EUROPEAN POLICY CENTRE

The climate is changing – is Europe ready? Building a common approach to adaptation

EPC ISSUE PAPER No. 70

SEPTEMBER 2012

By Annika Ahtonen with Serban Chiorean-Sime,
Caroline Schneider and Imogen Sudbury

ISSN 1782-494X

EUROPE'S POLITICAL ECONOMY PROGRAMME

The EPC's Programme on Europe's Political Economy

Taking the steps needed to make the EU a world leader in today's globalised economy, to ensure the sustainability of the European economic and social models and to maximise citizens' quality of life form the core of this programme's activities.

Europe's ability to create wealth on a sustained and sustainable basis, while at the same time ensuring employment growth, equitable income distribution and the efficient provision of public services, will depend on the necessary reforms being introduced to respond to the challenges of globalisation, the ageing of Europe's population, and climate change.

The European Union is well aware of the importance of pooling together the efforts of all member states, and ambitious EU frameworks such as the Europe 2020 strategy have been already approved. But Europe's commitment will have to be urgently translated into concrete policy actions at all policy levels in a consistent manner.

This programme addresses these issues through a number of forums and task forces. It engages in and stimulates debate on economic, social and environmental policy in general and looks at the extent to which European integration in these fields could bring more added value. It also works with other programmes on cross-cutting issues such as the economic integration of migrants, the EU budget, economic governance and Europe's relations with other parts of the world.

Table of Contents

About the authors

Annika Ahtonen is a Policy Analyst, Serban Chiorean-Sime is a former Programme Assistant, Caroline Schneider is a former trainee and Imogen Subdury is a former Policy Analyst at the European Policy Centre.

Acknowledgements

The contents of this paper draw on discussions at a series of workshops organised by the EPC, in conjunction with the King Baudouin Foundation (KBF), in 2010-2012.

The authors wish to thank all the participants in the discussions for taking part in and contributing to the work of the EPC-KBF Task Force on Climate Change Adaptation.

For their invaluable input, the authors would also like to thank those who participated as speakers in our workshops, namely Hazel Baird, Rosário Bento Pais, Joan Canton, Claudio Catalano, Laure Chabuis, Thomas De Lannoy, Claus Hvashøj Jørgensen, Agnes Kelemen, Christian Kirchsteiger, Claus Kondrup, Bettina Menne, Florence Mourey, Philippe Pochet, Patrick Pringle, John F. Ryan, Nancy Saich, Antony So, Andreas Spiegel, Hilkka Summa, Nikolaus van den Pas, Denise Van Regenmorter and Pascale Taminiaux.

A special thank you goes to KBF for their special support for this project and Natasha Walker, who facilitated the discussions and ensured that every participant had a voice at the meetings.

The authoring rapporteurs are responsible for the content of this paper.

Foreword

The climate is changing. Heat waves, forest fires and floods, which are also affecting Europe today, are indicators of this ongoing climatic change. We can no longer wait: much greater efforts are needed to mitigate climate change and prevent future increases in global temperature, and resulting changes to the climate and environment, by limiting CO2 emissions. At the same time, given the long time-lag between mitigation measures and their effect on the climate, it is becoming ever more obvious that efforts to reduce greenhouse-gas emissions must be coupled with adaptation to a warming world. Unfortunately even the best mitigation efforts will not stop altogether the extreme weather events that are already happening today.

The reality is that paying for the consequences of climate change is becoming more expensive all the time. More emphasis must be put on monitoring, preparing and adjusting to changing environmental and climatic conditions. In order to protect ecosystems, citizens and their livelihoods, it is important to find ways to increase their resilience and reduce their vulnerability to environmental disasters and weather events.

The climate challenge must be seen as an opportunity to promote a more sustainable European economy. This carries a significant innovation potential and is an enormous market opportunity. Products and services that support resource efficiency, help to lower the EU's greenhouse-gas emissions and assist with monitoring, preparing and adjusting to a changing environment are needed both in the EU as well as outside its borders. Thus, it is time to make adaptation an exemplary case for innovation and ensure that the best solutions are utilised. This also makes sense economically: smart and cost-effective climate-change adaptation solutions can help Europe to save significant amounts of money.

To explore the importance of adaptation for Europe, and to understand the related challenges and possibilities, the European Policy Centre, in conjunction with the King Baudouin Foundation (KBF), set up a Task Force in the autumn of 2010, under the auspices of the EPC's Europe's Political Economy Programme. During its meetings in 2010-2012, the Task Force brought together a wide range of representatives from EPC member organisations, including companies, regions and NGOs as well as experts from academia and the EU institutions to

- consider the potential environmental, social and economic impacts of climate change on Europe;
- discuss strategies for adapting to the impact of climate change in selected sectors (agriculture and natural resources, infrastructures, health and well-being) and for financing adaptation, and the role and added value of the EU in this process;
- look at the social and economic impacts of climate-change adaptation policies and actions on Europe and identify ways of mitigating adverse effects on the most vulnerable groups in society, bearing in mind the EU's commitment to promoting inclusion and well-being;
- consider the potential opportunities for growth, innovation and jobs arising from efficient climate-change adaptation; and
- make policy recommendations for action at EU level that can support and underpin local, regional, sectoral and national efforts on climate-change adaptation.

This report builds on the discussions and findings of these meetings, making the case for adaptation in Europe, across different regions and sectors. This is a timely discussion: the European Commission is currently working on the EU Strategy for Adaptation, which will be published in March 2013, and the EU is still engaged in the final battle over the EU budget for 2014-2020, where one of the remaining questions is the extent to which it will reflect the political priority given to creating a greener and more sustainable European economy, and the extent to which its programmes will promote climate action. As this report demonstrates, the EU can play an important role in supporting adaptation efforts in Europe and it should not shy away from turning this into an economic opportunity and a possibility for innovation and growth.

*by **Hans Martens***
Chief Executive, European Policy Centre

Executive Summary

Global temperatures have been rising since the 1850s and the rise has been speeding up since the 1970s. The effects of this change in climate are being felt in Europe as well as in other parts of the world. Higher water and air temperatures, changes in precipitation levels and wind speed, melting of ice, sea-level increases, and more frequent floods, heat waves and storms are all indicators of this change. In turn, these changes are having an impact on water and food security, human health, biodiversity, migration and economic development across the world, posing serious challenges to human well-being and prosperity.

As most climate scientists agree that global warming can be attributed to the rise in greenhouse-gas emissions due to human activities such as fossil-fuel consumption and deforestation, it would be economically, socially and environmentally too risky not to limit these main causes of warming. This is why climate-change mitigation and reducing global emissions is of great importance – and cannot wait.

At the same time, although the need for mitigation grows ever more urgent, even the best efforts will not stop heat waves, forest fires or floods, which already affect us today. Given the long time-lag between mitigation measures and their effect on the climate, it is becoming ever more obvious that the efforts to reduce greenhouse-gas emissions must be coupled with adaptation to a warming world.

With the economic crisis ongoing, it is more important than ever for Europe to pay attention to where money is spent, how it is spent, and how investments help to promote a more sustainable economy, economically and environmentally. It can no longer afford to make short-sighted decisions and pay for the consequences later.

While climate-change adaptation is mainly a national responsibility, the European Union (EU) is equipped with many tools which it can use to help member states, regions and businesses to make smarter decisions. The EPC-KBF Task Force on adaptation identified eight main areas for action where the EU could play a stronger role:

- Building the knowledge-base
- Building capacities to act
- Communicating and raising awareness about adaptation
- Mainstreaming mitigation and adaptation across EU policies
- Developing clear guidelines and criteria for financing adaptation projects
- Creating a market place for adaptation and encouraging innovation
- Sharing the burden and taking into account society's most vulnerable
- Setting a vision for adaptation

The European Commission is currently working on an EU Adaptation Strategy, which is expected to be adopted in March 2013. It would be in Europe's interest for the Strategy to contribute to creating a long-term vision for tackling the climate challenge and to build a framework for action in the eight areas mentioned above.

There is one target that the EU must set for its member states: adopting national adaptation strategies. To support this, it could provide member states as well as regional and local authorities with a set of indicators: a checklist that would enable them to

1) develop the right adaptation measures for a given region or sector, taking into consideration its vulnerabilities but also the possible benefits and adverse effects of these measures;
2) deliver the needed measures in a timely and cost-effective manner; and
3) ensure that the measures are effective in the long run.

While the climate change agenda has suffered a blow on the political agenda, partly due to the economic crisis, the reality has not changed: the impacts of climate change are already with us today. Thus, the EU should not shy away from the issue. Rather, it should make sure to use all the possible tools at its disposal to ensure that adaptation to these changes promotes economic and environmental sustainability, and adds to prosperity and welfare in Europe.

This paper has looked more closely at the impacts of climate change and the importance of adaptation for three sectors: agriculture and natural resources, infrastructures and Europeans' health and well-being. It has looked at the economics of climate-change adaptation and the different solutions for financing and co-operating in the projects needed. The sector-specific and the general recommendations in this paper are targeted at EU policymakers, member states, regions and public-sector bodies, as well as the private sector.

Chapter 1

STATE OF PLAY

1.1 CLIMATE CHANGE IS HAPPENING, AND LOSSES FROM WEATHER- AND CLIMATE-RELATED DISASTERS ARE INCREASING ACROSS THE WORLD

The climate is changing. Global average temperature has risen by 0.74 degrees Celsius since pre-industrial times and at an increasing speed in the last 50 years.[1] The World Meteorological Organisation found that the 13 warmest years on record occurred in the past 15 years.[2]

The impacts of higher temperatures are felt across the world. These are seen in longer and more intense heat waves, widespread melting of ice, rising global sea levels, more drought, more frequent heavy precipitation events, rain or snow, and in some places longer growing seasons.

According to the latest satellite data that evaluates the thickness of the Earth's polar caps, the rate of sea ice loss in the Arctic is 50% higher than polar scientists had previously expected. In the north of Canada and Greenland, levels of ice thickness in summer have dropped from around five to six metres a decade ago to one to three metres today.[3]

These changes in climate affect water and food security, human health, biodiversity, migration and economic development, not to mention various infrastructures that represent the basis of functioning societies. These changes pose serious challenges to human well-being and prosperity across the world.

[1] IPCC (2007) [Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B, Tignor, M. and Miller, H.L. (eds.)]: *"Summary for Policymakers"* in *"Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change".* Cambridge University Press, Cambridge, UK and New York, NY, USA. p.2.

[2] World Meteorological Organization (2011): "*Provisional Statement on the Status of the Global Climate: 2011: world's 10th warmest year, warmest year with La Niña on record, second-lowest Arctic sea ice extent*". Available at www.wmo.int/pages/mediacentre/press_releases/gcs_2011_en.html, accessed on 9 August 2012.

[3] McKie, R.: *"Rate of Arctic summer sea ice loss is 50% higher than predicted", EurActiv* (13 August 2012). Available at www.euractiv.com/climate-environment/rate-arctic-summer-sea-ice-loss-news-514271, accessed on 16 August 2012.

20 million people were displaced due to climate-related catastrophes in 2008,[4] and 42 million people were displaced as a result of events such as earthquakes and floods in 2010.[5] As the number of natural catastrophes and their impacts on people and assets become greater across the world, it is clear that migration due to environmental changes will continue to increase.

While knowledge about climate change is plagued by uncertainty and it is almost impossible to paint a comprehensive picture that takes into account every possible impact of climate change on people, ecosystems, infrastructures and businesses, there is enough data to recognise the trends. A significant amount of data exists and a number of studies have been published about the possible climate impacts and vulnerabilities regarding specific regions and sectors. Moreover, understanding of the potential economic impacts of climate change is increasing.[6]

Overall, the past decade has seen an exceptional number of unprecedented extreme weather events, which have resulted in significant social and economic costs across the world.[7] While developing countries lose more in terms of human lives and the economic costs are higher if expressed as a proportion of gross domestic product (GDP), economic losses caused by disasters are greater in developed countries.[8] For example, for the United States, 2011 was a year of extreme weather, with 14 events that caused losses in excess of USD one billion each.[9] Other parts of the world were affected by extreme weather in 2011 as well: rainfall records were set in Australia, Japan and Korea, whereas the Yangtze Basin in China experienced record drought. In Western Europe, the spring of 2011 was exceptionally hot and dry, setting records in several countries.

The Intergovernmental Panel on Climate Change (IPCC) notes that economic losses from weather- and climate-related disasters have increased in recent decades on a global basis, ranging from a few billion USD in 1980 to above 200 billion in 2005 (largely explained by Hurricane Katrina).[10]

According to a study carried out by Swiss Re, a global reinsurance company, annual insured losses from weather-related disasters worldwide have jumped from USD 5.1 billion in 1970-1989 to USD 27 billion for the last two decades.[11]

The German Institute for Economic Research has estimated that by 2100, extreme weather conditions will cost the world 20 trillion USD annually if nothing is done to slow down greenhouse-gas emissions.[12]

---

4 The United Nations Office for the Coordination of Humanitarian Affairs (OCHA), The Internal Displacement Monitoring Centre (IDMC), the Norwegian refugee Council (NRC) (2009): *"Monitoring disaster displacement in the context of climate change.* OCHA, IDMC, NRC. p.2. Available at www.internal-displacement.org/8025708F004BE3B1/(httpInfoFiles)/12E8C7224C2A6A9EC125763900315AD4/$file/monitoring-disaster-displacement.pdf, accessed on 11 September 2012.

5. Amland, B.: *" Natural disasters displaced 42 Million in 2010; Climate change could be the factor, Experts say", Huffington post* (6 June 2011). Available at *www.huffingtonpost.com/2011/06/06/natural-disasters-displaced-persons_n_871664.html* accessed on 11 September 2012.

6 See e.g. Stern N. (2007)*: "Stern Review: The Economics of Climate Change".* Cambridge University Press, Cambridge, UK.

7 Coumou, D., Rahmstorf, S. (2012*): "Nature Climate Change: 'A decade of weather extremes'"*. p.2. Available at www.nature.com/nclimate/journal/vaop/ncurrent/pdf/nclimate1452.pdf, accessed on 10 September 2012.

8 IPCC (2012) [Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G.-K., Allen, S.K., Tignor, M. and Midgley, P.M. (eds.)]: *"Summary for Policymakers"* in "*Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)"*. Cambridge University Press, Cambridge, UK, and New York, NY, USA. p.7.

9 World Meteorological Organization (2011): "*Provisional Statement on the Status of the Global Climate: 2011: world's 10th warmest year, warmest year with La Niña on record, second-lowest Arctic sea ice extent"*. Available at www.wmo.int/pages/mediacentre/press_releases/gcs_2011_en.html, accessed on 9 August 2012.

10 IPCC (2012) [Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G.-K., Allen, S.K., Tignor, M. and Midgley, P.M. (eds.)]: *"Summary for Policymakers"* in "*Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)".* Cambridge University Press, Cambridge, UK, and New York, NY, USA. p.7

11 Baur, E. (ed.) (2010): *"Weathering climate change: Insurance solutions for more resilient communities".* Swiss Re, Zurich, Switzerland. p.3. Available at http://europa.eu/epc/pdf/workshop/2-3_pub_climate_adaption_en.pdf, accessed on 10 September 2012.

It should be noted that estimations such as those of the IPCC only look at direct damage to assets. Impacts such as loss of human life, cultural heritage and ecosystem services are difficult to value and are therefore not properly reflected in these estimations. Another fact that is not reflected in these losses is that in every region of the world, the negative impacts of climate change will not be felt equally among the population or even within populations. People who are poor, elderly, uneducated, disabled or in poor health will be affected first and most severely.[13]

The character and severity of climate change impacts varies depending on the event, and is greatly influenced by how vulnerable the victims are: that is, how exposed and sensitive they are to climatic changes, and what their capacity is to adapt to the adverse effects.[14] Vulnerability is once again influenced, for example, by socioeconomic development, the health of eco-systems and current land use.

1.2 … ALSO IN EUROPE

Heat waves, forest fires and floods, which climate change can cause, are already affecting various parts of Europe today. For example, in 2003, Europe suffered its hottest summer for at least 500 years, and the intense heat waves in Southern Europe were responsible for 15,000 extra deaths in France alone, and 20,000 extra deaths in Spain and Italy.[15] Altogether, more than 80,000 additional deaths were recorded in Europe in 2003 compared to in 2002. A 2010 heat wave in Russia caused 11,000 deaths in Moscow alone,[16] and the combined effects of drought and wildfires severely damaged Russia's wheat crops and drove up the price of wheat. Floods in Central Europe in 2002 cost Europe over €20 billion.[17] Forest fires in Greece in 2007 caused 80 deaths and the storm 'Kyrill' in January 2007 caused 46 deaths and overall losses of €7.7 billion in Germany, Austria, the Czech Republic, the United Kingdom, France, Belgium, Poland, the Netherlands, Denmark, Switzerland and Slovenia.[18] One should not attribute every isolated event to climate change, but as temperatures continue to rise, the number of extreme weather events, changing weather conditions and environmental disasters is expected to increase, and these will continue to pose serious environmental, economic and social challenges for Europe.

