Policy:** mainstreaming adaptation into EU key policy areas;
3. **Markets:** employing a combination of policy instruments (market-based instruments, guidelines, public-private partnerships) to ensure effective delivery of adaptation;
4. **Cooperation and facilitation:** advancing international support on adaptation.

The preparatory phase of the EU adaptation strategy has started in 2009 and is still ongoing. The development of this EU

[61] UNCCCD: http://www.unccd.int/.
[62] PROVIA: http://www.provia-climatechange.org/.
[63] Cf. CEC, 2007 (b).
[64] Cf. CEC, 2009 (a).

strategy will be based both on top-down strategies for mainstreaming adaptation into sectoral policies and bottom-up initiatives for implementation. The preparation of EU adaptation strategy is lead by the Commission (DG CLIMA)[65] and supported by a high-level **Adaptation Steering Group** that includes representatives from EU Member States and environmental, business and other NGOs, and **Working Groups,** such as the Working Group on Knowledge Base that includes experts at a more technical level. The roadmap towards the EU adaptation strategy includes the provision of background studies[66], public consultations[67], as well as cooperation with other Commission's services.

The strategy is expected be adopted in March 2013 and will be accompanied by other relevant documentation such as an impact assessment study and guidelines to develop, implement and review national adaptation policies.

[65] DG CLIMA / EU Adaptation policies: http://ec.europa.eu/clima/policies/adaptation/index_en.htm.

[66] Background studies initiated by the Commissions that were completed so far include:

- a report on economic instruments;
- a report on short term actions for "climate-proofing" of EU policies (Cf. Altvater et al. 2012; more information on the project: http://ecologic.eu/4832).

More documentation is expected shortly:

- another report on "climate-proofing" (2012);
- a report on adaptation strategies in EU cities (2013).

[67] An on-line consultation on the Preparation of the EU Adaptation Strategy was open from 21 May 2012 to 20 August 2012: http://ec.europa.eu/yourvoice/ipm/forms/dispatch?form=AdaptStrategy .

3.2.1 Strengthening the knowledge base

To improve the knowledge base on adaptation, the White Paper envisaged the establishment of an European Clearinghouse Mechanism on adaptation, now renamed **"European Climate Adaptation Platform - CLIMATE-ADAPT"**[68], aimed at facilitating the collection and dissemination of information on adaptation with the aim of assisting the uptake of such knowledge by local and national decision makers, and contributing to a better coordination across sectoral policies and relevant institutions.

CLIMATE-ADAPT was officially launched on 23rd March 2012. It has developed into a platform that collects a wide range of information on observed and projected climate change impacts and vulnerabilities, adaptation measures and practices; and that provides useful interactive tools for understanding and planning adaptation. It also provides an overview of selected news and events on climate change adaptation. Its structure allows easy access to:

- **Available reports and publications and selected indicators** on observations and scenarios, vulnerabilities and risks, adaptation measures;
- **Guidance on uncertainty** related to climate information and projections, as well as on adaptation planning, specifically designed for policy-makers;
- **Sectoral perspectives on EU policies** with indicators, references and multimedia content for each sector

[68] CLIMATE-ADAPT platform: http://climate-adapt.eea.europa.eu/.

policy, and information on the process of mainstreaming of adaptation;

- **Geographical perspective on adaptation policies** at the level of countries (national strategies, plans and regional/local actions), as well as large transnational regions and cities.

CLIMATE-ADAPT on-line toolkit aim at supporting adaptation include:

- **Map viewer** that allows users to display maps per climate impact and adaptation sector. Information on observations and projections of climate change impacts, vulnerability and risks are drawn from ClimWatAdapt[69], ESPON Climate[70], JRC-IES[71] and ENSEMBLES[72] projects and organizations;
- **Case-study search tool** that provides users with access to case studies of interest with respect to climate impacts and/or adaptation sectors on the basis of a selected geographical location;
- **Adaptation support tool** offers policy guidance, links to useful information sources and provides access to other relevant tools needed for the development of climate change adaptation. It is structured as an iterative cycle with different steps and related guiding questions.[73] It builds on the UK Climate Impacts Programme (UKCIP) Adaptation Wizard[74] and various risk assessment frameworks.
- **A searchable database** that covers all the CLIMATE-ADAPT content catalogued by: Publications and reports, Information portals, Guidance, Tools, Maps, graphs and datasets, Indicators, Research and knowledge projects, Adaptation options, Case studies and Organizations. In particular, the database contains adaptation research projects from EU framework programmes, EU transnational cooperation programmes and other international programmes relevant to Europe. For nationally funded programmes and projects, information is available under each country section. Furthermore, a link to the project CIRCLE2 - *Climate Impact Research and Response Coordination for a Larger Europe*[75] redirects users to a database of national and local adaptation projects and programmes on adaptation, called InfoBase, which supplements information available on CLIMATE-ADAPT platform.