The IPCC has worked extensively to bring together the wide variety of scientific evidence for climate change, also with regard to Europe. For example, its report on 'Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation' brought together 220 authors from 62 countries and comments from more than 18,000 experts, and thus paints a comprehensive picture of which trends

---

12 Kemfert, C.: *" Global Climate protection – Immediate action will avert high costs"*. German Institute of Economic Research (DIW) (28 April 2008), Weekly report No12/2005, Volume 1. p135. Available at www.diw.de/documents/publikationen/73/diw_01.c.43084.de/diw_wr_2005-12.pdf , accessed on 10 September 2012.

13 Agrawal, A. (2008): *"The role of Local Institutions in Adaptation to Climate Change"*, Social Development Department, The World Bank Group, Washington DC, USA. p. 17. Available at http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/SDCCWorkingPaper_LocalInstitutions.pdf, accessed on 10 September 2012. For an analysis on Europe, see King Baudouin Foundation (2010): *"Climate change mitigation and social justice in Europe: striking the right balance"*. King Baudouin Foundation, Brussels, Belgium. See also King Baudouin Foundation (2011): *"Climate Change and Social Justice in Europe: Recommendations for three EU policy areas"*. King Baudouin Foundation, Brussels, Belgium.

14 IPCC (2007): [Parry, M.L, Canziani, O.F, Palutikof, J.F, Van der Linden, P.J. and Hanson C.E. (eds.)]: *"Summary for Policymakers"* in *"Climate Change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change."*. Cambridge University Press, Cambridge, UK. p. 21.

15 Robine, j.M, Cheung, S.L, Le Roy, S., Van Oyen, H. and Herrmann F.R (2007): *"Report on excess mortality in Europe during summer 2003"*. pp. 2-3. Available at http://ec.europa.eu/health/ph_projects/2005/action1/docs/action1_2005_a2_15_en.pdf, accessed on 9 August 2012.

16 Doyle, A., and Gardner, T.: *"Factbox: 2010 hit by weather extremes: Pakistan to Russia"*, *Reuters* (19 January 2011). Available at www.reuters.com/article/2011/01/19/us-climate-weather-factbox-idUSTRE70I4EJ20110119, accessed on 8 August 2012.

17 European Environment Agency (2010): *"Mapping the impacts of natural hazards and technological accidents in Europe"*. EEA Technical report, No 13/2010. Copenhagen, Denmark. p.8.

18 *Ibid*., pp.9-10.

scientists have been able to agree upon, what the estimated costs are for societies and what the options are for managing risk.[19]

The IPCC anticipates that nearly all European regions could be negatively affected by climate change.[20] The negative impacts of climate change can range from inland flash floods to more frequent coastal flooding and increased erosion. Mountain areas could experience melting of glaciers and reduced snow cover, which should be expected to reduce winter tourism and the number of species. Overall, ecosystems are expected to have difficulty adapting to climate change.

The actual impacts and their severity will vary across regions, and as a consequence regional differences are expected to increase in Europe. For example, a sea-level rise of approximately 0.5 metres would have a major impact on the coastal areas of the European Union in particular. The resulting floods could affect up to 1.4 million citizens, causing 19,000 square kilometres of land to be permanently lost by 2080, with an estimated economic cost of €18 billion.[21] For river floods, the economic losses are likely to be larger in absolute terms, as they would affect areas with high-value assets. The nature of impacts will depend on factors such as the likelihood and magnitude of extreme weather events, population density and the value of local economic assets.

The European Commission's White Paper 'Adapting to climate change: Towards a European framework for action' counts Southern Europe, the Mediterranean Basin, the Outermost Regions and the Arctic among the regions that are most susceptible to climate-change impacts. Furthermore, mountain areas – in particular the Alps – islands, coastal and urban areas, and densely populated floodplains are facing particular problems.[22]

Climate change has already made heat waves more severe in areas such as Southern Europe and the Mediterranean. In addition, high temperatures and drought are only expected to become more frequent, leading to reductions in water availability, hydropower potential, summer tourism and crop productivity. The increased number of heat waves and wildfires may also increase health risks.[23] More frequent heat waves, droughts and water shortages should also be expected to have a negative impact on Southern European tourism.

In Central and Eastern Europe, summer precipitation is expected to decrease, peatland fires should increase and health risks caused by heat waves are expected to increase.[24] Northern Europe could be the only region to benefit from climate change in the short term, due to increased crop yields and forest growth, and reduced demand for heating. However, even the North would not escape negative impacts such as more frequent winter floods, endangered ecosystems and increasing ground instability.[25] At the

---

19 IPCC (2012) [Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G.-K., Allen, S.K., Tignor, M. and Midgley, P.M. (eds.)]: *"Summary for Policymakers"* in "*Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)".* Cambridge University Press, Cambridge, UK, and New York, NY, USA. pp. 1-19.

20 IPCC (2007) [Parry, M.L, Canziani, O.F, Palutikof, J.F, Van der Linden, P.J. and Hanson C.E. (eds.)]: *"Summary for Policymakers"* in *"Climate Change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change".* Cambridge University Press, Cambridge, UK. p.14.

21 Kelemen, A. presentation : *"Climate change adaptation and infrastructure investment under cohesion policy"* at the 3rd meeting of the EPC-KBF Climate Change Task Force on "*Infrastructure: water, construction, energy and transport*". European Policy Centre, 10 May 2011, Brussels, Belgium.

22 European Commission (2009) *"White Paper on Adapting to climate change: Towards a European framework for action"*, COM 147 final, p.4.

23 IPCC (2007) [Parry, M.L, Canziani, O.F, Palutikof, J.F, Van der Linden, P.J. and Hanson C.E. (eds.)]: "*Summary for Policymakers"* in *"Climate Change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change".* Cambridge University Press, Cambridge, UK. p. 14.

24 *Ibid.*

25 *Ibid.*

same time, the tourism industry around winter sports in both Alpine regions and Northern Europe could suffer greatly from reduced snow cover.

Tourism is a good example of an economic activity that is highly dependent on other sectors such as ecosystems, water management, transport, construction, energy and land use. Should climate change affect these sectors negatively, it is likely to also have an impact on the attractiveness of the tourist destination.

The Arctic provides data for changes in climate and is an area where climate change has clearly transformed from theory into reality. This is an area where the warming of the climate could bring a significant boost to the economy and create possibilities for European actors. It would likely increase resource development – which is already seen in the oil companies' rush to explore the area – help to create new shipping routes, and at the same time support the Arctic's service and tourist industry. However, the negative impacts would be seen in the loss of Arctic species, habitats and possibly whole ecosystems.

1.3 NEED FOR MITIGATION

There is no longer any debate about whether climate change is happening: as described above, the evidence shows that global warming is a threatening reality. However, the complexity of the issue makes it difficult to assess and predict what influences what, and what the impacts of even a small increase in temperature could be on the world, its climate, ecosystems and human populations.

Nevertheless, it should be noted that the overwhelming majority of climate scientists agree that global warming can be attributed to the rise in greenhouse-gas emissions due to human activities such as fossil fuel consumption and deforestation.[26] There is also an understanding that should the global average temperature rise by up to 2°C relative to pre-industrial times, it would lead to significant negative impacts on ecosystems and water resources, and if the increase were more than 2°C, it could exceed the adaptive capacity of many systems. The alarming news is that the world is quickly heading towards a 2°C increase: so far the global average temperature has risen by 0.74°C since pre-industrial times: and at an increasing speed in the last 50 years.[27] As no-one knows where the tipping point is and what the full extent of the negative consequences may be, it would be economically, socially and environmentally too risky not to limit the main causes of warming.

As indicated by international climate negotiations, there is a worldwide understanding that the impacts of climate change can create a threat to ecosystems, citizens and their livelihoods, and thus more must be done to reduce greenhouse gas emissions at global level. The climate negotiations have continued to bring to the fore the need for global political, technological and financial action. In 1997 the Kyoto Protocol under the United Nations Framework Convention on Climate Change (UNFCCC) set up emissions reduction targets for 37 developed countries and the European Community, and in recent years much emphasis has been put on formulating a new policy for the post-2012 period.

[26] IPCC (2007) [Pachauri, R.K. and Reisinger, A. (eds.)]: *"Summary for Policymakers"* in "*Climate Change 2007: Synthesis report". Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC, Geneva, Switzerland. p.36.

[27] IPCC (2007): [Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B, Tignor, M. and Miller, H.L. (eds.)]: *"Summary for Policymakers"* in "*Climate Change 2007: The Physical Science Basis". Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change".* Cambridge University Press, Cambridge, UK and New York, NY, USA. p.2.

Unfortunately, however, progress has been slow and concrete measures have remained weak due to intellectual scepticism in the developed world, the short-sighted nature of policymaking versus the long-term implications of climate change, the initial investment required and a lack of buy-in and commitment from governments, the public and private sectors, and citizens. Much greater worldwide efforts are needed to mitigate climate change and limit greenhouse gas emissions in order to prevent future increases in global temperature.

The slow progress in international climate negotiations under the UNFCCC has emphasised the need for negotiations in other international forums that can encourage bilateral and regional action. For example, the European Union's 20/20/20 climate and energy targets for 2020 are an important starting point. These targets include improving energy efficiency by 20%, increasing the share of renewable energy in the EU's energy mix to 20%, and reducing greenhouse gas emissions by 20%, rising to 30% if the international conditions are right. These goals have also been incorporated into the 'Europe 2020' strategy for smart, sustainable and inclusive growth and into its flagship initiative 'Resource-efficient Europe'.[28]

Although this publication focuses on adaptation, it must be stressed that mitigation is essential and cannot wait. It should also be recognised that tackling climate change, for example through energy-efficient and low-emission solutions, can bring significant additional benefits immediately, ranging from economic stimulus and energy security to savings on health expenditure.[29] For example, meeting the 20% emission reduction target by 2020 could lead to annual health savings worth €52 billion, and if the EU's domestic target were to be increased to 30%, it could lead to additional savings of €10-30 billion per year.[30]

1.4 … AND ADAPTATION

While the need to reduce greenhouse-gas emissions grows ever more urgent, the reality is that even the best mitigation efforts will not stop heat waves, forest fires or floods, all of which already affect us today. Given the long time lag between mitigation measures and their effect on the climate, our efforts to reduce greenhouse-gas emissions must be coupled with adapting to a warming world.

In fact, whatever one may think about the causes of climate change and whether or not extreme events are caused by climate change, what matters is that when natural disasters or extreme weather events occur, we are prepared for them and can respond and adjust to their consequences. The importance of adaptation can no longer be ignored. To protect our societies, ecosystems, citizens and their livelihoods, we need to find ways to increase their resilience and to reduce their vulnerability to environmental disasters and extreme weather events. This can help to save money, but may also encourage the development of new solutions, for which there is a demand across the world. At its best, adaptation can provide a way to turn the climate challenge into an opportunity.

While the developed world has been slow to take adaptation seriously, it has become obvious that the developing world cannot afford to do that. Higher temperatures, changes in precipitation patterns, rising sea levels, and more frequent weather-related disasters pose risks for agriculture, food and water supplies, or in the case of small island states, to their very existence. These effects will be and are already being felt most strongly in the developing world. This explains why in the UNFCCC climate negotiations,

[28] European Commission (2010): "*Communication on: EUROPE 2020, A strategy for smart, sustainable and inclusive growth",* COM (2010) 2020.

[29] The EPC has produced also other publications on this topic. See e.g. Ahtonen, A., Chiorean-Sime, S. (2012): *"Green revolution: making eco-efficiency a driver for growth".* EPC Issue Paper No.68. Brussels, Belgium.

[30] Health and Environment Alliance (HEAL) and Health Care Without Harm Europe (HCWH) (2010): *"Acting now for better health – a 30% reduction target for EU climate policy"*. p.8.

countries that are especially vulnerable and already affected by the impacts of climate change are putting significant emphasis on adaptation and on the need for an international adaptation programme that clearly defines what adaptation activities will be supported and where the funding will come from.

The *Maldives*, as a low-lying country where land is scarce, is already greatly affected by the impacts of climate change today. Extreme winds and flooding pose serious risks to the country, and the sea level is predicted to rise within a range of 10-100 centimetres by the year 2100, which in the worst-case scenario would submerge the entire country. The Maldives has therefore worked hard to draw attention to both stopping climate change by reducing greenhouse gas emissions and the need to adapt to these changes. Nevertheless, although much can be done in the Maldives, it cannot do this alone.

Although this publication focuses on the adaptation efforts required in Europe and will not consider international climate negotiations, it is clear that in order for developing countries to adapt socially, technologically and financially to the potential impacts of climate change, they will need support from the developed world. Global efforts to mitigate climate change must be combined with cost-effective adaptation. If action is not taken now, the costs will keep on increasing. The World Bank has estimated that developing countries' cost of adapting to an approximately 2°C warmer world by 2050 could be in the range of 75 billion to 100 billion USD a year.[31]

As the costs of climate change increase in the developed world too, it is becoming clearer that the current practice of reacting to extreme weather events and environmental disasters after they have occurred and paying for the consequences later is no longer sustainable economically, socially or environmentally. The PESETA project, funded by the European Commission's Joint Research Centre, has assessed the impacts of climate change in Northern Europe, the British Isles, Central Europe North, Central Europe South, Southern Europe and in the following sectors: agriculture, human health, river basin flooding, coastal systems and tourism. According to the project, if the climate of the 2080s were to be seen today, without adaptation to climate change in these sectors, the annual damage to the EU economy in terms of GDP loss could be between 20 billion euros for a 2.5°C rise scenario and 65 billion euros for a 5.4°C scenario.[32] These costs would be greatly explained by damage to coastal systems, production losses in the agricultural sector, and damage to residential buildings due to river floods. In the worst-case scenario, annual welfare growth in the EU could fall from 2% to 1%.[33]

According to the study, increased river flooding due to climate change will affect between "250,000 and 400,000 additional people per year in Europe by the 2080s, more than doubling the number with respect to the 1961–1990 period".[34] The main areas affected would be Central Europe and the British Isles, and the additional economic costs would amount to between €7.7-€15 billion.[35] Depending on different scenarios for rising global sea levels – ranging from 48cm to 88cm by the end of the 21st Century – and in the absence of adaptation measures, the number of people affected by coastal floods per year in the 2080s could increase from 775,000 to 5.5 million people.[36] As for the health implications, estimates show that in the absence of adaptation, heat-related mortality (not including estimates for heat waves) could increase from 60,000 to 165,000 deaths, and cold-related mortalities between 60,000 and 250,000 per year by the 2080s.[37] The study is not comprehensive, as it does not take into account, for example,

---

31 World Bank (2009), Executive Summary : "*The Cost to Developing Countries of Adapting to Climate Change, New Methods and Estimates - The Global Report of the Economics of Adaptation to Climate Change Study*". World Bank. p.1.

32 Ciscar, J.C. (ed.) (2009), "Climate change impacts in Europe", Final report of the PESETA research project, The Joint Research Centre of the European Commission, p.91.

33 *Ibid.,* p.93.

34 *Ibid.,* p.19.

35 *Ibid.*

36 *Ibid.*

37 *Ibid.,* p.20.

impacts on transport, energy, forestry, biodiversity or major economic damage due to catastrophic events in Europe. However, it provides an important foundation for further studies. Also, while the PESETA study considered only a few adaptation measures, for example building dikes to protect coastal systems, it showed that the cost of climate change impacts can be significantly reduced with only a modest outlay on adaptation.[38]

Adaptation can include a broad range of measures, including policies, practices and projects, which aim to reduce the vulnerability of the economy and society to climate change, and implicitly the costs of climate-change impacts. Measures can include better preparation for disasters by, for example, organising awareness campaigns, transforming land use, moving homes away from coastlines and implementing early-warning systems, or creating protective infrastructure such as dams, dikes and sea walls. Adaptation can also include responses to direct effects or assistance with the recovery of economic, societal and natural systems. It should be stressed that a distinction is often made between 'hard' or 'grey', 'green' and 'soft' measures. Hard measures tend to be construction measures that use engineering services, green approaches contribute to increasing ecosystems' resilience and use the functions and services provided by them, and soft solutions help to enhance adaptive capacity by promoting behavioural changes, using emergency systems, and sharing information and building knowledge among citizens, policymakers and businesses.

While a number of possible adaptation measures will be explored in this paper under the chapters on agriculture and natural resources, health and well-being and infrastructures, it should be noted that adaptation measures are not and should not always be just about adaptation. The best measures bring greater value to the economy, society and the environment straight away. They may help to mitigate climate change, for example, via increased energy efficiency, or to increase resource efficiency via improved water efficiency. They may help to improve people's health or living environment. Although hard infrastructure projects will be needed, this paper hopes to also make the case for more innovative approaches to adaptation that can create immediate value for Europe.

In order to prepare for the impacts of climate change, the starting point must be to understand the key vulnerabilities in society within different regions and economic sectors. The European Commission's Vulnerability Index for regions is a move in the right direction.[39] It takes into account, for example, potential drought hazards and the vulnerability of fisheries, agriculture and tourism to temperature and precipitation changes. The results show that around 170 million people live in strongly affected regions and the impacts of climate change are very asymmetrical. It demonstrates that as a result, there is a strong need for regionally- and locally-tailored strategies.

At the same time, adaptation may also lead to difficult questions. For example, migration can be both a consequence of climate change as well as an adaptive measure. However, it is neither an easy nor necessarily a cost-effective form of adaptation. While the links between environmental changes such as floods or droughts and migration are complicated, and environmental changes per se do not necessarily lead to migration, they can have economic, social and political implications that increase migration. This raises the question of which migrants can be defined as climate refugees. Or – as in the case of Maldives – should a country become submerged by rising sea levels, where can its entire population move? What happens to countries that disappear, and what legal rights will their populations continue to be

[38] *Ibid.,* p.52-58.

[39] Commission of the European Communities (2008): Commission staff working document: *"Regions 2020: An assessment of future challenges for EU regions".* Available at http://ec.europa.eu/regional_policy/sources/docoffic/working/regions2020/pdf/regions2020_en.pdf, accessed on 9 September 2012.

granted?[40] How could such migration trends be managed while ensuring that host countries and regions can provide newcomers with food, water, energy and the relevant infrastructure?

EU member states have differed greatly in their responses to adaptation. They are at different stages of preparing, developing and implementing national adaptation strategies, with only 12 out of 27 having adopted national adaptation strategies at all.[41] In order to avoid and minimise climate-related losses in the future, adaptation must be taken seriously by all EU countries.

Although Europe's diverse climatic zones require different regional responses and different economic sectors demand tailored solutions, much more could be done to cooperate and to tackle these challenges together. The EU can play an important role in providing the impetus for action, and promoting coordinated, multi-sectoral and multi-level approaches, thus creating a basis for effective adaptation.

1.5 EU POLICY FRAMEWORK FOR ADAPTATION IN EUROPE

Although not well-known, adaptation is not a brand new topic in Europe. The European Commission's Green Paper in 2007[42] was followed by the White Paper on 'Adapting to climate change: towards a European framework for action'[43] and three sectoral papers on water, coasts and marine ecology;[44] agriculture[45]; and health issues[46] in 2009. In 2010 the European Parliament endorsed the White Paper while making a number of important observations, for example, about the lack of attention paid to transport sector and stressing the need to take into account the needs of more vulnerable people and ensuring that the EU's financial framework is in the line with addressing climate change impacts.[47]

The White Paper shows that adaptation measures are already being carried out in Europe, but in a fragmented and inconsistent manner. In order to ensure that such measures are effective, a more strategic approach should be adopted, encompassing all sectors and governance levels.[48] The White Paper describes the EU's Adaptation Framework as a two-step approach: "phase 1 (2009-2012) lays the ground work for preparing a comprehensive EU adaptation strategy, which is to be implemented during phase 2, commencing in 2013".[49]

---

40 See e.g. Gronewold, N.: *"Island Nations May Keep Some Sovereignty if Rising Seas Make Them Uninhabitable"*, *The New York Times* (25 May 2011). Available at www.nytimes.com/cwire/2011/05/25/25climatewire-island-nations-may-keep-some-sovereignty-if-63590.html, accessed on 17 August 2012.

41 The Country strategies can be accessed via the European Climate Adaptation Platform: http://climate-adapt.eea.europa.eu/web/guest/countries , accessed on 11th June 2012.

42 European Commission (2007): *"Green Paper on Adapting to climate change in Europe – options for EU action"*, COM (2007) 354 final.

43 European Commission (2009): *"White Paper on Adapting to climate change: Towards a European framework for action"*, COM 147 final.

44 European Commission (2009): *"Climate Change and Water, Coasts and Marine Issues"*. Commission staff working document accompanying the *"White paper: Adapting to climate change - Towards a European framework for action"*, SEC (2009) 386;

45 European Commission (2009): *"Adapting to climate change: the challenge for European agriculture and rural areas"*. Commission staff working document accompanying the *"White paper: Adapting to climate change - Towards a European framework for action"*, SEC (2009) 417.

46 European Commission (2009): *"Human, animal and plant health impacts of climate change"*. Commission staff working document accompanying the "*White paper: Adapting to climate change - Towards a European framework for action"*, SEC (2009) 416.

47 European Parliament resolution of 6 May 2010 on the Commission White Paper: 'Adapting to climate change: Towards a European framework for action' (2009/2152(INI)).

48 European Commission (2009): *"White Paper on Adapting to climate change: Towards a European framework for action"*, COM (2009), COM 147 final. p.3.

49 *Ibid.,* p.7.

The White Paper suggested 33 non-legislative actions, most of which are ongoing or have already been completed. The actions included strengthening the knowledge base on adaptation, facilitating the integration of adaptation into EU policies, exploring mechanisms to finance adaptation, and increasing international cooperation. The Commission's main emphasis has been on sharing information and trying to integrate adaptation into other policy areas, such as agriculture and regional policy. This is a start. However, as demonstrated in this paper, it is clear that much more could be done.

An important part of the package is the European Climate Adaptation Platform, a recently-launched online information portal, which provides users with access and the chance to share information on expected climatic changes in Europe, the current and future vulnerability of regions and sectors, national and transnational adaptation strategies, case studies and potential adaptation options and tools that support adaptation planning.[50] The portal is new and is naturally a work-in-progress. However, it should aim to become the main information tool for Europe, its regions and public and private actors.

In the European Commission, the creation of a Directorate-General for climate change (DG Climate Action or DG CLIMA) together with a unit for adaptation has laid the foundations for taking the issue of adaptation seriously, building expertise and exploring possibilities for EU action. The next important step will be the development of the EU's Adaptation Strategy, which is expected to be published in the beginning of 2013. It will build on the White Paper and the work of a group of experts, called the Steering Committee.

The development of the adaptation policy is also supported by the Europe 2020 Strategy, which puts a strong focus on climate action. While the main emphasis is on resource efficiency and mitigation, the European Commission has agreed to create a vision of the necessary structural and technological changes required in order to create not only a low-carbon and resource-efficient but also a climate-resilient economy by 2050. This will include looking at disaster prevention and response, and possibilities for cohesion, agricultural, rural development and maritime policies to support adaptation measures.[51]

In line with the political priorities outlined in the Europe 2020 Strategy, the assumption is that under the new Multiannual Financial Framework for 2014-2020, climate action and ensuring climate resilience across key sectors will be promoted in all relevant EU programmes, including cohesion, energy, transport, and research and innovation.[52] Hopefully this objective will not be undermined by ongoing budget negotiations and practice.

Although most action on climate-change adaptation will need to be taken at national, regional or local level, there are compelling reasons why the EU should also play a role. Firstly, the EU can do more to gather and share knowledge on the impacts and risks of climate change, as well as on best practices and easily applicable cost-effective solutions for adaptation. Secondly, as events such as floods can have cross-border consequences for the natural environment and for people's lives and livelihoods, the EU can help to coordinate national activities that have an impact on, for example, river basins or cross-border infrastructures. Thirdly, the EU can use legislation and targets to mainstream both mitigation and adaptation efforts in its other programmes and policies too. Fourthly, it can help to ensure that vulnerable regions and people are capable of taking the necessary adaptation measures, and that adaptation goes beyond big infrastructure projects and providing solutions for the wealthy. Lastly, the EU

[50] Climate change adaptation in Europe. European Climate Adaptation Platform: http://climate-adapt.eea.europa.eu/, accessed on 17 August 2012.

[51] European Commission (2010): "*Communication on: EUROPE 2020, A strategy for smart, sustainable and inclusive growth".*COM (2010) 2020. p. 16.

[52] European Commission (2011): "*Communication on: A Budget for Europe 2020 - Part II: Policy fiches"*, COM (2011) 500 final, Part II. p.13.

can play an important role in providing funding for adaptation projects as well as post-disaster financial assistance, which should be based on clear criteria.

The EU's current and possible role in adaptation efforts in Europe will be explored further under the sectoral chapters on agriculture and natural resources, infrastructures, health and well-being, and financing adaptation. These chapters will also make recommendations for action at EU level that can support and underpin local, regional, sectoral and national efforts on climate-change adaptation.

Chapter

2

AGRICULTURE AND NATURAL RESOURCES

2.1 IMPACTS OF CLIMATE CHANGE ON AGRICULTURE AND NATURAL RESOURCES

The steady change in Europe's weather patterns over the past decades has had significant consequences for agriculture, food security and the sustainability of our natural resources. Europe's forests, farmlands, oceans and waterways are extremely vulnerable to atmospheric changes such as air temperature and rainfall, carbon dioxide levels and ground-level ozone. Any climate-change impacts on these ecosystems will have knock-on effects for habitats, animal health, crop yields, plant diseases, pests and fish populations, and in the end on people's well-being.

Agriculture, which depends directly on climatic conditions, has been among the first sectors to experience the impacts of climate change. It has become obvious that, for example, the following changes can influence agricultural productivity:

- Rising temperatures can lengthen the growing season in regions with a relatively cool spring and autumn, adversely affect crops in regions where hot summers already limit production, increase soil evaporation rates, and increase the chances of severe drought.
- Changes in rainfall quantities and patterns affect soil erosion rates and soil moisture, both of which are important for crop yields.
- Increased atmospheric concentrations of CO2 can act as a fertiliser and enhance growth of crops such as wheat, rice and soybeans.
- Higher levels of ground-level ozone limit the growth of crops, potentially offsetting the benefits of the fertilisation effects.
- Finally, changes in climatic variability and extreme events such as heat waves, drought, floods and hurricanes multiply the impacts of the mentioned changes on crop yields and livestock.

It is well established that there will be significant regional differences in the impacts of climate change on agriculture and natural resources. While some aspects of climate change may bring benefits in some regions, the net effect is expected to be negative.[1]

Northern, central and continental northern zones will face increased risk of winter flooding, accompanied by hotter and drier summers and influxes of new pests and diseases. This may increase the productivity of some crops and even allow new crops to be introduced to these areas, but the benefits will only be felt if there is sufficient water available. In mountainous regions, particularly in the Alps, loss of snow and ice is very likely to accelerate and may have further impacts on hydrological cycles in river basins. Central European countries like Hungary are also likely to be affected by decreases in summer precipitation and may also face problems of soil erosion, while coastal areas will experience the impacts of sea-level rises, resulting in an increased risk of flooding and salination damage to farmland.

In the south of Europe, meanwhile, severe droughts and water shortages are already visible and the pace of change is accelerating. A study commissioned by the German Federal Environment Agency on regional climate impacts predicts that by 2030, Spain will experience a decrease in water resources in several main river basins of 4-14%. By the year 2080, 14-38% of the Mediterranean population could be living in catchments with increased water stress, while in Greece, the return period of a 100-year drought might decrease to 10-40 years by the end of the century.[2] The PESETA study shows that the impact of these changes on certain crop yields by 2080 would be catastrophic for some southern regions, where enduring changes in climate, water supply and soil moisture could make it impossible to continue crop production.[3]

The potential impacts of climate change on agriculture and natural resources can be roughly divided into two groups: biophysical and socio-economic impacts.

Biophysical impacts

Biophysical impacts include effects on agricultural production (crops and livestock), water, soil, wildlife, forests and marine ecosystems. The expected risks in relation to each of these areas are outlined below.

The impact of climate change on crop yields is a key issue for agriculture. At the same time it must be acknowledged that not all farmers have necessarily yet felt these impacts, as over the past 40 years, technological improvements and climate variability have driven a steady increase in yields.[4] However, according to the projections of the PESETA project, which examined the short and long-term impacts of climate change, yields may be reduced by as much as 30% in Southern Europe by 2080.[5] Moreover, the fact that the study did not take into account the adverse effects of unexpected or extreme weather events means that even this projection may be optimistic.

Unsurprisingly, climate change is likely to have a significant impact on the geographical distribution of agro-climatic zones, leading to the loss of some indigenous crop varieties, regional shifts in farming

1 European Commission's assessment of the situation available at http://ec.europa.eu/agriculture/climate-change/index_en.htm, accessed on 11 June 2012.

2 Leipprand, A., Dworak, T., Benzel, M., Berglund, M., Kadner, S., Hattermann, F., Post, J. and Krysanova, V. (2008): *"Impacts of climate change on water resources – adaptation strategies for Europe"*. Ecologic and Potsdam-Institute for Climate Impacts Research on behalf of German Federal Environment Agency. p.ii.

3 Ciscar, J.C. (ed.) (2009): "*Climate change impacts in Europe"*, Final report of the PESETA research project, The Joint Research Centre of the European Commission. pp 39-42.

4 Rosenzweig, C., Parry, M.L, Fischer, G., and Frohberg, K. (2003): *"Climate change and world food supply"*. Research Report No. 3, Environmental Change Unit Oxford, UK. Available at www.ciesin.org/docs/004-046/004-046.html, accessed on 12 June 2012.

5 Iglesias, A., Garrote, L., Quiroga, S. and Moneo, M.(2009): *"Impacts of climate change in agriculture in Europe"*. PESETA-Agriculture study. Office for Official Publications of the European Communities, Luxembourg. pp 31-32. Available at http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=2900, accessed on 12 June 2012.

practices and shifts in optimal conditions for pest species and disease types. The quality and variability of perennial cultivations such as wine and olives will be severely affected by extreme events such as storms and droughts, and the suitable areas for these crops may move north and eastwards. Indeed, one study estimates that agro-climatic zones have already moved 250km northwards over the past two decades.[6]

Climate change affects livestock productivity both directly and indirectly. The climate determines the type of livestock most adapted to different agro-ecological zones and therefore the animals that are able to sustain rural communities. Changing climate patterns may have serious consequences for health, growth and output, the spread of disease and the productivity of pastures and forage crops. Again, due to the diversification of production systems, the impacts will vary greatly across the EU. The humid regions of the north and west are expected to see increased productivity, while in the south, shorter grazing periods and reduced quantities of forage are likely.

The water cycle and water resources have always been at the centre of climate-change policies. The European Commission estimates that by 2007, at least 11% of Europe's population and 17% of its territory had been affected by water scarcity,[7] and the situation is expected to deteriorate as temperatures keep rising and rainfall patterns become less predictable. Water concerns have already grown from an isolated issue affecting just a few regions into one that affects the whole of the EU. Changes in temperature, river flows and groundwater recharge, floods and droughts, a rise in the sea level by as much as five metres,[8] the salination of groundwater and estuaries, coastal erosion and increased pollution are all affecting water resources.

Climate change is expected to lead to major changes in water availability across Europe, due to less predictable and more intense storms. This will result in increased water scarcity, especially in Southern Europe, and an increased risk of flooding throughout much of the continent. The resulting changes will affect many land and marine regions and many different natural environments and species.

These changes can have adverse effects on the quality, security and distribution of drinking water. They carry significant risks for aquatic ecosystems, resulting on the one hand in the loss of some species and on the other in rising numbers of pests and invasive species. Changes in global ocean circulation patterns, sea-level rises and ocean salinity affect the biological properties and distribution of species, which will have a significant impact on fisheries, for example. Many protected areas may be put at risk, such as wetlands, and a northward movement of eco-regions is to be expected. Increased water scarcity will lead to soil degradation, which poses a major threat to the sustainability of Europe's land resources and may impair European agriculture's ability to successfully adapt to climate change. Increased salinity may result in land being abandoned as it becomes unsuitable for crops. In addition, competing demands for this essential resource will put more pressure on the agricultural sector to explore more efficient irrigation practices.

Soil provides food and storage, helps to filter substances such as water, carbon and nitrogen, provides raw materials and serves as a platform for human activities. For soil, the major risks include erosion, degradation of soil quality, groundwater depletion, pollution during flooding, loss of organic matter with

---

6 European Commission Information Centre, Research and Innovation: "*Adapting to changing climate proving tricky for Europe's birds"*, available at: http://ec.europa.eu/research/infocentre/article_en.cfm?id=/research/headlines/news/article_12_01_20_en.html&item=Infocentre&artid=23573 , accessed on 12 June 2012

7 European Commission – Environment: *"Water Scarcity and Droughts in the European Union"*. Available at http://ec.europa.eu/environment/water/quantity/scarcity_en.htm, accessed on 12 June 2012

8 Iglesias, A., Avis, K., Benzie, M., Fisher, P., Harley, M., Hodgson, N., Horrocks, L., Moneo, M. and Webb, J. (2007): *"Adaptation to climate change in the agricultural sector"*. AEA Energy and Environment, Report to the European Commission Directorate-General for Agriculture and Rural Development. p iii.

an impact on the carbon footprint, food price variability, landslides and natural disasters. Unfortunately currently only nine EU member states have adopted specific legislation on soil protection, which demonstrates weak recognition of soil's importance in Europe.