CLIMATE-ADAPT is also linked to other EU clearinghouse initiatives such as: the Biodiversity Information System for Europe (BISE)[76], the Water Information System for

[69] ClimWatAdapt: http://www.climwatadapt.eu/.
[70] ESPON Climate: http://www.espon.eu/main/Menu_Projects/Menu_AppliedResearch/climate.html.
[71] JRC-IES: http://ies.jrc.ec.europa.eu/.
[72] ENSEMBLES: http://ensembles-eu.metoffice.com/.
[73] It implies an iterative policy cycle made of the following steps: 1) Assessing risks and vulnerability to climate change; 2) Identifying adaptation options; 3) Assessing adaptation options; 4) Implementation; 5) Monitoring & Evaluation.
[74] UKCIP Adaptation Wizard: http://www.ukcip.org.uk/wizard/.
[75] CIRCLE-2: http://www.circle-era.eu.
[76] BISE: http://biodiversity.europa.eu/.

Europe (WISE)[77] and Global Monitoring for Environment and Security (GMES).[78]

The European Environment Agency (EEA) is in charge of maintaining CLIMATE-ADAPT and is currently supported by the European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation (ETC/CCA).[79] CLIMATE-ADAPT content will be continuously updated and broadened by the on-going relevant projects aimed at performing and coordinating research on climate change impacts, vulnerability and adaptation, whose outcomes will eventually feed into the knowledge base for adaptation. For instance, relevant European institutions such as the EEA will contribute with **a number of key technical and thematic reports on adaptation**.[80] Also, users can share information on adaptation actions and research at all levels by directly submitting content inputs. All these contributions are expected to support the knowledge base needed for the development of the 2013 EU adaptation strategy.

[77] WISE: http://water.europa.eu/.
[78] GMES: http://www.gmes.info/.
[79] ETC/CCA: http://cca.eionet.europa.eu/.
[80] EEA forthcoming documentation include:
- EEA report on climate change impacts, vulnerability and adaptation, that will provide insights on observed trends and/or projections of climate change, analysis of impacts and analysis of risks and vulnerability in selected regions and sectors across Europe (Nov 2012);
- EEA "Adaptation in Europe" report, based on policy information contained in CLIMATE-ADAPT (Feb 2013);
- a thematic assessment on vulnerability to floods, water scarcity and droughts (2012);
- a report on coastal zones (early 2013);
- synthesis report on water (Nov 2012).

3.2.2 Mainstreaming adaptation into EU policy areas

The European Commission put forward a **EUROPE 2020 Strategy** for growth[81] covering the coming decade and a vision for Europe's future. Significantly, energy and climate goals are considered among the five top targets contained in the Strategy. In the Territorial Agenda 2020, questions relating to climate change and environmental risks are also regarded as important and they are seen to pose both challenges and opportunities for territorial development. Besides the clear political signal, mainstreaming climate change adaptation (and mitigation) effectively into the EU budget and funding schemes is considered crucial for turning policy objectives into reality. **Concrete action to integrate adaptation into EU policies is being undertaken or explored in sectors such as agriculture and forestry, infrastructure (energy and transport), health, water management, coastal areas, marine and fisheries, ecosystems and biodiversity, and disaster risk reduction**. The Commission is expected to release a specific **Communication on Mainstreaming Adaptation and Mitigation** including a strategy and concrete actions to mainstream climate adaptation and mitigation in other EU policies and financial instruments. **This would include in particular "climate proofing" of policies of strategic EU importance.**[82]

[81] Cf. CEC, 2010 (b).
[82] Commission Work Programme 2010: http://ec.europa.eu/atwork/programmes/docs/cwp2010_annex_en.pdf.

To date, a specific project of the European Commission named ***Climate Proofing of key EU policies – short term actions*** has identified adaptation measures that would have to be applied in some key EU policy sectors (energy, agriculture, infrastructure and transport, and urban areas) in order to ensure adequate response to climate change challenges. For a selection of those identified measures the relative costs and their potential economic, social and environmental impacts are also been estimateed.[83]

Inter alia, integration of adaptation into EU policies has been and will be carried out through existing EU legislation and its possible revision, including:[84]

- the *Water Framework Directive* and the *First River Basin Management Plans (2009-2015)*;
- the *Floods Directive*;
- the *Strategy on Water Scarcity and Droughts*;
- the *Common Agricultural Policy* reform and the new rural development policy plan;
- *EU Health Strategy* and the *2010 European Regional Framework for Actio*n;
- the *Habitat Directives* and *Natura 2000 Network*;
- The *EU Forest Action Plan*;
- EU Structural Funds;
- *Environmental Impact Assessment (EIA)* and *Strategic Environmental Assessment (SEA)*, and the related Directives.

More information on each EU sector policy is available on CLIMATE-ADAPT.[85]

3.3 National Strategies for climate change adaptation[86]

A National Adaptation Strategy is defined as a "long-term vision that includes both hard and soft measures, with the purpose of reducing climate change impacts and vulnerabilities and enhancing adaptive capacity of society".[87]

Ahead of the 2013 EU Adaptation Strategy, MSs are encouraged to act considering the possibility of mandatory requirements for MSs to develop their own NAS, or, more likely, the requirement for mandatory reporting by MSs on adaptation actions being undertaken or planned. To ensure the compatibility of national and European actions on adaptation, the Commission is currently exploring a range of different options and tools.