Wildlife can be affected by biodiversity loss, threats to the food chain, and fragmentation and the disappearance of habitats. Climate change may also result in the spread of species with no more natural enemies. For example, a recent study funded under the EU's FP7 programme found that temperature increases are already making life non-viable for certain species of bird and butterfly, which thrive in cool climates. Yet while butterflies have adapted quickly to this situation and have moved on average 114km further north, birds have only moved 37km northwards.[9] This could have worrying consequences for the delicate balance of natural ecosystems, as caterpillars and insects in general represent an important source of food for many birds and could proliferate if their predators do not move at the same speed.

Regarding forests, the first impacts of climate change are already visible in the form of increased severity and frequency of forest fires, damage caused by storms, altered seeding times and more outbreaks of pests and disease. Deforestation, whether or not caused by climate change, has devastating effects on soil fertility and biological diversity. Its effects are worrying for agriculture, as trees and forests play a crucial role in ensuring the sustainability of agricultural production by buffering winds, regulating the water table, providing shade for crops and animals, and stabilising coastal areas.

Marine ecosystems have already been affected by climate change too. Changes in sea temperatures have led to changes in the availability of plankton, which is the main source of food and thus a key part of the marine food chain.

Socio-economic consequences

The socio-economic consequences of these impacts are significant. Without adaptation, increasing variability of crop yields and agricultural production will result in price volatility, reduced marginal GDP from agriculture, risks for farm income and farm infrastructure, and growing disparities between regions. Climate change will add to other socio-economic pressures in rural areas, as mounting difficulties for farmers and more job losses may provoke the abandonment of land and the countryside and the loss of specialised knowledge and know-how, given younger generations' lack of interest in taking over. The most deprived communities are likely to bear the brunt of adverse changes. In the medium to long term, the impacts could lead to increased food insecurity and potentially even to migration and civic unrest in Europe.

It should also be noted that the growing world, and especially middle-class, population increases demand for global food production. As the consequences of climate change can have devastating impacts on the agricultural sector worldwide, without adaptation, the sector in the EU and outside its borders will face a serious challenge to meet these demands, and this can be expected to result in rising agriculture costs.

It is worth emphasising here that a complete no-adaptation scenario is quite unrealistic. The historical success of farmers, fishermen and local communities in coping with the vagaries of climatic patterns is testimony to the human capacity to adapt. Farm-level analyses have shown that large reductions in the

[9] European Commission Information Centre - Research and Innovation: "*Adapting to changing climate proving tricky for Europe's birds".* Available at: http://ec.europa.eu/research/infocentre/article_en.cfm?id=/research/headlines/news/article_12_01_20_en.html&item=Infocentre&artid=23573, accessed on 12 June 2012.

adverse impacts of climate change become possible when adaptation is fully implemented.[10] Several examples, such as the rapid increase in the production of quality sparkling wine in the south of England, demonstrate that autonomous farm-level adaptation and building on the possibilities created by climate change is already happening.

There are further grounds for optimism. Effective climate-change adaptation policies are feasible, available and can be connected to many existing policy frameworks. Moreover, as the final section of this chapter will consider, adapting to climate change also presents many opportunities. If managed correctly, the adaptation process can bring benefits that reach far beyond specific climate issues, enabling communities to become more resilient to multiple hazards and promoting a balanced and sustainable approach to resource management. However, much depends on how all this is implemented. Action must be taken urgently, and the window of opportunity is small.

2.2 CURRENT ADAPTATION EFFORTS IN EUROPE AND THE FRAMEWORK FOR ACTION

Adaptation initiatives at national, regional or local level

As demonstrated above, adaptation will be needed in a variety of ecosystems, including agro-ecosystems (crops, livestock, grasslands), forests and woodlands, inland waters, and coastal and marine ecosystems. Due to the varying severity and nature of climate impacts among Europe's regions, most adaptation initiatives will be taken at national, regional or local level.

At farm level, farmers are already putting in place a range of measures to cope with these impacts, such as changing their crop rotation to make the best use of available water, adjusting sowing dates according to temperature and rainfall patterns, using crop varieties better suited to new weather conditions and which are more resilient to heat and drought, and planting new hedgerows to reduce water run-off and act as wind-breaks.[11]

However, farm-level adaptation alone will not address all the related challenges, and may even be counterproductive. For example, farmers' shift to animal breeds or varieties that can better resist changing conditions may have adverse effects in terms of CO2 emissions, for example. Increased use of pesticides to respond to the proliferation of pests could reduce soil quality, provoking landslides and floods, and consequently leading to the destruction of farming/natural infrastructure and resources.

Although most adaptation measures will be carried out at farm level, member states and regions can provide incentives to change farming practices, land use and landscape management. It is important for the policies to contribute to protecting the ecosystems as a whole.

In *Belgium*, a number of measures are in place to encourage farmers to take environmental and climatic aspects into account. Financial support is available for investments related to building adaptation, reassessment of water and waste systems, the prevention and erosion of land, and the maintenance of

[10] Mendelsohn, R. and Dinar, A. (1999): *"Climate Change, Agriculture, and Developing Countries: Does Adaptation Matter?"*. The World Bank Research Observer, Vol.14.Number2. pp 277-293. Available at www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2000/08/04/000094946_00050105301141/Rendered/PDF/multi_page.pdf, accessed on 10 September 2012.

[11] European Commission: *"Agriculture and Climate change".* Available at http://ec.europa.eu/agriculture/climate-change/index_en.htm, accessed on 12 June 2012.

soil hummus content. The underlying goal of the Belgian Agricultural Programme, to maintain the carbon content of agricultural land, serves both mitigation and adaptation objectives.[12]

In *France* two complementary options are promoted in order to prepare for increased scarcity of water: reducing water requirements for crops and improving the efficiency of resource use. Two financial initiatives support farmers in their preparation for climate hazards: the development of insurance mechanisms, and the creation of a mutual fund to compensate farmers in the event of outbreaks of animal or plant diseases or environmental disasters.[13]

A range of projects, studies and action plans are carried out and have been published in Europe, providing valuable data to support policymaking on adaptation. Member states and regional authorities should study and utilise these projects and findings when working on their own vulnerability assessments and adaptation strategies. Learning from each other and sharing best practices is the key to building efficient adaptation strategies.

CARAVAN, *an online mapping tool*, helps to describe the vulnerability of agricultural livelihoods and adaptive capacity in the Nordic region.[14]

The Circe project considers impacts and possible adaptation actions in the Mediterranean region. It aims to: 1) predict and quantify physical impacts of climate change in the Mediterranean area; 2) evaluate the consequences of climate change for society and the economy; 3) develop an integrated approach to understanding the combined effects of climate change, and; 4) identify adaptation and mitigation strategies in collaboration with regional stakeholders. Much attention is naturally given to adapting agriculture, forests and ecosystems.[15]

The *Finnish Ministry of the Environment* has published an updated Action Plan, which promotes concrete adaptation measures with a focus on biodiversity, land use and construction, environmental protection and the use and management of water resources. A major focus is to integrate adaptation into land use and community planning. Much of the practical implementation in this regard takes place in regions and municipalities, especially with regard to spatial planning at different levels. Preparation for protecting against the impact of flooding on properties and functions vital to society in flood-risk areas, in areas that are being planned, and particularly in areas that have already been built up, is an important part of this work.[16]

Adaptation at EU level

The White Paper on 'Adapting to Climate Change', accompanied by sectoral working documents on water, coasts and marine issues, and agriculture have considered the key sectors for action. As reflected in the working documents, these are sectors that can be greatly affected by climate change and which would benefit enormously from adaptation. For the EU, one of the best ways to ensure that climate-

12 National Climate Commission (2010): *"Belgian National Climate Change Strategy"*. Available at www.climat.be/IMG/pdf/NASpublicatiedruk.pdf, accessed on 10 September 2012.

13 French Ministry of Ecology, Sustainable Development, Transport and Housing (2010): *"French National Climate Change Impact Adaptation Plan: 2011-2015"*. p. 34 available at www.developpement-durable.gouv.fr/IMG/pdf/ONERC_PNACC_Eng_part_1.pdf, accessed on 10 September 2012.

14 Caravan: *"Climate change : A regional assessment of vulnerability and adaptive capacity for the Nordic countries":* www.iav-mapping.net/CARAVAN/CARAVAN.html, accessed on 10 September 2012.

15 Circe Project: www.circeproject.eu/, accessed on 10 September 2012.

16 Finnish Ministry of the Environment (2011): *"Adaptation to Climate Change in the Administrative Sector of the Ministry of the Environment - Action Plan Update for 2011–2012"*. Available at www.ymparisto.fi/download.asp?contentid=130689&lan=en, accessed on 10 September 2012.

change adaptation is supported in these sectors is to mainstream it into relevant policies, and this work is slowly progressing.

The Common Agricultural Policy (CAP) contains aspects that contribute to adaptation. The 2003 CAP reform introduced the cross-compliance mechanism, which links direct payments to compliance by farmers with basic standards regarding the environment, food safety, animal and plant health, and animal welfare, as well as a requirement to keep land in good agricultural and environmental condition (GAEC).

The introduction of the cross-compliance mechanism was accompanied by an obligation for member states to set up a Farm Advisory System (FAS)**.** The precise composition and mandate of each FAS varies from country to country, but the core aspect is to help farmers understand and meet EU rules on the environment, public and animal health, animal welfare and the GAEC, and provide advice on adaptation measures.

Furthermore, the rural development measures under the first and second pillars of the CAP offer several opportunities to promote adaptation. For example, funding can be provided for flood and drought prevention/protection measures, preventing natural disasters, and restoring agricultural and forestry production damaged by extreme events.

The Commission's proposal for the CAP post-2013 would greatly increase opportunities for the policy to contribute to climate adaptation. According to plans currently on the table,[17] 30% of direct payments to farmers available under the first pillar of the reformed CAP would be made conditional on 'greening'. The requested measures, for example diversifying cultivation by growing at least three crops on arable land and maintaining an "ecological focus area" of at least 7% of farmland through field margins, hedges, trees and forested areas, would also act as adaptation measures. It is naturally important that adaptation does not mean a blank cheque, but that there are clear criteria on which adaptation projects are supported and under what conditions.

Similarly, current plans to reform the Common Fisheries Policy[18], which would limit available financial support to only environmentally-friendly initiatives that contribute to smart and sustainable growth, could be harnessed to support climate adaptation measures. The overall budget for both the reformed CAP and the CFP will ultimately be decided in separate talks between EU governments on the Multiannual Financial Framework for 2014-2020.

As regards the development of policies to adapt to the impact of climate change on water, there are several key pieces of EU legislation. First, the Water Framework Directive[19] (WFD) adopted in 2000 provides the overarching legislative architecture for EU policies dealing with this precious resource. Based not on national or political boundaries, but on natural geographical and hydrological formations such as river basins, it requires coordination of different EU policies and sets out a precise timetable for action, giving 2015 as a target date for getting all European waters in good condition.

Second, the EU Directive on Flood Risk and Prevention[20] stipulates that projected climate change should be taken into account in assessments of future flood risk. Modelled on the WFD, the EU Marine Strategy

---

17 European Commission (2011*): "Proposal for a Regulation of the European Parliament and of the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy.* COM/2011/0625 final.

18 European Commission (2011): *"Proposal for a Regulation of the European Parliament and of Council the on the Common Fisheries Policy"*, COM/2011/0425 final.

19 Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy.

20 Directive 2007/60/EC of the European Parliament and of the Council on the assessment and management of flood risks.

Framework Directive[21] (MSFD) aims to protect and preserve the marine environment, prevent its deterioration and restore marine ecosystems. To achieve these objectives, member states have to adopt programmes of measures to achieve good environmental status by 2015. The MSFD makes direct reference to the impact of climate change on the marine environment and the necessity to adapt. It recognises climate change as a factor that influences marine ecosystems, in addition to the natural variability and changing patterns of human activities.

In addition, the Water Scarcity and Droughts Communication[22] outlines the way forward both at national and EU level, including better water pricing policies, allocating water and water-related funding more efficiently, and fostering water efficient technologies and practices. Since adaptation to climate change will in many cases be equivalent to coping with intensified water scarcity, the policy options outlined in the Communication can be considered important tools for climate change adaptation.

The EU has adopted also a number of other policies and initiatives that recognise the importance of maintaining and restoring healthy and resilient ecosystems. Examples include directives on protecting birds[23] and habitats[24], the European Commission's Thematic Strategy for Soil Protection,[25] and a recent Commission report looking at soil degradation trends, future challenges to protect soil and its own actions in this regard[26]. The challenge with policies and initiatives such as these is that they are sectoral. In order to encourage cross-sectoral adaptation, they would need to be integrated more effectively. At the same time, progress on implementing these initiatives has been slow, and it is becoming questionable how healthy ecosystems are and whether they can continue to adjust to changing conditions.

At its best, the EU-level framework on adaptation could bring great added value in promoting a strategic, coordinated and multi-sectoral approach that ensures resilience to climate change, economic and social viability, and coherence with environmental objectives. However, action is urgently required given the considerable efforts needed to prepare for climate-related impacts and the time required for economic sectors such as agriculture, forestry and fisheries to adapt to these changes. If correctly implemented, climate-change adaptation can present significant opportunities.

2.3 POTENTIAL OPPORTUNITIES FOR GROWTH AN INNOVATION

The basis of the EU approach should be to build up resilience to multiple hazards/risks at individual, household, community, local, national and international levels, and thus reduce negative impacts on the economy. Smart adaptation of our natural and agricultural resources to the possible impacts of climate change promotes sustainability, is far-sighted, supports regional cohesion and social equity, increases variability and diversity, encourages innovation, and improves the EU's competitiveness and international relations. For example, drought-resistant crops and smart irrigation technologies are not only possibilities for Europe, but can have significant export potential. It should also be noted that warming may create possibilities for regions in Northern Europe, which could benefit from rising food production.

[21] Directive 2008/56/EC of the European Parliament and of the Council establishing a framework for Community action in the field of marine environmental policy.

[22] European Commission (2007): *"Communication on addressing the challenge of water scarcity and droughts in the European Union"*. COM(2007) 414 final.

[23] Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds.

[24] Council directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.

[25] European Commission (2006): *"Communication on Thematic Strategy for Soil Protection.* COM(2006) 231.

[26] European Commission (2012): *"The implementation of the Soil Thematic Strategy and ongoing activities"*. COM/2012/046 final.

Taking adaptation measures with 'no regrets' would help to harness win-win opportunities while adapting to climate change, creating climate-resilient ecosystems, promoting more sustainable use of resources, saving costs, and possibly even triggering growth. Such measures help to increase resilience and can be justified from economic, social, and/or environmental perspectives, whether natural hazard events or climate change take place or not.

Increasing irrigation as a result of drought and increased temperature, for example, is not a sustainable adaptation measure, as in the long-term it will put additional pressure on water resources. In contrast, adapting to droughts requires more efficient and sustainable use of water. Using technologies for automated irrigation and developing systems for rainwater storage and use are not just examples of adaptation measures. They contribute to more sustainable use of resources, leading to savings in the long term as the price of water increases. They are examples of innovative solutions, for which there is a market both within and outside the EU. They bring benefits to society as a whole. Innovative solutions to support adaptation can range from new products and technologies to new practices like consulting services.

Technologies such as *satellite-borne sensors* can play an important role in monitoring the climate and forecasting changes to the climate and the environment, while *satellite communications* can be used to locate survivors, prepare rescue teams and provide a means of communication when land-based systems have been damaged.

A number of exciting new products which enable farmers to adapt more effectively to climate change are currently under development. For example, farmers have long used instruments called tensiometers to set *irrigation* frequencies and to assess the depth of water penetration. However, in the future, irrigation scheduling could be based on remote sensing, whereby digital-spectral data on the rate of evaporation and the level of soil moisture content is regularly collected, and irrigation only triggered when absolutely necessary.

In the region south of German capital Berlin, the *Berlin Utility for Water Supply and Sewage Treatment and Disposal (BWB)* discharges some treated wastewater into former drainage ditches. The water is then further directed via ditches and canals to the River Dahme, upstream of Berlin. It thereby passes greenland and peat land, improving their hydrological situation by partly infiltrating into the soil. There also have been positive side-effects as the lowland peat land is re-established as a CO2 sink, thus mitigating climate change, and conditions for animals and plants that favour humid locations in the lowlands have been improved.[27]

Aguas de Barcelona (AGBAR) (Gas, Water and Multi-utilities) invests in adaptive measures through its Water Technology Center (CETaqua). The company *researches and develops methods and tools* for managing flood risks, to combat droughts and to analyse the environmental impact of generated water and the rainfall cycle. This includes evaluations of the medium- and long-term impacts of global change more broadly. The company is also working on a research project related to assessing the climate resilience of water resources and water-supply infrastructure. The objective is to estimate the capacity of current infrastructure to adapt to climate change, and to define how to advance infrastructure that takes climate change into account. Thus CETaqua provides guidance in a broad spectrum to apply cost-efficient adaptation measures.[28]

[27] BWB (2009): *"Water for Berlin".* p.4. Available at www.bwb.de/content/language2/downloads/info-engl-09.pdf, accessed on 10 September 2012.

[28] Park, J. (project manager) (2012): *"Business and climate change adaptation: toward resilient companies and communities"*. United Nations Global Compact. pp 16-18. Available at www.unglobalcompact.org/docs/issues_doc/Environment/climate/Business_and_Climate_Change_Adaptation.pdf, accessed on 10 September 2012.

However, when developing and deploying new solutions, it is important to consider wider social, economic and environmental impacts too. Adaptation efforts should always be based on avoiding unwanted consequences.

Developing products such as heat and drought-resistant seeds could contribute greatly to adaptation efforts. However, the development and uptake of *Genetically Modified Organisms (GMOs)* in particular must be based on evaluating and understanding their implications for ecosystems and human health. The debates and studies must continue in order to ensure that using new agricultural products, such as GMOs, does not disrupt the balance of ecosystems or pose threats to human health.

A caravan park in the East Riding Coastal Zone (England) has one of the fastest-eroding coastlines in North-West Europe. The coastline is one of the region's key environmental assets and the caravan park is an important tourist destination. Given the need to adopt a sustainable approach to maintaining the viability of the caravan industry on this coastline, the concept of "rollback" was developed by the local authority, the Environment Agency and caravan park owners. Rollback looks at how caravan parks can physically move further inland away from the threat of coastal erosion whilst improving the quality of the local environment and sustaining the communities which are dependent on coastal tourism. Partners such as the Local Planning Authority have looked at the implications of re-locating the parks, and have developed guidelines, standards and policies within which moves can be made.

Moreover, it should not be forgotten that nature itself can support adaptation measures. One example would be to plant trees on slopes, which would help to reduce landslide and flood risks. Another would be to manage land and soils in agriculture and forestry so that they can store large quantities of water during intense precipitation events. It is good to note that genetically-diverse populations and species-rich ecosystems have greater potential to adapt to climate change. Thus adaptation strategies and efforts should aim to boost natural defences and promote greater biodiversity.

For example, the adaptive management of *forests* could contribute to sustaining the livelihoods of over two billion people worldwide.[29] Trees and shrubs in farming systems (including agroforestry) can play a significant role in promoting adaptation to the impacts of extreme events and the resulting threats to food security. In addition, reforestation, using the appropriate species, could bring benefits such as the provision of wood and non-wood forest products, the restoration of soil fertility, and the conservation of biological diversity.

Conservation agriculture and organic agriculture that combine zero or low tillage and permanent soil cover offer promising support for adaptation efforts. Such methods reduce mineral fertiliser use, reduce on-farm energy costs and increase soil organic carbon. The improved soil matter performs better in the event of flooding and water scarcity. Increased carbon content improves and stabilises the soil structure so that it can absorb larger amounts of water without causing surface run-off, which could result in soil erosion and, further downstream, in flooding. Soil organic matter also improves the water absorption capacity of the soil during periods of extended drought.

With total funding of up to €70 million, authorities in the province of Ter Heijde in South Holland deposited a large amount of *sand* off the coast, in order for a natural coastline to grow. These 'mega-nourishments' gradually create new dune formations, adding an extra buffer for communities living close

[29] FAO (2007): *"Adaptation to climate change in agriculture, forestry and fisheries: Perspective Frameworks and priorities"*. p.13. Available at ftp://ftp.fao.org/docrep/fao/009/j9271e/j9271e.pdf, accessed on 10 September 2012.

to the sea and additionally attracting surfers to the tourism industry, as the new dune formation creates almost perfect waves to surf.[30]

Natural Economy Northwest recognised that *ecosystem services* support social, cultural and economic prosperity, and these should be valued. Some of the economic benefits of green infrastructure are that it reduces pollution (which leads to asthma and heart disease), counters hot summer temperatures in cities, and acts as drainage and flood defence. Green spaces near workplaces reduce sickness and absences, thus increasing productivity, and it is notable that natural landscape views can add up to 18 % to property values.[31]

2.4 RECOMMENDATIONS

The environment consists of interlinked ecosystems and resources, where a small change in one ecosystem can have a domino effect on other resources and other ecosystems. Thus within the agricultural sector and with natural resources, better risk-management approaches are needed to encourage **integrated and coordinated adaptation efforts**. The EU, member states, businesses, and regional and local actors can help to promote consistency between measures, avoid conflicts and make use of synergies. A good example is adapting to water scarcity with measures that reduce water consumption and use water more efficiently. The aim must be to promote 'no regret' adaptation efforts that deliver benefits no matter what the climate scenario. At its best, adaptation can contribute to creating climate-resilient ecosystems, promote more sustainable use of resources, and trigger growth by offering new business opportunities.

Adaptation efforts would benefit from **increased monitoring** of environmental catastrophes and changing weather patterns. This must not be limited to Europe, because for example the impacts on water resources outside the EU can also affect it, and thus require careful monitoring and assessment. The European Climate Adaptation Platform, for example, could benefit from information provided by European satellite technology, and it could become the main platform for sharing this information with member states.

At the same time, **further research** is needed to fill the knowledge gaps and to better understand regional and sectoral climate-change impacts, as well as the costs, benefits and effectiveness of adaptation measures. In order to improve the climate change resilience of the communities, services, utilities and businesses that are dependent on ecosystem services, their vulnerabilities and resilience must be examined. Matching available maps of vulnerable regions and areas with economic activities could also help with preparation. Climate change could have tremendous impacts on the mining sector and landfills if no risk assessments are carried out before their development.

More **innovative approaches to adaptation** are also needed in the agricultural sector. Partnerships and cooperation between local authorities, farmers and the private sector can play a major role in promoting innovative adaptation, and these need to be encouraged.

It should be recognised that demand for new adaptation technologies, services and products, such as new crops – also outside the EU – can be a source of growth and create new business opportunities. Thus it is

[30] European Commission (2010) - Climate Action*: "Case study: The Hague's sand engine"*. Available at*:* http://ec.europa.eu/clima/sites/change/how_adapt_to_climate_change/coasts_en.htm, accessed 20 July 2012.

[31] European Environment Agency (EEA) (2012): "*Urban adaptation to climate change in Europe - Challenges and opportunities for cities together with supportive national and European policies".* Office for Official Publications of the European Union, Luxembourg. p.84.

essential for the EU and its member states to work to create a functioning **internal and external market** for new and old innovative solutions.

The EU institutions, including the European Commission, member states, regional and local authorities, and private-sector actors should contribute to **raising awareness and communicating** about the impacts of climate change, as well as the short and long-term benefits and importance of adaptation to each other as well as for farmers and citizens, thus preparing the ground for political decisions. They must share knowledge and expertise between one another about the necessary changes to infrastructures, processes and land use, and about possible funding, products and services in pro-active adaptation. If these measures do not prove to be enough and consequently some farmland is abandoned, it should be ensured that specialised know-how is not lost and attention is paid to the countryside's viability, condition and shape in future. The EU institutions can naturally play an important role in creating communication channels between key stakeholders in the EU and also share good practices from outside the continent. The European Climate Adaptation Platform should become a key communication channel for the EU.

The EU should ensure that **economic incentives and regulation** push member states to take adaptation seriously. At the same time, EU legislation must become more integrated and flexible, thus providing the foundations for efficient adaptation efforts. The starting point must be to give ecosystem services and natural resources a value. The Common Agricultural Policy (CAP) should become an instrument that promotes behavioural change among farmers and rewards forward-looking actions. It should reflect clearly the EU's mitigation and adaptation objectives and could, for instance, discourage farmers from setting up farms in risky areas. Also cohesion policy can be used to support and steer adaptation efforts. It should pay specific attention to tackling regional differences due to different levels of risk or adaptive capacity.

As water is a key element within ecosystems and its availability and quality can be greatly affected by climate change, the EU must work together on a **long-term water strategy**. The expected Blueprint to Safeguard Europe's Water must take into account current and expected climatic challenges and aim to strengthen the sector's resilience to them. Solutions for more sustainable use of water range from land and wastewater management to more efficient irrigation practices, and these must be encouraged. It is essential to incorporate the necessary measures into other policies, including the CAP.

Chapter

3

INFRASTRUCTURE: BUILDINGS, WATER, ENERGY AND TRANSPORT

3.1 IMPACTS OF CLIMATE CHANGE ON INFRASTRUCTURE

Functioning infrastructure is the basis of a functioning society. Buildings and the concrete infrastructure around us, our access to essential services such as water and energy, and our ability to travel within cities, regions and across EU member states require infrastructures that meet the needs of the people – at all times. Although climate change and its possible impacts on infrastructure are plagued by uncertainty and it is often difficult to predict the severity of the impacts, it is short-sighted to ignore the risks when planning, constructing and maintaining these infrastructures.

Buildings and the concrete infrastructure around us includes everything from private households to public and private infrastructures such as schools, hospitals, stations, offices and industrial buildings. Water infrastructure comprises the facilities and installations used for the supply, treatment, distribution and delivery of water to users. This includes the collection, treatment and disposal of waste water. Energy infrastructure can encompass a wide array of installations, ranging from the entire electrical power network with all its elements, including the grid and generation plants, to pipelines, coal-handling facilities and electric vehicle networks. Transport infrastructure refers to fixed installations such as roads, railways, airways, waterways, canals, pipelines and terminals such as airports, railway stations, bus stations, warehouses, trucking terminals, refuelling depots and seaports.

Understanding and being able to assess how infrastructures are affected by changes in climate is very important for EU countries, regions, cities and public and private actors, and they need to be adequately prepared for such impacts. To begin with, a wide variety of environmental changes, which may act as indicators of climate change, including changes to water or air temperature, precipitation quantities, wind speed, sea levels, and the occurrence of floods, heat waves, storms, coastal erosion or river and flash floods, can have significant impacts on infrastructures.

Looking more closely at the infrastructures, first of all, in the building sector and construction projects, climate change can induce significant new challenges. For example, floods and heat waves can amplify flaws in poor building design. Warmer summers will increase demand for more effective cooling installations. Drying soil can affect water tables and building foundations in clay soils, while increased

humidity could lead to growth of mould.[1] One of the greatest challenges for this sector is posed by the increased frequency of sudden, heavy rainfall, which means that better solutions are needed to direct surface water away from buildings and roads, in order to ensure their durability. Meeting these challenges requires innovative and energy-efficient construction techniques and use of new building materials. It is essential to ensure that preparing and adapting to these risks does not undermine efforts to mitigate climate change. One good example is air conditioning and cooling systems, the use of which increases with warmer temperatures, but which are often energy-intensive and can lead to significant increases in greenhouse-gas emissions.

Water infrastructure is also very vulnerable to climate-change impacts. Increased precipitation levels, for example, can put additional stress on old dams and subsequently on urban drainage systems. This was the case in 2001 and 2002 in the Canadian city of Stratford, where the sewer system could not manage heavy rainfall, leading to flooding of numerous basements. Ex-post adaptation of the water infrastructure cost the municipality $70 million Canadian dollars, in addition to the $250 million in lawsuits raised by affected residents.[2] But this is just one risk. Another is that heat waves or frequent draughts can increase water demand. In Europe, reduced river flows in summer are expected to significantly affect water availability. Indeed, water scarcity is already posing problems in a number of regions across Europe, and climate change is expected to increase the number of high-water-stress areas from the current 19% to 35% by the 2070s.[3] This will have significant implications for the agricultural sector and food production, for example.

Climate-change impacts could have serious implications for energy infrastructures and production, and the risks must be carefully considered when building and maintaining technologies for electricity generation. For example, electricity production is strongly dependent on water, be it for hydropower, biomass production or cooling in power plants. While evaporation will reduce the use of hydropower, increased precipitation can affect biomass production, and increases in water temperature or scarcity can impact negatively on electricity production in thermal power plants that are fired by coal and nuclear. Electricity generation from thermal power plants can also be affected by flooding and increases in ambient air temperature.

The consequences of the 2003 heat wave were particularly dire in France, where it affected water supplies and thus restricted nuclear energy generation, which is the source of almost 80% of the country's electricity. In addition, as the authorities were forced allow high-temperature water from the cooling systems to be drained into rivers, this arguably caused damage to local flora and fauna.[4]

Furthermore, heavy storms, heat waves and flooding can pose risks for renewable energy sources. Electricity transmission and distribution may again suffer from heavy storms, flooding and increases in ambient air temperature. Changes in temperature can also affect electricity demand. While demand for heating may fall during winter, demand for cooling is likely to increase during warmer summer months.

1 Ross, K., Saunders, G., and Novakovic, O. (2007): "*Climate change and innovation in house building: Designing out risk*". NHBC Foundation, Amersham, UK. p.5.

2 Boroumand, N. (2007): "*Local Government Responses to Climate Change: Canadian Jurisdictions Outside of BC*". Local Government Institute, University of Victoria, Working Paper Series. p.7.

3 European Commission (2009): *"White Paper on Adapting to climate change: Towards a European framework for action"*. COM(2009) 147 final. p.5.

4 See e.g. *"Heatwave hits France power production, The Guardian* (12 August 2003). Available at www.guardian.co.uk/world/2003/aug/12/france.nuclear, accessed on 5 September 2012. Also Kanter, J.: *"Climate change puts nuclear energy into hot water". The New York Times* (20 May 2007). Available at www.nytimes.com/2007/05/20/health/20iht-nuke.1.5788480.html?pagewanted=all, accessed on 11 September 2011.

It is clear that much work remains to be done to provide a safe and stable supply of energy also at times of extreme weather events. There are great differences with regard to preparation and adaptation between different actors in the energy sector. While the heat wave in France demonstrated a climate-related challenge with nuclear, unfortunately the renewables sector is even less prepared for the adverse effects of climate change.

Last but not least, rising temperatures and sea levels as well as extreme weather conditions cause serious damage to the European transport system. Whilst predicting the consequences of warming is difficult, there are estimations which put the annual cost in the range of €2.5 billion[5] to €15 billion[6]. Automobile traffic will be the most affected mode of transport and unfortunately car accidents, and related costs, are forecast to rise due to climate change and more frequent extreme weather conditions.

Although much more information is needed about the potential impact of climate change on transport infrastructure, such as harbours, transport services and networks, and current regional vulnerabilities, it has already be established that the challenges are manifold. For instance, heavy storms and temperature changes can cause degradation of road surfaces. Increases in storms and precipitation can increase the risk of landslide, bridge damage and tunnel inundation, but also delays and disruption due to flooding. For example, the floods in 2010 caused serious problems in several Central European countries, leading to the loss of many road and railway assets. Heat waves can cause railways to buckle and asphalt to deteriorate. Melting permafrost can damage roads and affect pipeline transport. Sea-level rise, which is estimated to be between 0.22 metres and one metre by 2100, can affect transport infrastructure via coastal erosion or coastal flooding, with ports at particularly high risk.[7] Simultaneously, temperature increases could also lead to positive impacts, such as extended periods without frost or snow that would cause fewer disruptions and accidents, and the retreat of Arctic ice could lead to the emergence of new sea routes and shorter distances for Asia–Europe trade, and thus reduce fuel consumption and emissions.

No matter what the infrastructure is, the severity of direct, biophysical impacts of climate change generally varies and depends very much on their type and geographic location. Climate-change impacts on infrastructure will also be shaped by the way in which our societies continue to evolve. Growing urban settlements and dying rural areas, changes in supply and demand for water or energy, and the age and quality of infrastructures will affect vulnerability and adaptation capabilities in different regions.

It must also be noted that impacts on infrastructure are inherently complex, interdependent and cross-sectoral. For example, poor spatial planning and design can expose certain roads to floods, some of which might happen to provide access to electrical substations. Storms can cut electricity, which is also needed to supply water. It is thus easy to see how such events can negatively affect various infrastructures simultaneously. At the same time, the impacts and consequences of climate change will be experienced on multiple scales, ranging from the implications of poor building design for elderly patients in care homes to the wider implications that changing ship routes in the Arctic Ocean could have for Europe.

Lastly, it should be noted that climate change aggravates existing socio-economic pressures created by urbanisation and ageing populations, and increases people's vulnerability. This can have serious impacts on social justice. The most vulnerable societal groups, including migrants and older or poorer citizens, will be most affected by the negative impacts of climate change, and consequently the disparities between regions and groups are likely to increase. For example, damage caused to electricity generation

---

5 Enei, R., Doll, C., Klug, S., Partzsch, I., Sedlacek, N., Kiel, J., Nesterova, N., Rudzikaite, L., Papaniko-laou, A. and Mitsakis, V. (2011): *" Deliverable 2: Vulnerability of transport systems - Main report"* Project WEATHER - Weather Extremes Impacts on Transport Systems and Hazards for European Regions. p. xiii.

6 VTT Technical Research Centre of Finland (2012): *"The costs of extreme weather for the European transport Systems"*. p.4.

7 Peduzzi, P. (2010): *"Extreme events from climate change: their related impacts on transport and connectivity".* UNECE-UNCTAD Conference. pp.3-5.

technologies can lead to increased costs for energy services, and the higher costs would naturally affect first and foremost low-income groups. Similarly, road degradation due to climate change can lead to higher costs and taxes in the transport sector. Disruptions to water supply in hospitals would be especially harmful for those in need of care. On the other hand, cheaper housing areas may suffer from poor building design, for example, including lack of insulation or ineffective cooling systems. This can have serious implications for people's well-being.