3.3.1 National reporting on adaptation

Currently MSs are not subject to any reporting obligations by the Commission on actions relevant for climate change adaptation. At the international level MSs regularly report such information to the UNFCCC through their national

[83] Altvater et al., 2012.
[84] Cf. EEA, 2010.
[85] CLIMATE-ADAPT/EU sector policies: http://climate-adapt.eea.europa.eu/web/guest/eu-sector-policies.
[86] Cf. CEC, 2009 (b), p.19 et seq.
[87] Biesbroek at al., 2010; EEA, 2008.

communications. However, in such broad documents, the information on adaptation reported may be fragmented and inconsistent across MSs due to different reporting approaches adopted. Coherent collection and elaboration of such data and information across MSs would be helpful to compare and evaluate the status of adaptation processes with the aim of further supporting the provision and dissemination of best practices on adaptation.[88] **Given the need for a more structured reporting of MSs on adaptation at the EU level, some proposals are currently being considered.** For instance, the EU *Monitoring Mechanism Decision on greenhouse gas emissions and the implementation of the Kyoto Protocol*[89] could be subject to revision. **In this case, a proposal for amendment of the Monitoring Mechanism is considering including new annual reporting requirements on the climate change impacts, costs, vulnerability and measures being taken on adaptation.** Such requirements would eventually provide key information and data that could be input into CLIMATE-ADAPT and thus become widely available.[90]

3.3.2 Overview of national adaptation strategies

A fragmented variety of autonomous and planned adaptation activities have been undertaken at the national, regional and local scale across Europe. They are usually intended as stand-alone measures and are often not even tagged as adaptation although they promote adaptation to climate change. In addition, they are often not framed under a coherent national adaptation strategy. **Measures that are beneficial to adapting to climate change are often carried out within existing sectoral policies such as natural hazard prevention, coastal defence strategies, environment protection and sustainable resource management**.[91] Generally speaking, in Europe, implemented adaptation measures are more of reactive nature, that is to say they do not anticipate climate change impacts, but rather react to those impacts once they manifest.

With respect to planned adaptation at the country level, EU MSs are at different stages of designing, developing and implementing formal National Adaptation Strategies. Since 2005, **13 countries**, including EU MSs and non-EU countries members of EEA, **have formally adopted their NAS in Europe** (see table in **Annex 6**)[92], namely:

- **Finland (2005)**
- **Spain (2006)**
- **France (2006)**
- **Hungary (2008)**
- **The Netherlands (2008)**
- **Denmark (2008)**
- **Germany (2008)**
- **United Kingdom (2008)**[93]

[88] Cf. Herold at al., 2011. This report made for DG CLIMA includes a proposal with specific requirements for reporting and monitoring on adaptation.

[89] Monitoring Mechanism, summary of legislation: http://europa.eu/legislation_summaries/environment/tackling_climate_change/l28044_en.htm.

[90] From the "Background note on the state of play of the preparation of the EU Adaptation Strategy – 5th meeting of the Adaptation Steering Group (Feb 2012)".

[91] Cf. CIRCLE, 2008.

[92] As of July 1, 2012.

[93] In 2008 the Climate Change Act (an Act of Parliament of the UK) became legislation. In terms of

- **Sweden (2009)**
- **Portugal (2010)**
- **Belgium (2010)**
- **Switzerland (2012)**
- **Malta (2012)**

In addition, **many other European countries have started assessing their adaptation needs and priorities in preparation for the development and adoption of their own NAS**. In particular, some MSs are well advanced in their progress towards the adoption of a NAS and are expected to finalize such process in the near future, such as Austria, Czech Republic and Slovakia, while others are at early phases of identifying their paths to adjust to new climatic conditions. Only a few countries have not reported progress on adaptation so far.[94]

NASs of MSs at different stages have been compared and analysed[95], however the fast-evolving nature of those NAS processes quickly make these types of analyses outdated. Continuously updated information is available in the CLIMATE-ADAPT national section.

By the time the first comparative review of NASs was made (2009), all MSs appeared to be well aware of the need to adapt to climate change. In the countries considered, adaptation policy development seemed to be a joint result of top-down activities from the national government and bottom-up activities at the local level. Particularly vulnerable municipalities and sectors had often already started reducing their vulnerability before NASs were being developed. In those cases, the NASs offered a framework for such activities, and an incentive to further implement and harmonise adaptation actions.[96]

NASs by definition are country-specific as they provide frameworks for adaptation actions based on national circumstances. However, in the NASs analysed, **water management (especially flood protection), land use and agriculture, biodiversity and ecosystems were considered as priority sectors by the majority of MSs**. It can be pointed out that **while biodiversity and ecosystems seemed to be more prominent in northern Europe, food production and security were the most critical matter in central European adaptation strategies.**

Also, important common **crosscutting issues were highlighted in the general design of the NASs analysed** such as:

- **Mainstreaming;**
- **Spatial planning oriented approach;**
- **Awareness rising;**
- **Stakeholders involvement;**
- **Information sharing;**
- **Research;**
- **Coordinated action.**

Following up on the adoption of a NAS, **developing implementation plans**

adaptation, this requires a National Adaptation Programme to be introduced in 2013.

[94] From CLIMATE-ADAPT/Countries: http://climate-adapt.eea.europa.eu/web/guest/countries.

[95] PEER, 2009; Biesbroek et al., 2010; Termeer et al., 2011.

[96] *Ibidem.*

seems to represent a key policy challenge in many countries especially with respect to mainstreaming adaptation within existing policies and economic instruments, and establishing reporting / monitoring mechanisms.[97] Although acknowledging that there is no "one-size-fits-all" framework for adaptation, the guidelines on national adaptation policies that will accompany the 2013 EU Adaptation Strategy are expected to assist policy-makers in EU countries in successfully developing, implementing, and reviewing adaptation policies based on common elements of good adaptation practices.