3.2 CURRENT ADAPTATION MEASURES AND THE FRAMEWORK FOR ACTION

Adaptation initiatives at national, regional or local level

Buildings, water, energy and transport are all crucial sectors for European society, both from an economic and social standpoint, and the resilience of these infrastructures will greatly influence not just Europe's ability to counter the effects of climate change, but also the competitiveness of our economy and Europeans' quality of life.

Adapting infrastructures to the potential impacts of climate change is regarded as predominantly the responsibility of EU member states, and public and private actors. As already seen in some EU countries, the starting point must be to assess the vulnerabilities and adaptive capacities of a given society and its key economic sectors, and use this information to define adaptation strategies.

For example, the *FINADAPT project* assessed the adaptive capacity of the Finnish environment and society. It looked at climate data and scenarios, biological diversity, forestry, agriculture, water resources, human health, transport, the built environment, energy infrastructure, tourism and recreation, and urban planning.[8]

In *Switzerland*, reduced rainfall and increased evaporation are affecting water levels and thus the proper functioning of hydropower plants, which generate roughly 60% of the country's electricity. As a result, the *hydropower industry* is seeking to compile all relevant information, including on resource availability, vulnerability assessment and projected electricity demand. The overall aim of this effort is to develop a framework for planning the use of hydropower, while taking into account estimated fluctuations in water supply.[9]

For *The Netherlands*, country where most of the population lives below sea level, the increasing number of floods due to rising sea levels presents a serious threat but also an opportunity for innovation. The Delta Committee gave the Dutch government in 2008 recommendations on working with water to improve safety and sustainability, general welfare and quality of the environment.[10] Suggestions include using flood defences as roads and utilising floodplains for recreation. The Committee's report is an excellent example of how making a strong case for adaptation can influence the public agenda and government policies before a major disaster has happened.

At the same time, more concrete adaptation measures are needed to ensure that Europe's infrastructure is economically viable in the long term, in order to protect the most important assets and to gain long-

[8] Carter, T.R (2007): *"Assessing the adaptive capacity of the Finnish environment and society under a changing climate: FINADAPT"*. Finnish Environment Institute (SYKE), Helsinki, Finland.

[9] Meister, H.P, Kroger, I., Richwien, M., Rickerson, W. and Laurent, C. (2009): "*Floating Houses and Mosquito Nets: Emerging Climate Change Adaptation Strategies Around the World. Case Studies from Selected Countries".* Meister Consultants Group, Boston, USA. p.94.

[10] Deltacommissie (2008): "*Working together with water – A living land builds for its future"*.

term benefits. As three quarters of Europeans live in urban areas, it is obvious that most adaptation efforts will have to address the challenges that climate change creates there.[11] Cities face specific challenges, such as exacerbated heat waves due to artificial surfaces and a lack of vegetation, leading to 'urban heat island' effects. Cities need to improve, for example, urban drainage and sewage systems and building standards in order to adapt to changing conditions.

The *New Orleans wall* was built after Hurricane Katrina had devastated the south-eastern US state of Louisiana in 2005, killing close to 2,000 and causing damage of around 81 billion USD.[12] The physical barrier, stretching 2.4 km and measuring eight metres in height, is part of a network of flood defences that received state funding of 15 billion USD.[13] It is designed to prevent a similar catastrophe from happening again.

The *Copenhagen Metro City Ring line* has been designed to cope with extreme weather events, like frequent storms or heavy rainfall, and it has been made resilient to sea-level rises. The so-called City Ringen is one of the largest projects undertaken in Denmark since World War II, and it is expected to link 17 new stations upon completion in 2018. The entrances will be built 2.5 metres above the local harbour's average water level, the station doors will be watertight, and thicker support structures will provide increased resistance to the pressure caused by a higher groundwater table.[14] It should also be noted that when preventive measures are included in planning, this reduces the final costs significantly.

Investments in adaptation do not necessarily have to be expensive, and much more emphasis should be placed on combining these 'hard' concrete projects with less costly measures. For example, external shading for buildings and windows as well as trees can act as adaptive measures and provide much-needed cooling in the event of heat waves. In addition, using 'soft' measures such as promoting behavioural changes, sharing information and building people's capacities to act can have significant impacts with much lower costs.

The Netherlands has harnessed nature to support adaptation and to bring added value for society. It has changed its water management by giving more space to rivers by lowering and widening flood plains, and at the same time creating additional nature areas.[15]

In *Zaragoza, Spain*, after serious water shortages in the 1990s, citizens and businesses adopted a 'water saving culture', which has helped to cut water consumption by almost 30% within last 15 years.[16] Measures that supported this change included awareness-raising campaigns, revision of water tariffs and controlling water leakages.

---

11 European Environment Agency (EEA) (2012): "*Urban adaptation to climate change in Europe - Challenges and opportunities for cities together with supportive national and European policies".* Office for Official Publications of the European Union, Luxembourg.

12 Webley, K.: *"Top 10 historic U.S. floods"*, TIME (11 May 2011). Available at www.time.com/time/specials/packages/article/0,28804,2070796_2070798_2070785,00.html, accessed on 12 July 2012.

13 Larsen, H.: *"Building a barrier to protect New Orleans from hurricanes". COWI* (10 December 2008). Available at: www.cowi.com/menu/NewsandMedia/News/Newsarchive/Pages/buildingabarriertoprotectneworleansfromhurricanes.aspx, accessed on 12 July 2012.

14 Isager, E. and Stæhr, J. (2009): *"Subterranean challenges". Feature News Magazine*, No.19. pp.20-23. Available at: www.e-pages.dk/cowi/14/fullpdf/full4fdcf398d75cf.pdf, accessed on 12 July 2012.

15 European Environment Agency (EEA) (2012): "*Urban adaptation to climate change in Europe - Challenges and opportunities for cities together with supportive national and European policies".* Office for Official Publications of the European Union, Luxembourg. p. 91.

16 *Ibid.,* p.61.

Adaptation at EU level

As national efforts to adapt infrastructure to the potential impacts of climate change vary greatly between member states, the EU can play an important role in sharing best practice, supporting adaptation developments and improving construction standards. Furthermore, common and coordinated action is necessary to strengthen the resilience of cross-border infrastructure, such as transport or energy networks.

The Policy Paper on Water, Coasts and Marine Issues, which accompanies the European Commission's 'White Paper on Adapting to Climate Change: Towards a European framework for action', indicates that successful adaption to climate change in the water sector will depend "not just on effective national and European water regulations, but also on the extent to which water management can be integrated into other sectoral policies, such as agriculture and energy policies".[17] This is due to the interconnectivity of various sectors, and in particular due to their dependency on water. Another important document setting the framework for addressing water management issues is the EU Water Framework Directive (WFD), complemented by the more specific EU Floods Directive, and the EU Water Scarcity and Droughts Strategy. The WFD sets the "legal framework for the protection, improvement and sustainable use of all water in Europe. It applies to rivers, canals, lakes, lochs, groundwater, wetlands, estuaries and coastal waters, and requires governments to take a holistic approach to their management".[18]

Another Commission White Paper entitled 'Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system' specifies that transport infrastructure projects that are co-funded by the European Union must reflect the need to improve resistance to the potential impacts of climate change. It also encourages the use of new construction materials.[19] For transport infrastructure, adaptation measures could range from using heat-resistant materials and insulation to ensuring the functioning of alternative routes and strengthening foundations. However, it must be mentioned that traditionally both the transport and energy sectors have focused on mitigation and paid only little attention to adaptation measures.

Similarly, for the energy sector the European Commission recently launched a 'Proposal on guidelines for trans-European energy infrastructure', which mentions that energy infrastructure "should be upgraded in order to prevent and increase its resilience to natural or man-made disasters, adverse effects of climate change and threats to its security, notably concerning European critical infrastructure".[20] The Annex of the document also suggests that new energy infrastructure projects should take into account "expected changes in climate-related extreme weather events and their impact on infrastructure resilience,"[21] and when assessing the security and quality of energy supply, disruptions caused by climate change must also be considered.[22] Unfortunately, however, adaptation is far for being mainstreamed across energy policies. For example, the Energy Performance of Buildings Directive focuses only on mitigation, while measures such as insulation could also help to adapt to heat waves.

---

17 European Commission (2009): *"Climate Change and Water, Coasts and Marine Issues"*. Commission staff working document accompanying the White paper: "*Adapting to climate change - Towards a European framework for action"*. SEC (2009) 386. p.2.

18 *Ibid.,* p.5.

19 European Commission (2011): *"White Paper on Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system".* COM (2011) 144 final. p. 27.

20 European Commission (2011): *"Proposal on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC"*.COM (2011) 658 final, p.10.

21 European Commission (2011): *"Proposal on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC - Annex IV: Rules and Indicators Concerning Criteria for Projects of Common Interest"*. COM(2011) 658 final. Annex IV, 2(c). p. 41.

22 *Ibid.,* Annex IV, 4(d). p.42.

EU policy on research and innovation and EU-funded research projects such as ESPON CLIMATE, which considers the effects of climate change on different regional and local sectors and infrastructures,[23] play an important role in the effort to build a knowledge base on necessary adaptation measures. However, the work has only just started and major gaps must still be filled with regard to understanding the vulnerabilities of different infrastructures in different regions, their adaptation capacities, possibilities for action and potential opportunities for innovation and development.

Another important policy that takes climate challenges into account and could help to promote the innovative and cost-efficient adaptation of infrastructures is the EU's cohesion policy. For example, the European Commission's 'Proposal on specific provisions concerning the European Regional Development Fund' emphasises that investment priorities should include "climate change adaptation, risk prevention and management [by] supporting dedicated investment for adaptation to climate change [and] promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems".[24] Moreover, the Cohesion Fund is dedicated to supporting "investment in climate change adaptation and risk prevention, investment in the water and waste sectors and the urban environment,"[25] and the European Social Fund repeatedly mentions the need to move towards a climate-resilient economy.[26] However, the actual budget share for adaptation in the proposal for 2014-2020 is still unknown.

The proposal for the next EU budget recognises EU institutions' role in promoting climate action and ensuring climate resilience across sectors. The budget is likely to encourage investments in "technologies that improve energy efficiency, […] renewable energy sources and related infrastructures, and […] investments for adaptation to climate change".[27] It is time to ensure that the EU budget and spending on climate change start to reflect the level of political priority that has been given to it at EU level. This requires mainstreaming adaptation efforts into all key EU programmes, including cohesion, energy, transport, and research and innovation, and climate-proofing all EU financing. Climate-proofing can help to ensure that money is spent on measures that protect the climate and/or enhance the target's adaptive capacity and resilience to climate change.

Towards 'no regrets'

While the World Bank points out that the cost of adapting to climate change, given the baseline level of infrastructure provision, is no more than 1–2 percent of the total cost of providing that infrastructure,[28] the costs of adaptation within infrastructures can be high, and thus it is important to ensure that investments are smart, cost-effective and far-sighted.

It is important to consider adaptation to the potential impacts of climate change preferably before the investments are made. This is required to secure a long-term energy supply, for example. While nuclear and fossil power have tried to incorporate resilience measures against climate-change risks and are implementing long-term strategies, renewable technologies such as wind have been much slower to take

---

23 ESPON: *"EPSON CLIMATE - Climate change and Territorial effects on Regions and Local Economies in Europe"*: www.espon.eu/main/Menu_Projects/Menu_AppliedResearch/climate.html?currentPage=2

24 European Commission (2011): "*Proposal 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 final. Art 5(b). p.12.

25 European Commission (2011): *"Proposal on the Cohesion Fund and repealing Council Regulation (EC) No 1084/2006"*. COM(2011) 612 final/2. p.5.

26 European Commission (2011*): "Proposal on the European Social Fund and repealing Council Regulation (EC) No 1081/2006"*, COM(2011) 607 final /2. pp. 5-12.

27 European Commission (2011): "*Communication on: A Budget for Europe 2020 - Part II: Policy fiches"*, COM (2011) 500 final, Part II. p.12.

28 Hughes, G., Chinowsky, P., and Strzepek, K. (2010): "*The Costs of Adapting to Climate Change for Infrastructure"*. The International Bank for Reconstruction and Development / THE WORLD BANK, Washington, USA. p.43.

adaptation seriously. As a consequence, the costs in terms of generation loss and the necessary investments after an extreme weather event, for instance, would be three times higher for renewable technologies than for thermal generation. Thus, if renewables are to become a central part of the energy mix, it is crucial to address their vulnerabilities and improve their resilience.[29]

As adaptation is hindered by market failures such as uncertainty, imperfect information, and missing or misaligned markets, these must be recognised and, if possible, tackled. The Stern Review notes that measuring the costs and benefits of adaptation investments requires reliable information and more accurate climate-change projections, but admits that a certain degree of uncertainty will always remain.[30] Regarding missing or misaligned markets, the same report mentions that private agents will always "weigh the uncertain future benefits of adaptation against its more certain current costs".[31] If they, as payers, are not able to fully reap the benefits, this can constitute a barrier to investment decisions. Furthermore, as some adaptation measures will benefit the wider community beyond the private investor, the latter might not be willing to invest up to the socially optimal level, since he/she would not reap the full benefits from that point on.[32]

Europe must overcome the challenge of short-term decision-making, which undermines long-term benefits. When building, renovating or maintaining infrastructures, the starting point must be to evaluate and accept the maximum level of risk for the society, company and people that use the given infrastructure, and prepare for that. The European Commission, member states and the private sector must all participate in revaluating existing systems and provide guidance on risk levels.

The EU should help to provide incentives for investment and create a market for adaptation that recognises the existing market failures. Regulation and standards should be used to provide member states, regions and private-sector actors with incentives to adapt. The starting point should be to climate-proof EU policies and EU-funded projects, and thus make sure that they promote both mitigation and adaptation when relevant. For example, building regulations should consider both the aims of mitigation and adaptation, and environmental impact assessments for national and EU projects should take into account not just the current but also the future environment. Policy instruments such as price signals, financing schemes via public-private partnerships, and research and development incentives can encourage greater participation by private actors.

Adaptation measures can be costly for society and taxpayers if they are not carefully considered. Infrastructure development and investment decisions must acknowledge the uncertainty factor inherent in the impacts of climate change. At the same time, adaptation projects should not be over-exaggerated and maladaptation should be avoided. For example, building sea walls in places where they are not needed or adapting one sector while neglecting other interlinked sectors are not cost-effective adaptation measures. As another example, ensuring that people's access to water will not be affected during environmental catastrophes, but at the same time failing to provide cooling water for electricity generation, will reduce the benefits of adaptation. When possible, 'hard' infrastructure projects should be combined or replaced by using 'green' infrastructure, such as trees and wetlands as adaptation, or 'soft' measures such as behavioural adaptation, emergency systems and providing information for vulnerable

---

29 Kirchsteiger, C. presentation "*Investment needs for future adaptation measures in EU nuclear power plants and other electricity generation technologies due to the effects of climate change"* at the 3rd meeting of the EPC-KBF Climate Change Task Force on "*Infrastructure: water, construction, energy and transport"*, European Policy Centre, 10 May 2011, Brussels.
For further information see: European Commission - DG Energy (2011): Rademaekers, K., van der Laan, J., Boeve, S. and Lise, W. *"Investment needs for future adaptation measures in EU nuclear power plants and other electricity generation technologies due to effects of climate change"*. pp. 31-34.

30 Stern N. (2007)*: "Stern Review: The Economics of Climate Change".* Cambridge University Press, Cambridge, UK. pp.411-412.

31 *Ibid.,* p.412.

32 *Ibid.*

groups. The best adaptation measures reflect innovative thinking, benefit society from the first day of the investment and are not merely costly infrastructure projects.

The Netherlands has been particularly innovative in its approach to adaptation. For example, building dikes that can be used as golf courses, or plazas that at times of heavy rain collect water and at other times provide a place for recreation and sports, are examples adaptation measures that bring immediate additional benefits for the population.

Not just climate change mitigation,[33] but also adaptation in different infrastructures can have an impact on social justice. Recognising the social dimension and ensuring that adaptation measures do not undermine the most vulnerable societal groups is of key importance. The more vulnerable in society will likely be most affected by the impacts of climate change and least prepared for its consequences. Thus the element of social fairness should not be forgotten during climate-change adaptation projects. It is important to consider how support schemes, incentives and knowledge-sharing could be used for this aim. If adaptation is not carried out, the costs for society and the economy may become even higher. For this reason, it is important to identify the most vulnerable regions, sectors and groups, and promote cost-effective adaptation measures in these areas. For example, should residential buildings on coastlines or in isolated places come under threat, key services such as water management should be protected.

3.3 POTENTIAL OPPORTUNITIES FOR GROWTH AND INNOVATION

Preparing for climate-change impacts across different infrastructural sectors can represent a significant opportunity. As the costs of inaction and failure to adapt can be very high, adaptation, early action and reducing the negative effects of a changing climate and extreme weather events on infrastructure will save money and resources, and possibly even create new business opportunities.