3.4 Regional and urban adaptation strategies

National Adaptation Strategies often provide a framework for the development of regional strategies. In other cases, pre-existing regional adaptation strategies are legitimised and included in NASs.[98] **Regional adaptation strategies can be very different in spatial scope, ranging from EU macro-regions to sub-national regions.** Climate adaptation strategies and plans are increasingly being implemented at the level of EU regions through large cooperation programmes.[99] In addition, Macro-Regional Strategies has been created in order to address key trans-boundary issues, including climate change in areas of special interest such as the Baltic Sea[100] and the Danube regions. Furthermore, several so-called "cross-boundary regional knowledge nodes"[101] contribute to the development of adaptation measures at the sub-national scale. Within regions, **cities are often taking the lead in planning for adaptation due to their high concentration of socio-economic assets that make them particularly vulnerable to the risks posed by climate change**. National and international networks of local and regional authorities committed to sustainable development are growing, as well as initiatives specifically focused on increasing engagement of cities for climate change adaptation.

The following is a selection of the most significant examples in place:

- **Macro-regional strategies (also including climate change challenges)**: Baltic Sea Strategy (2009) and Danube Region Strategy (2010)[102].
- **Cross-boundary regional knowledge nodes:** Alpine Convention Water[103] and Hazards[104] Platforms, Climate

[97] EEA, 2010.
[98] Ribeiro at al., 2009.
[99] The Commission (DG REGIO) has established transnational cooperation programmes for 13 EU regions: http://ec.europa.eu/regional_policy/cooperate/cooperation/transnational/index_en.cfm.
[100] Baltic Sea Region Strategy: http://ec.europa.eu/regional_policy/cooperate/baltic/index_en.cfm; EUSBSR: http://www.balticsea-region-strategy.eu/.
[101] Isoard, 2011.
[102] Danube Region Strategy: http://ec.europa.eu/regional_policy/cooperate/danube/index_en.cfm ; EUDRS http://www.danube-region.eu/.
[103] Alpine Convention - Water Management Platform: http://www.alpconv.org/theconvention/conv06_WG_e_en.
[104] Alpine Convention - Hazards Platform: http://www.alpconv.org/theconvention/conv06_WG_c_en.htm.

change observatory for the Pyrenees[105], Carpathian Convention[106];

- **Regional adaptation strategies:** Andalucía (Spain), North-Rhine Westphalia (Germany), Rhône-Alpes (France);
- **Urban adaptation strategies:** Barcelona, Copenhagen[107], London[108], Rotterdam[109];
- **Initiatives on adaptation and cities:** *EU CITIES - Adaptation Strategies for European Cities* project[110]; *ICLEI – Local Governments for Sustainability*[111]; *Covenant of Mayors*.[112]

A project initiated by the Commission produced **Guidelines for Regional Climate Change Adaptation Strategies**, intended to help regional and locally-based administrations plan for climate change adaptation. Those guidelines include a review of existing regional actions, describe the whole process of development and implementation of adaptation strategies, and provide numerous links to existing tools and databases. [113] Furthermore, the Commission is expected to release a report on adaptation strategies in EU cities by 2013, which is intended to provide a better overview of adaptation present and future action at the level of municipalities across Europe.

More information is available on CLIMATE-ADAPT sections under Transnational Regions[114] and Cities.[115]

[105] Pyrenees Climate Change Observatory: http://www.opcc-ctp.org/.
[106] Carpathian Convention: http://www.carpathianconvention.org/the-convention-17.html.
[107] Copenhagen Climate Adaptation Plan: http://klimatilpasning.dk/en-us/service/newsletter/sider/climateadaptationplanforcopenhagen.aspx.
[108] London Climate Change Adaptation Strategy: http://www.london.gov.uk/climatechange/.
[109] Rotterdam Climate Initiative: http://www.rotterdamclimateinitiative.nl/en/100_climate_proof/projects/?portfolio_id=44.
[110] EUCITIES: http://eucities-adapt.eu/cms/.
[111] ICLEI: http://www.iclei.org/.
[112] Covenant of Mayors: http://www.eumayors.eu/index_en.html.

[113] Cf. Ribeiro at al., 2009.
[114] CLIMATE-ADAPT/Transnational regions: http://climate-adapt.eea.europa.eu/web/guest/transnational-regions.
[115] CLIMATE-ADAPT/Cities: http://climate-adapt.eea.europa.eu/web/guest/cities.

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CLIMATE-ADAPT, European Climate Change Adaptation Platform: http://climate-adapt.eea.europa.eu/.

DG CLIMA, Policies / Adaptation: http://ec.europa.eu/clima/policies/adaptation/index_en.htm.

DG ENVIRONMENT: http://ec.europa.eu/environment/index_en.htm.

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Next updates

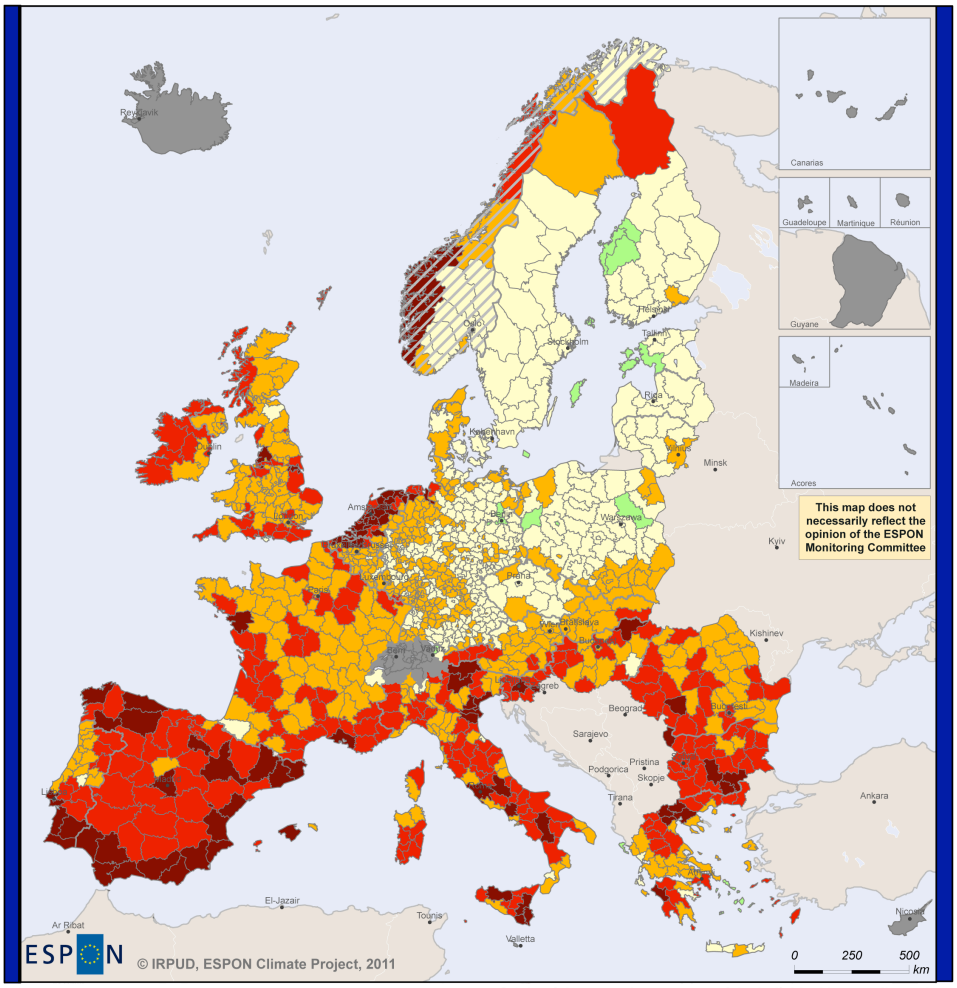
EEA, Report on climate change, impacts and vulnerability (Nov 2012)

EEA, "Adaptation in Europe" Report (Feb 2013)

EC, Report on adaptation strategies in EU cities (2013)