Preparing and planning is of key importance. At the same time, managing emergencies requires recognition of the inter-linkages between sectors. For example, if household water supply relies on electricity, good preparation takes into account possible power cuts that may hinder access to drinking water.

Satellites can help to monitor climate change both in Europe and outside its borders, and provide objective data that can be shared across member states. By enabling climate change monitoring, they can support both mitigation and adaptation. They can monitor and assess floods, landslides, infrastructures and forestry, and thus support early warning systems, and help to avoid massive economic and social damage. Global navigation satellite systems such as Galileo, Europe's own Global Navigation Satellite System, can also be used to improve transport management and logistics, and to adapt them to the impacts of climate change. They contribute to building the necessary knowledge-base for Europe, but can also play a key role in civil protection and rescue activities.

Global Monitoring for Environment and Security (GMES)[34] is an EU-led initiative that aims to develop operational user services based on satellite earth observation and in-situ data. COSMO-SkyMed, a four satellite constellation designed and built in Europe, is part of the GMES programme. It produces up to 1800 images per day and covers up to 1600 km2 with a single acquisition. These technologies can provide Europe, including the European Climate Adaptation Platform, with information on the impacts of climate

[33] King Baudouin Foundation (2010): *"Climate change mitigation and social justice in Europe: striking the right balance"*. King Baudouin Foundation, Brussels, Belgium. See also King Baudouin Foundation (2011): *"Climate Change and Social Justice in Europe: Recommendations for three EU policy areas"*. King Baudouin Foundation, Brussels, Belgium.

[34] GMES: www.gmes.info/

change, and thus support adaptation to climate variability and change across the continent. While such initiatives can help to save lives and livelihoods, this is also sector that can create new jobs for Europe.

The United Kingdom Climate Impacts Programme (UKCIP) helps organisations to assess how they might be affected by climate change, so they can prepare for its impact. It has developed an *online programme* which provides individuals and organisations with tools and information on climate change for adaptation purposes. It allows them to assess vulnerability to the current climate and future climate change and to identify options to address key climate risks, and helps them to develop and implement a climate change adaptation strategy.[35]

Water scarcity due to long droughts can pose particularly high risks to the water supply of Mediterranean countries like Spain. In 2008 for example, the city of Barcelona was confronted with this risk following an extremely dry winter. The authorities acted promptly and developed an emergency plan that allowed the city to be supplied with water from tankers and through a pipeline connected to the Ebro river. A handbook was later developed by the Spanish Ministry for the Environment in cooperation with the Association of Spanish Water Utilities that provided guidelines for other cities to develop *plans to tackle water shortages*, and to coordinate such actions at national level.[36]

While preparation can help to save money and reduce negative impacts in emergencies, it can also create new market possibilities. For example, the building sector would naturally benefit from demand for houses, sanitation systems and roads, designed and built to withstand the impacts of climate change. This is an enormous possibility for engineers to develop new technologies and materials, which are not only needed in Europe but could carry a significant export potential.

Preparation for threats and risks related to climate change could boost the EU *security industry*, which covers critical infrastructure protection and crisis management/civil protection. With an estimated market value in the range of €26 billion to €36.5 billion and around 180,000 employees,[37] the security market can only be expected to continue to grow as the frequency of natural disasters increases. This could be an opportunity for the European security industry to boost its international profile. This possibility has already been recognised in the EU, and the European Commission has identified measures that can help to overcome market fragmentation, reduce the gap from research to market, and better integrate the societal dimension, thus helping to turn the EU security industry into a source of competitiveness, growth and jobs.[38]

Research and innovation, and co-creating solutions by involving policymakers, academic researchers, NGOs, consultancy firms and private companies, can bring down the costs of adaptation and increase support for these measures. Adaptation of infrastructures to climate change should be seen as an opportunity for innovation and development. Adaptation efforts will benefit from creativity.

Around the world, and particularly in the Netherlands, architects are exploring *technologies that can help with the fight against climate change-induced water disasters*, such as floods and sea level rises. Floating homes and even larger amphibious structures like hospitals or hotels are gaining attention. This is partly due to recent innovations in construction materials such as expanded polystyrene and new building

35 UKCIP: www.ukcip.org.uk/wizard/

36 Meister, H.P, Kroger, I., Richwien, M., Rickerson, W. and Laurent, C. (2009): "*Floating Houses and Mosquito Nets: Emerging Climate Change Adaptation Strategies Around the World. Case Studies from Selected Countries"*. Meister Consultants Group, Boston, USA. p.97.

37 European Commission (2012): *"Communication on: Security Industrial Policy - Action Plan for an innovative and competitive Security Industry"*. COM (2012) 417 final. p.3.

38 *Ibid.,* pp.5-12.

methods. New techniques and materials allow for the construction of larger floating buildings with smaller quantities of construction materials, and are thus ever more cost-effective.[39]

Promoting mitigation and adaptation together offers great opportunities. It can enhance policy coherence and ensure the optimal allocation of resources to tackle the risks and impacts of climate change. It will help to avoid or reduce potential adverse consequences or maladaptation. As an example, although air conditioning is an important adaptive measure during heat waves, it may lead to higher emissions due to its use of fossil fuel. Thus it is important that all cooling systems are climate-proofed: they are not only adaptive measures but must also help to mitigate climate change. As another example, using parks and trees in urban planning to provide shade and absorb carbon dioxide emissions combines mitigation with adaptation.

There is currently a high amount of energy loss due to *poorly insulated buildings*, and addressing this issue alone could bring the EU massive savings. The European Insulation Manufacturers Association (EURIMA) points to the fact that in Europe, buildings account for 40% of total energy use, and that "it is possible to cut energy use in buildings in half, through simple measures such as wall and roof insulation".[40] Such measures would generate savings of €270 billion per year, and at the same time reduce CO2 emissions by 460 million tonnes per year.[41] Energy-efficient buildings can contribute to climate-change mitigation through their lower energy consumption, and to climate-change adaptation through measures that improve their resilience in the event of extreme weather events.

More efficient water management again combines resource efficiency with adaptation, and can create significant economic, social and environmental benefits. Solutions such as producing energy from waste and recovering calories from waste water to heat swimming pools should be promoted more.

Not long ago on the Spanish Mediterranean coast, the economic boom and massive construction projects created unsustainably high levels of water demand and destabilised local ecosystems. The solution on the Catalonian coast was to build the housing settlement Urbanización Panorámica, Sant Jordi, which proved to be extremely efficient in its *water consumption*. While the main water supply comes from a local well, an additional system was developed that collects rainwater from the settlement as well as from a nearby golf course. This water is then filtered through a water treatment plant and stored separately. Moreover, some of the used water in this housing area is also filtered and re-used, which can cover up to 40% of local needs.[42] Such efforts to reduce water consumption through effective construction practices can significantly lower the demand for ground water and function as cost-effective prevention in emergencies.

---

39 Science Daily (26 August 2011): *"Adapting to Climate Change With Floating Houses?"* Available at: www.sciencedaily.com/releases/2011/08/110826111517.htm, accessed on 12 July 2012. and Gray, D. (2012): *"A growing answer to rising seas: floating homes"*. *Associated Press*. Available at: www.csmonitor.com/World/Making-a-difference/Change-Agent/2012/0404/A-growing-answer-to-rising-seas-floating-homes, accessed on 12 July 2012.

40 European Insulation Manufacturers Association (EURIMA) (2007): *"U-Values for Better Energy Performance of Building"* Brussels, Belgium. p.3. Available at: http://www.eurima.org/uploads/ModuleXtender/Publications/13/EURIMA-Ecofys_VII_leaflet_0412071.pdf, accessed on 12 July 2012.

41 *Ibid.,* p.2.

42 Meister, H.P, Kroger, I., Richwien, M., Rickerson, W. and Laurent, C. (2009): "*Floating Houses and Mosquito Nets: Emerging Climate Change Adaptation Strategies Around the World. Case Studies from Selected Countries"*. Meister Consultants Group, Boston, USA. p.97.

3.4 RECOMMENDATIONS

Sector-specific recommendations

Each of the four sectors discussed in this section are different, and clearly different adaptation measures will be needed in order to make them climate-resilient. While the key is to build comprehensive strategies which recognise the importance of co-operating across sectors, it is important to acknowledge sector-specific particularities too.

To begin with, in the building sector researchers from various sectors should work together to explore the possibility of using new construction materials and creating more resource-efficient buildings. Cooperation is needed across sectors, and the win-wins of working together with the water or energy sector could be significant. A particularly illustrative example mentioned before is the cost savings and reduced energy and CO2 emissions that could be generated by better insulating buildings.

Access to water is the pre-condition for life and a fundamental contributor to quality of life. Thus whether for personal consumption, agriculture, energy production or other industrial use or health care, access to water must not be hindered under any circumstances. It is vital that water infrastructure is adapted to every possible consequence of climate change.

Europe needs to promote innovative solutions in water management, and measures such as re-using water and promoting a life-cycle approach to the use of water are essential. More water-efficient practice includes identifying leaks, recycling water onsite, and installing equipment capable of harvesting rainwater. At the same time it is vital to ensure that key institutions such as healthcare facilities and hospitals have a secure supply of clean water at all times. While there are certainly great business opportunities for the private sector, public investments will also be needed.

In the transport sector, priority should be given to soft measures such as training staff, using information systems and developing contingency planning. Secondly, it is important that infrastructure and personal automobiles, and public transport vehicles like buses, trams, trains and airplanes, are developed so that their impact on the surrounding environment is limited and that they are adapted to changing environmental conditions. Member states should share best practices in building resilient roads and railways in a more sustainable way. One example is concrete roads, which arguably reduce emissions and are not as vulnerable to extreme temperatures as asphalt roads. New standards could be implemented to avoid road or railway degradation due to extreme temperatures or precipitation oscillations. Promoting innovation and developing intelligent systems that promote energy efficiency and resilience, especially in the face of extreme events, would also be important steps in the adaptation process.

Satellite systems can play an important role in monitoring and planning adaptation measures. Through the development of Galileo, Europe's own Global Navigation Satellite System, Europe could soon use its own high precision navigation system, allowing for better transport planning and management.

Finally, in the energy sector more attention must be paid to preparing for extreme weather events. While for example the nuclear sector has been active in taking such risks into account, similar measures are also needed in the renewables sector. Legislation that still contradicts the needs of climate adaptation should be identified and adjusted accordingly. Adaptation costs should be integrated into the final cost of energy.

General recommendations

Adaptation measures for infrastructure need to focus on making the entire infrastructure network in the EU climate-resilient, but this will require **coordinated action**, across sectors and at all levels, from strategic to operational programmes, and eventually to project level. Coordinating action at the strategic level would require ensuring consistency between EU priorities and national and regional adaptation strategies. At the operational programme level, it would require, among other things, the consistent use of information provided for example through the European Climate Adaptation Platform. At project level, coordination should focus on conducting and sharing more economic impact analyses and cost-benefit analyses between public and private actors, as well as providing technical assistance to support project development.[43] Moreover, adaptation measures should not be limited to national efforts, but they can benefit enormously from **cross-border cooperation**. Member states play a crucial role in strengthening this cooperation, and the EU must encourage these efforts.

Experts, researchers, insurance companies, businesses, regions and local authorities, as well as the EU through institutional actors such as the European Commission and the European Environment Agency, all have important roles to play in **building the knowledge-base.** Learning from past experiences and gathering more evidence about the regional impacts of climate change, the vulnerability of different infrastructures, and the costs, benefits and effectiveness of adaptation measures, is essential. It is important for the regions most directly affected by extreme weather events and environmental catastrophes to participate in collecting and sharing data and exchanging best practices. Including climate-change adaptation in the standard risk management of public and private actors would encourage both monitoring and sharing of best practices. At the same time, for example, ICT can bring together enormous amounts of data needed for adaptation measures, and sensors and space technology provide essential tools for monitoring changes to the climate and the environment.

Private actors working on adaptation, the EU, and insurance companies need to **raise awareness and communicate** both the short- and long-term benefits of adaptation to member states, public and private actors, and citizens. The European Climate Adaptation Platform must play a central role in educating and sharing best practices and information with all relevant stakeholders. This requires providing policy- and decision-makers with 'numbers' to make the case for adaptation, including evidence of possible damage costs and net benefits.

Resilience and flexibility are important attributes for adaptation measures, and they need to be promoted by actors across all sectors. Key infrastructures will need to be able to absorb unexpected shocks, and be flexible enough to easily adapt to changing knowledge and experience with regard to the impacts of climate change. For example, bad adaptation measures such as poor spatial planning may actually worsen flood risks. Thus, adaptation measures should continuously learn from mistakes. It must be acknowledged that a certain level of uncertainty will always exist when dealing with climate change, and adapting infrastructures should reflect this.[44] Thus when building or renovating infrastructures, it is sensible to evaluate the maximum level of acceptable risk and prepare for that.

The EU also needs to channel more of its efforts towards **mainstreaming** adaptation: climate resilience should become a precondition of infrastructure projects. The Cohesion Policy package is an important step in the right direction, through its consistent promotion of a climate-resilient economy, which should

[43] Kelemen, A. presentation: *"Climate change adaptation and infrastructure investment under cohesion policy"* at the 3rd meeting of the EPC-KBF Climate Change Task Force: "*Infrastructure: water, construction, energy and transport"*, European Policy Centre, 10 May 2011, Brussels, Belgium.

[44] Pringle, P. presentation: *"The impact of climate change on Europe's infrastructures and the importance of adaptation"* at the 3rd meeting of the EPC-KBF Climate Change Task Force: "*Infrastructure: water, construction, energy and transport"*, European Policy Centre, 10 May 2011, Brussels, Belgium.

also include adaptation. It is important to encourage knowledge-sharing between different communities of experts and stakeholders such as the European Commission, member states, regions, and practitioners from across sectors. But also EU regulation must be consistent with adaptation needs, and where there is a cross-border interest, the EU should ensure that the infrastructure and building standards are checked against adaptation needs too.

Adapting infrastructures to the potential impacts of climate change requires financial muscle, flexible designs, consistency across borders and the ability to learn from best practices and failures. Local policymakers, industries and the EU must all contribute to **building adaptive capacities.** People need the skills and knowledge to make the right decisions, both in terms of investment and in terms of actions during emergency situations. Policymakers must learn to cope with and communicate better the uncertainties related to climate events.

Improving the decision-making process both at EU and member-state levels is one of the key steps in developing effective climate-change adaptation measures with regard to infrastructure. This can be done by correctly identifying when and where adaptation is most relevant, at what level decisions must be made, and what kind of information is needed to support good decisions in the context of inherent uncertainty in this field.

Private-sector actors and public investments must be channelled towards **building on the business opportunities and innovation potential** that climate-change adaptation brings. Examples include the development of intelligent transport systems, new materials for construction and transport, resource-efficiency, or making renewable technologies more resistant to the potential impacts of climate change. Technologies and innovative solutions can play a crucial role in helping societies to adapt, while at the same time creating new jobs and growth. It must not be forgotten that new products and services, which promote innovative adaptation for infrastructures, carry significant export potential.

Scientists, experts, private actors working on adaptation, the European Commission and public-private partnerships can all help to create further **incentives for adaptation**. This is crucial because the costs of adaptation are indeed likely to be less than the risks, but at the moment there is a market failure: when looking only at immediate costs, the future benefit is discounted. As not all investments need to be made at once, being able to optimise the time for investment could help to incentivise adaptation measures. Also, as adaptation is about accepting the level of risk we are willing to take, the European Commission, member states and the private sector must participate in revaluating existing systems and provide guidance on risk levels. Last but not least, the EU must create a market for innovative products and services that can support both mitigation and adaptation within infrastructures.

Financing adaptation must be smart and forward-thinking. Financial assistance should only be given to adaptation projects that are supported by comprehensive assessments that take into account possible impacts on a given sector or an area. At the same time, the EU should be careful with providing direct financing for costly hard infrastructure projects. While it will be necessary to protect existing and future infrastructures, the EU could benefit more by increasing its support for research and funding innovative projects that promote the use of less costly options such as using parks, forests and green roofs for cooling, or using soft measures such as behavioural changes to manage risks.

When carrying out adaptation measures, EU and national policymakers should not forget the **element of social justice**. The burden of climate-change adaptation needs to be shared, with specific attention being paid to the most vulnerable groups.

Chapter 4

HEALTH AND WELL-BEING

4.1 IMPACTS OF CLIMATE CHANGE ON EUROPEANS' HEALTH AND WELL-BEING

The environment is one of the most significant determinants of health and well-being. It provides us with the foundation for life and protects us from different threats to life. The environment includes the air around us and provides oxygen for all living species. It is an essential source of nutrition and water. It protects people from UV radiation via the ozone layer. By continuously adjusting to changing conditions, it continues to preserve life and biodiversity.

However, disruptions to our environment, also outside the EU, are directly and indirectly affecting basic elements of our well-being. Floods, droughts, storms, thawing permafrost, changes in air quality, food quality and quantity, heat waves, fires and increased UV radiation all have serious implications for animal, plant and people's health.