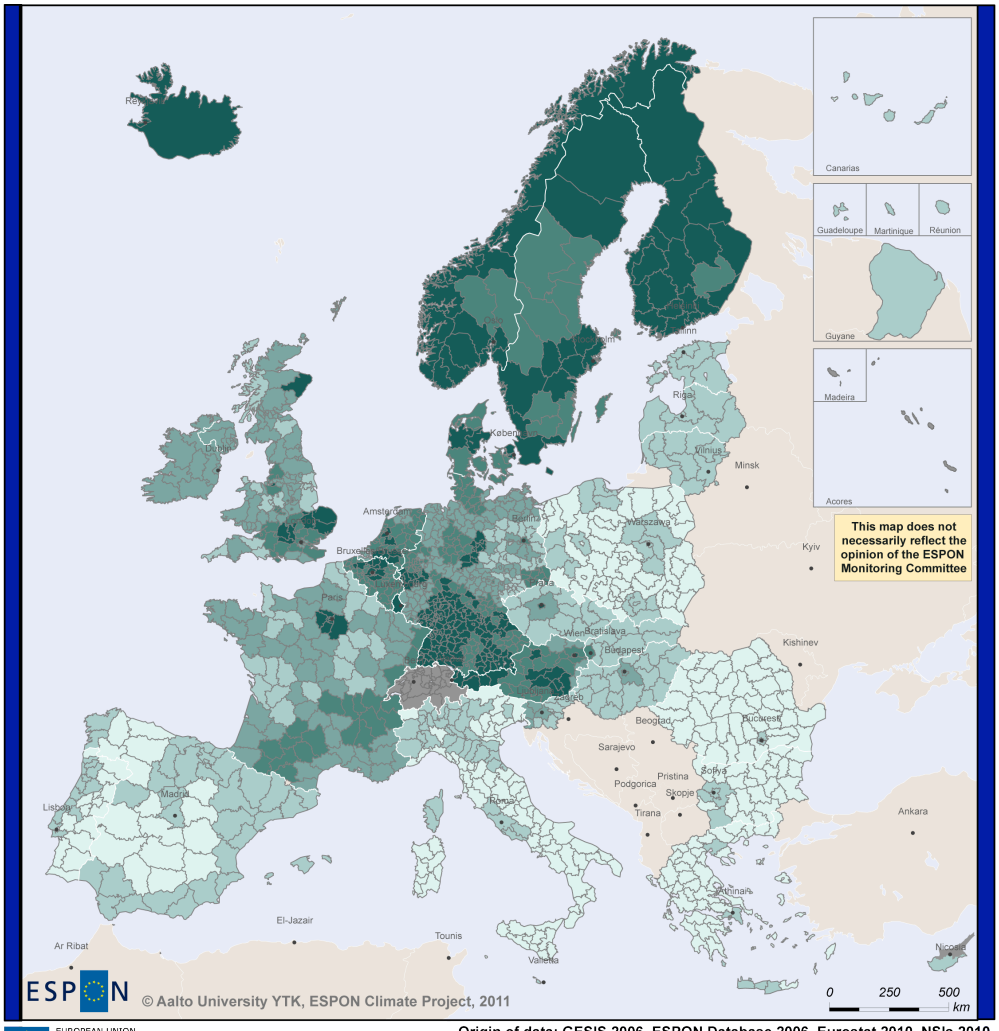
4 Annexes

ANNEX 1: Aggregate potential impacts of climate change over Europe



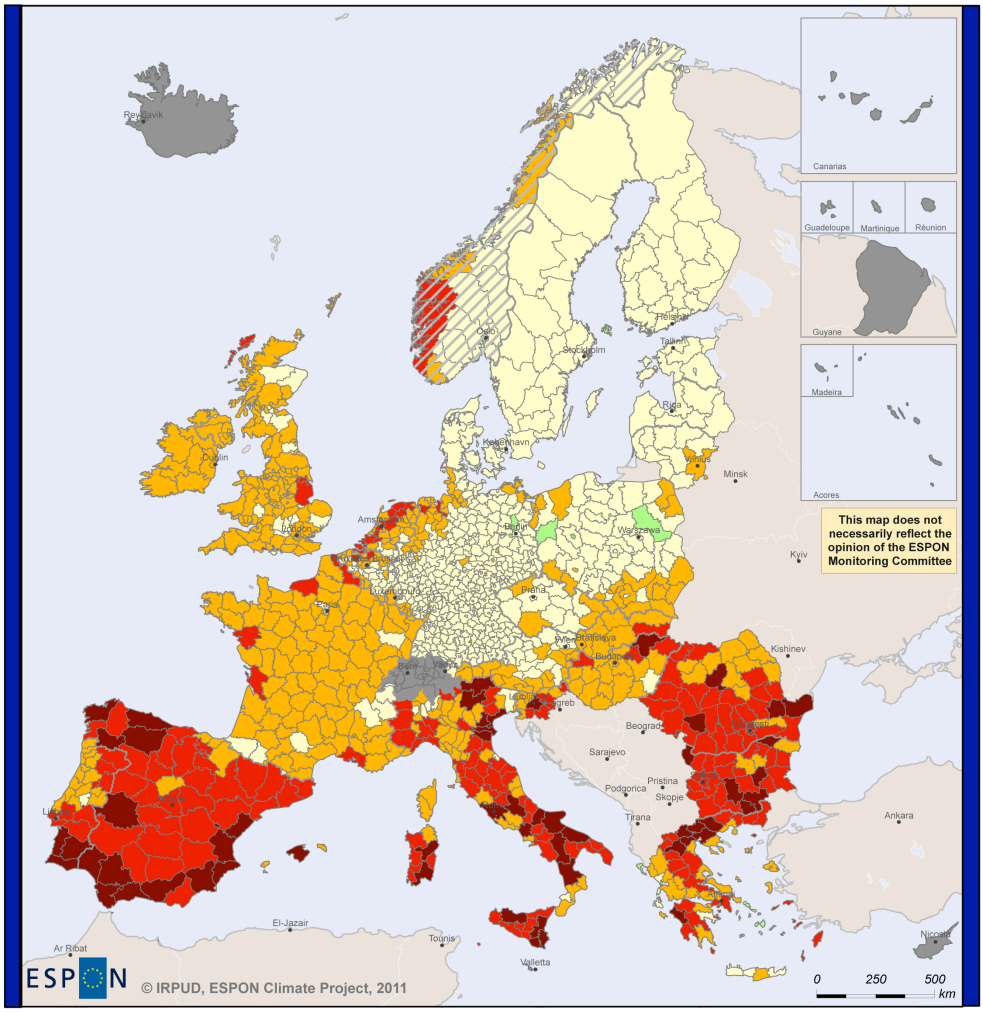
Map 1 - Aggregate potential impacts of climate change (Source: ESPON CLIMATE - Greiving et al., 2011)

ANNEX 2: Overall capacity to adapt to climate change in Europe



Map 2 - Overall adaptive capacity towards climate change in Europe (Source: ESPON CLIMATE - Greiving et al., 2011)

ANNEX 3: Aggregate potential vulnerability to climate change over Europe



Potential vulnerability to climate change

- highest negative impact (0.5 - 1.0)
- medium negative impact (0.3 - <0.5)
- low negative impact (0.1 - <0.3)
- no/marginal impact (>-0.1 - <0.1)
- low positive impact (-0.1 - -0.25)
- no data*
- reduced data*

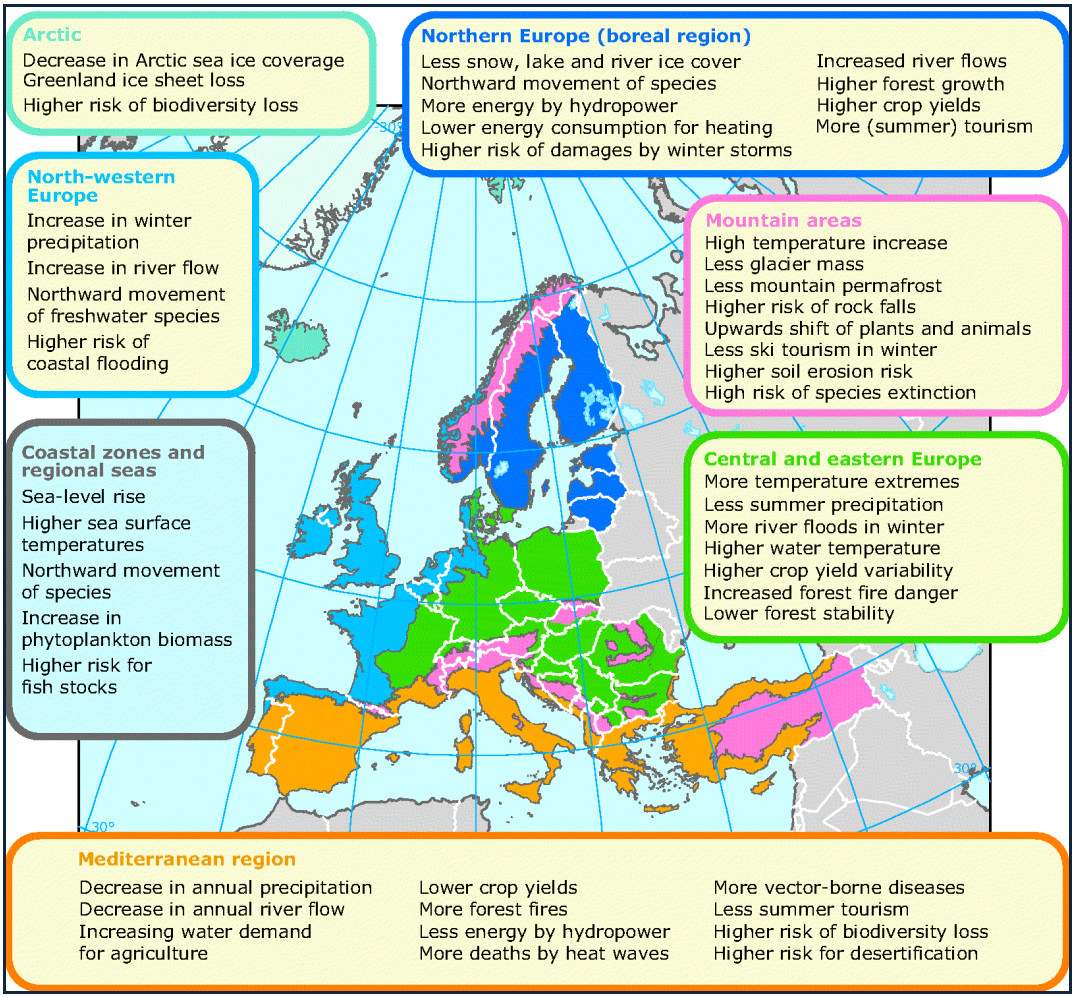
Vulnerability calculated as the combination of regional potential impacts of climate change and regional capacity to adapt to climate change.

The potential impacts were calculated as a combination of regional exposure to climate change (difference between 1961-1990 and 2071-2100 climate projections of eight climatic variables of the CCLM model for the IPCC SRES A1B scenario as well as resulting inundation depth changes for a 100 year return flood event based on river flooding projections of the LISFLOOD model and coastal storm surge height projections of the DIVA model adjusted with a 1 m sea level rise) and most recent data on the weighted dimensions of physical, economic, social, environmental and cultural sensitivity to climate change. Adaptive capacity was calculated as a weighted combination of most recent data on economic, infrastructural, technological and institutional capacity as well as knowledge and awareness of climate change.

* For details on reduced or no data availability see Annex 9.

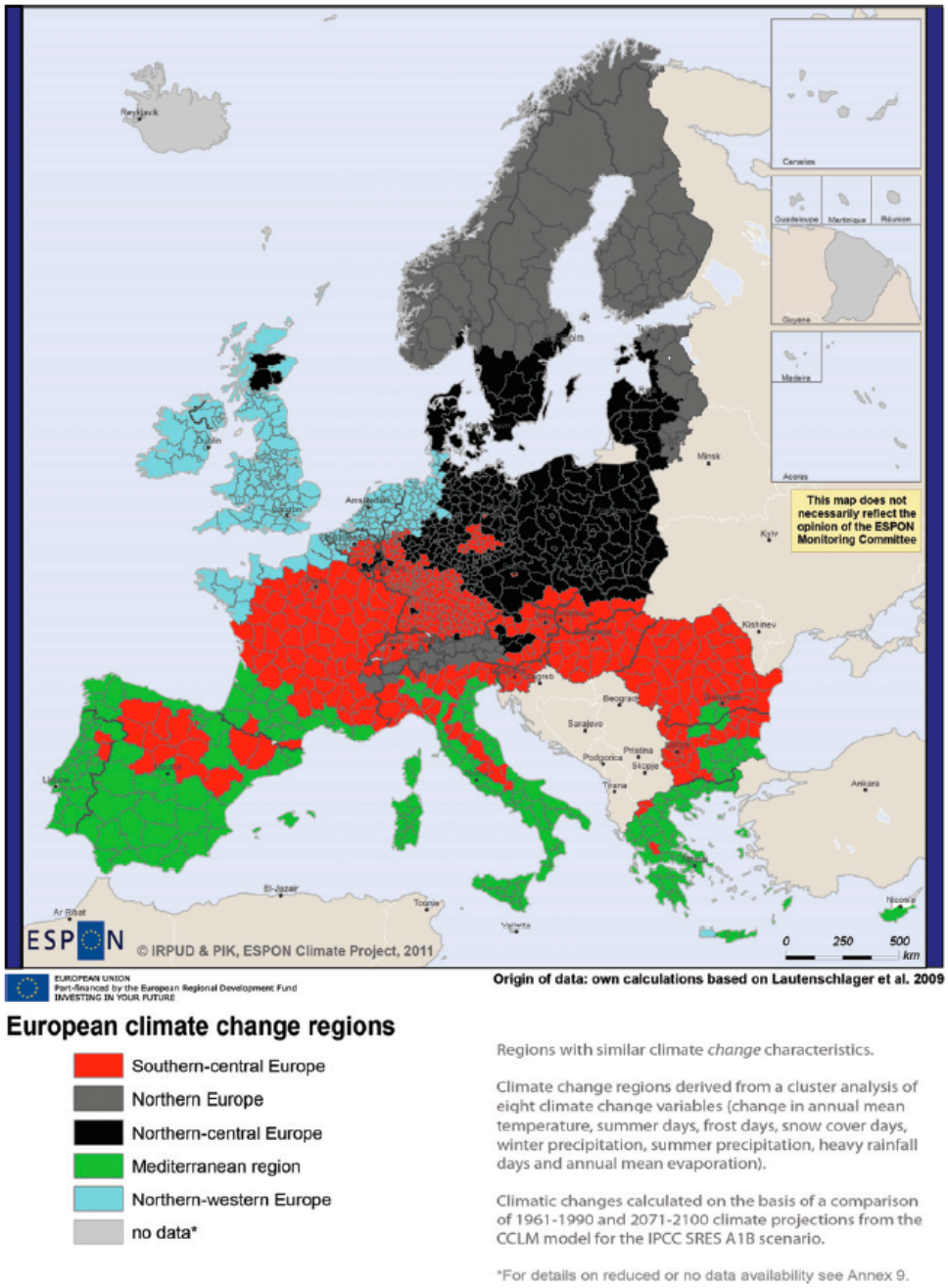
Map 3 - Potential vulnerability to climate change over Europe calculated as a combination of regional potential impacts and adaptive capacity (Source: ESPON CLIMATE - Greiving et al., 2011)

ANNEX 4: Key impacts for the main bio-geographical regions of Europe



Map 4 – Key past and projected impacts and effects on sectors of main bio-geographical regions of Europe (Source: EEA-JRC-WHO, 2008)

ANNEX 5: Climate change regions clustered according to projected impacts



Map 5 - European regions with similar climate *change* characteristics (Source: ESPON CLIMATE - Greiving et al., 2011)

ANNEX 6: Overview of National Adaptation Strategies

EU Member States	NAS adopted	NAS foreseen
Austria		2012
Belgium	2010	
Bulgaria		
Czech Republic		2012
Cyprus		
Denmark	2008	
Estonia		2015
Finland	2005	
France	2006	
Germany	2008	
Greece		
Hungary	2008	
Ireland		
Italy		2013
Latvia		
Lithuania		
Luxembourg		
Malta	2012	
The Netherlands	2008	
Poland		2013
Portugal	2010	
Romania		
Slovakia		2012
Slovenia		
Spain	2006	
Sweden	2009	
United Kingdom	2008	

Non-EU Countries	NAS adopted	NAS foreseen
Iceland		
Liechtenstein		
Norway	2008 (not called NAS)	2012
Switzerland	2012	
Turkey		

Table 1 and 2 – Overview of National Adaptation Strategies adopted across EU Member States and non-EU countries in Europe (main source: CLIMATE-ADAPT accessed in July 2012)

5 Basic glossary

Based on IPCC, 2007 (a) (Appendix I: Glossary) unless otherwise specified.

Adaptation

"Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

- **Anticipatory adaptation** – adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation;
- **Autonomous adaptation** – adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation;
- **Planned adaptation** – adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state".

Adaptation benefits

"The avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures".

Adaptation costs

"Costs of planning, preparing for, facilitating, and implementing adaptation measures, including transition costs".

Adaptive capacity (in relation to climate change impacts)

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

(***climate change) Impacts***

"The effects of climate change on natural and human systems.

Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts:

- **potential impacts**: all impacts that may occur given a projected change in climate, without considering adaptation;
- **residual impacts**: the impacts of climate change that would occur after adaptation".

National Adaptation Strategy

"Long-term vision that include both hard and soft measures, with the purpose of reducing climate change impacts and vulnerabilities

and enhancing adaptive capacity of society".[116]

Mitigation

"An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks".

Vulnerability

"Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity".

[116] Biesbroek at al., 2010; EEA, 2008.

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