As people's health reflects the quality of the natural and living environment, the health of a population is therefore an important indicator of the impacts of climate change on ecosystems, and the physical and socio-economic environment. Unfortunately, there is growing evidence that climate change is having an increasingly negative impact on health. For example, the World Health Organisation (WHO) has done a lot of work to study and communicate about how health and environmental risks are interlinked, and about the impacts of climate change on health.[1]

Worldwide 150,000 deaths are attributed to climate change every year.[2] Although people's resilience to the negative impacts of climate change and resulting health outcomes are a result of various factors, including initial health status, economic status and the effectiveness of healthcare systems, warming will continue to have an increasing impact on people's well-being.

For example, floods may lead directly to increased injuries and death, and trigger displacement of populations as a result of shoreline erosion, coastal flooding and agricultural disruption. They damage

[1] See World Health Organization: www.who.int/globalchange/en/, accessed on 10 September 2012 and e.g. World Health Organization - Media Center (2010): "Climate change and health". Factsheet No 266. Available at www.who.int/mediacentre/factsheets/fs266/en/index.html, accessed on 10 September 2012.

[2] The Health and Environment Linkage Initiative (HELI): "*Climate Change*". WHO, UNEP. Available at www.who.int/heli/risks/climate/climatechange/en/, accessed on 24 August 2012.

homes and medical facilities and can have an indirect impact on people's health via increases in disease-causing mould and funghi in buildings. If water infrastructure and treatment systems are compromised, this will again have an impact on water quality and thus create further health risks. They may put an unbearable strain on health systems.

Heat waves, such as those experienced in Europe in 2003, can increase levels of air pollution, which causes cardiovascular and respiratory diseases that can be deadly, especially among elderly people. Illnesses that are caused or made worse by extreme heat, including heat exhaustion, heat stroke, cardiovascular disease and kidney disease, already lead to hundreds of deaths each year.

In the summer of 2003 over 70,000 excess deaths were recorded in Europe.[3] Most of these deaths were attributed to the several heat waves that year. The heat waves themselves create other health hazards such as air pollution and forest fires, and limit supplies of water, food and electricity.

Heat waves can also spoil food, resulting in an increase in food-borne diseases. Incidences are likely to increase as global temperatures mount, and if combined with storms and power cuts, the numbers may become even graver.

According to the PESETA project, the number of temperature-sensitive infectious diseases, including food-borne infections such as Salmonella, is likely to increase. This could potentially lead to 20,000 additional cases per year by the 2020s and up to 40,000 extra cases per year by the 2080s.[4] The damage could cost between €70-140 million by 2040, if the average treatment per case were €3,500-€7,000.[5]

Climate change is expected to lead to changes in water quality and quantity.[6] Changing rainfall patterns affect agriculture and freshwater supplies, and thus affect key elements of our well-being: food and water. Drought can increase malnutrition in areas where populations are particularly dependent on crop and livestock productivity. Droughts and higher precipitation rates can lead to the spread of waterborne diseases, especially among populations where water, sanitation and personal hygiene standards are already low but in other locations too.

The sewer system in the metropolitan area of Chicago, in the United States, diverts storm water and sewage into temporary reservoirs. However, it has become clear that in the event of strong storms, the system is not able to handle the water run-off, and significant amounts of contaminated water end up in Lake Michigan. In 2007-2010, 19 billion gallons of wastewater were discharged into the lake, causing disease and killing fish.[7]

3 Robine, J.M, Cheung, S.L, Le Roy, S., Van Oyen, H. and Herrmann F.R (2007): *"Report on excess mortality in Europe during summer 2003"*. p.2. Available at http://ec.europa.eu/health/ph_projects/2005/action1/docs/action1_2005_a2_15_en.pdf, accessed on 10 September 2012.

4 Watkiss, P., Horrocks, L., Pye, S., Searl, A. and Hunt, A. (2009): "*Impacts of climate change in human health in Europe. PESETA - Human health study*".European Commission, Joint Research Centre. p.33.

5 *Ibid*., pp. 39-42.

6 World Health Organization – Department for International Development (2009): *"Vision 2030 – The resilience of water supply and sanitation in the face of climate change"*. p. 15. Available at www.who.int/water_sanitation_health/vision_2030_9789241598422.pdf, accessed on 10 September 2012.

7 Chicago chapter of Physicians for Social Responsibility (Chicago PSR) (2012)*: "Cook County Climate Change and Public Health Action Plan"*. p.11.

According to a recent study on Baltic Sea, the warming pattern has coincided with the emergence of *Vibrio* infections in Northern Europe.[8] The bacteria can cause diarrhoea, vomiting and abdominal pain, and are normally found in warm coastal areas such as the Gulf of Mexico.

Although not always easily monetised, the negative impacts on people's health and well-being will come at a cost for every society. Among the most affected will be health systems and citizens, who will suffer from an increased number of deaths, injuries, diseases and mental health problems, but the resulting impacts will also be felt by the economy as a whole as a result of increased costs and reduced productivity.

According to a study which included in the cost of illnesses broader economic impacts, such as changes in labour productivity and demand for health care, concluded that the additional costs for six disease groupings as a result of climate change would be 38 billion USD in the EU in 2050.[9]

Another way of looking at the costs is to estimate the money saved from damage averted as a result of carrying out carbon reduction measures. For example, reaching the EU's 20% emission reduction target by 2020 could lead to annual health savings worth €52 billion, and if the EU's domestic target were to be increased to 30%, it could lead to additional savings of €10-30 billion per year.[10]

Unfortunately research and assessments on the impacts of climate change on welfare costs is still limited, and mainly limited to heat- and cold-related mortality or other direct and quantifiable economic impacts. As a result, more calculations about the health impacts and related productivity costs are needed. It should not be forgotten that climate change may also bring health benefits, of which one example could be reduced mortality due to decreased exposure to cold. However, as outlined above, these will undoubtedly be outweighed by negative impacts.

No matter what the country or region, some people will be more vulnerable than others. Less wealthy, sick, old and young people are at higher risk of being affected by changes to the climate, and special attention must be paid to protecting their health from the adverse impacts of climate change.

A recent study showed that in the United States alone, increases in the frequency and intensity of heat waves will lead to 150,000 extra deaths in the biggest cities by the end of the century. One major explanation for these estimations is poor people's lack of access to air conditioning. The most disastrous heat waves are those that last beyond two days in urban areas, as municipal services are often unprepared for large numbers of heat-sickened people and they are not able to reach the most vulnerable populations, such as the elderly. [11]

It is vital for societies, health systems and people themselves to develop and implement adaptation strategies. In order to determine the adaptation measures needed, one must understand the potential impacts of climate change on people's health in the coming decades, what the related damage costs could be, and what cost-effective adaptation should consist of.

---

8 Baker-Austin, C., Trinanes, J., Taylor, N., Hartnell, R., Siitonen, A. and Martinez-Urtaza, J. (2012): *"Emerging Vibrio risk at high latitudes in response to ocean warming"*. Nature Climate Change. Available at: www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate1628.html , accessed on 10 September 2012.

9 Bosello, F., Roson, R., and S.J Tol, R. (2004): "*Economy-Wide Estimates of the Implications of Climate Change: Human Health"*. p.14. Available at www.feem.it/userfiles/attach/Publication/NDL2005/NDL2005-097.pdf, accessed on 6 September 2012.

10 Health and Environment Alliance (HEAL) and Health Care Without Harm Europe (HCWH) (2010): "Acting now for better health – a 30% reduction target for EU climate policy". p.8.

11 Altman, P. and al. (2012): *"Killer summer heat: Projected death toll from rising temperatures in America due to climate change"*. Natural Resources Defense Council (NRDC). Available at www.nrdc.org/globalwarming/killer-heat/files/killer-summer-heat-report.pdf, accessed on 6 September 2012.

4.2 CURRENT ADAPTATION MEASURES AND THE FRAMEWORK FOR ACTION

Adaptation initiatives at national, regional or local level

Adaptation measures build on planning ahead rather than paying for consequences later. It is in the interest of every European country to prepare and protect Europeans from infectious diseases and the increased number of respiratory diseases and other climate change-related health effects.

As the number of extreme weather events ranging from heat waves to floods and their devastating impacts on European societies has increased, this has led to a new understanding about the importance of adaptation in some EU member states.

The European heat wave in 2003 caused over 14,000 deaths in France. The high figure was later attributed to the unforeseen nature of the event, inadequate surveillance of heatwave deaths, and a limited public-health response due to a lack of experts, the limited strength of public-health agencies, and poor exchange of information between public organisations. As a result, France noted the need for the following measures: increased health and environmental surveillance, putting into operation health-warning systems for heat, re-evaluating care for the elderly, and carrying out structural improvements to residential institutions.[12]

In Germany, although responsibility for disaster control lies with the regions, *Länder*, the state also takes part in civil protection via emergency precautions and hazard prevention systems. The state runs a nationwide satellite-based warning system (SatWaS) and for large-scale hazards it broadcasts warning announcements within seconds via media such as the radio, television and the Internet. The federal and regional authorities are also working on the possibility of enabling wake-up calls under the warning system. The German Weather Service, on the other hand, operates a heat warning system that provides the regions with early warning forecasts, for example about heat waves.[13]

However, it must be noted that preparedness plans and adaptation strategies still vary greatly between member states. There is little capacity at national or sub-national level to understand the impacts of climate change on health. While health systems and services play a key role in providing a buffer against the risks related to climatic changes, for example, in identifying, monitoring and detecting infectious diseases and in ensuring efficient care at all times, it should be emphasised that health-system preparedness is not enough. Action is needed across different sectors and at all levels of society in order to promote a healthier society that can cope with the impacts of climate change and adjust to the changing conditions. National vulnerability impact assessments would be an important starting point in creating the necessary knowledge-base for preparedness plans and adaptation strategies.

Cost-effective examples of adaptation measures can range from awareness campaigns to training medical staff, and from early-warning systems to energy-efficient cooling facilities and other improvements in housing and urban planning. At the same time, it must be noted that a healthier society is not only an asset in good times, but it is also more capable of coping with bad times. For example, chronic diseases increase people's vulnerability to other diseases, and an individual's fitness and level of physical activity will determine how well one can react, for example, to extreme heat. Thus individuals and society at large both have an interest in paying more attention to preventing these diseases and promoting health at all

[12] IPCC (2007), [Parry, M.L, Canziani, O.F, Palutikof, J.F, Van der Linden, P.J. and Hanson C.E. (eds.)]: *"Full report"* on *"Climate Change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change"*. Cambridge University Press, Cambridge, UK. Chapter 8: Human Health .p.397.

[13] German Federal Government (2008): "*German Strategy for Adaptation to Climate Change"*. p. 18, 71.

times. Whatever the measure, adaptation efforts must always take into account the needs of vulnerable groups such as children, the elderly, the poor and people with diseases.

The WHO has worked hard to make the case for protecting health from climate change, also in Europe. It has looked at current and envisaged risks to health, as well as related challenges for European health systems, and made recommendations about adaptive actions for European countries and decision-makers.[14] Under the European Regional Framework for Action, five strategic objectives were set for European countries in 2010. These included 1) ensuring that current and future mitigation and adaptation climate-change measures, policies and strategies integrate health issues at all levels; 2) improving the capacity of health, social and environmental systems and services to prevent, prepare for, and cope with climate change; 3) raising awareness and encouraging mitigation and adaptation policies in all sectors; 4) greening the health sector and ensuring that it also contributes to reducing greenhouse-gas emissions; and 5) identifying research gaps and sharing best practices.[15]

The EU has also taken on an active role in helping member states to prepare and adapt for climate change and related impacts. As shown below, it has supported a number of initiatives and projects that can help member states to prepare and adapt to climate-related health impacts.

Adaptation at EU level

The 2009 White Paper 'Adapting to climate change: Towards a European framework of action' and the 2009 Commission Staff Working Document 'Human, Animal and Plant Health Impacts of Climate Change' laid the foundations for a horizontal approach to climate-change adaptation. They acknowledge that adaptation must take into account animal and plant health in addition to human health.

The Commission Staff Working Document highlighted the following priorities for the EU's Health Programme: strengthening surveillance systems for infectious diseases and diseases linked to climate change; reinforcing member states' preparedness and response plans with health action plans for extreme weather; strengthening collaboration between different sectors, including human, animal and plant services, and encouraging international collaboration.

The wide range of studies, projects and initiatives supported by the EU's Health Programme demonstrate that EU health policy is advanced in its approach to climate-change adaptation. Compared to, for example, transport policy, which suffers from a lack of data and has been very slow to react to the expected impacts of climate change with adaptation, health policy is supported with strong knowledge-base. The EU has funded a number of research projects, such as cCASHh, which consider the environmental and climatic impacts on health. Other examples of EU-funded projects include EUROSUN, which monitors ultraviolet exposure and its effect on skin cancer levels, Aphekom, which provides information and tools for decision-makers to understand and tackle the impacts of air pollution on health, and EuroHEAT, an online tool that predicts the likelihood of heat waves for affected European countries and regions, and complements national warning systems with medium-range heat forecasts.

Despite these efforts, unfortunately, the importance of health considerations as a part of the wider climate debate has still not been fully recognised in Europe. It appears that among member states, these

[14] Menne, B., Apfel, F., Kovats, S. and Racioppi, F. (2008): "*Protecting health in Europe from climate change".* Regional Office for Europe of the World Health Organization and Regional Office for Europe of the World Health Organization (2010): "*Protecting health in an environment challenged by climate change: European Regional Framework for Actions, Contribution of the Climate Change and Health Task Force".*

[15] Regional Office for Europe of the World Health Organization (2010): "*Protecting health in an environment challenged by climate change: European Regional Framework for Actions, Contribution of the Climate Change and Health Task Force".* pp.3-4.

threats have not become risky enough to provide an impetus for action. Thus, a lot of work still remains to be done.

The Commission's internal Task Force on health adaptation and climate change was established in 2009, bringing together experts, for example, from the Food Safety Agency, the European Environment Agency, the European Commission's Joint Research Centre, the Directorate-General for Climate Action and the Directorate-General for Health and Consumers. This kind of cooperation across sectors is essential for understanding the challenges to human, animal and plant health and making adaptation efforts as effective as possible.

The Commission is also working with the European Environment Agency on cost-benefit analysis and economic assessments of policy options that will likely feed into the debate on the sustainability of health systems. It is recognised that convincing policymakers across Europe of the need to invest in the health sector will require generating more evidence and disseminating this information.

Promoting health and well-being, preventing diseases, creating healthier environments, and treating and caring for Europeans requires action beyond health systems. This is one of the biggest challenges for the EU: to recognise and treat health not as a separate policy issue, but as an essential part of other policy areas.

Another challenge is the lack of buy-in from member states. The EU can provide a lot of information and tools, but in the end it is up to member states and the relevant authorities to prepare and implement adaptation strategies. Preventing unwanted health outcomes should be a key priority for EU member states. It would bring significant social and economic benefits to European society.

4.3 POTENTIAL OPPORTUNITIES FOR GROWTH AND INNOVATION

The starting point for understanding the potential opportunities with regard to protecting health from climate change is to recognise that a healthy population is a source of growth, welfare and prosperity. If people's health is worsened by environmental and climatic factors, this will create costs for any given economy and increase the burden on health systems. Thus it is in every European country's interest to prevent preventable diseases and reduce negative health outcomes, if possible before they emerge.

The starting point is to ensure that adaptation and mitigation efforts complement each other. All adaptation efforts should be designed, if possible, to promote sustainability and reduce emissions. By reducing emissions, adaptation efforts would contribute to improving local air quality, for example, and at the same time would improve people's healthy life year expectancy, reduce respiratory diseases and hospital admissions, and reduce sick leave, thus increasing productivity. This would lead to significant health savings. One example of such a measure helping to mitigate and adapt to the negative impacts of climate change would be planting trees in cities to absorb emissions and reduce heat.

Climate change is considered to be one of the major challenges for health systems around the world. At the same time, ageing populations and limited public budgets are putting pressure on health and care systems in Europe. Thus it is widely recognised that health systems will remain sustainable only if major reforms are carried out that address all of these challenges.

The reforms must help to create health systems where more emphasis is placed on preventing preventable diseases rather than only treating them. In the same line of thought, the health systems would benefit from a shift from disaster response to long-term risk management. This change in approach

would help health systems to avoid significant costs that arise from the current tendency to pay for the consequences later.

The UK National Health Service (NHS) has acknowledged that mitigating against and adapting to climate change will prevent negative health outcomes and help to reduce demand for health services. It recognises that health systems can play a significant part in reducing emissions, and has thus set itself the target of reducing its emissions by 10% by 2015 from a 1990 baseline.[16] It has also acknowledged that it is more effective to adapt to the unavoidable impacts of climate change and plan ahead rather than just react to events.[17] Sea-level rises, more frequent extreme weather events and greater risk of droughts and floods can have a significant impact on the whole health sector, and by addressing these risks, planning and developing flexible arrangements, the health sector can avoid significant financial costs and reputational losses.

According to the Sustainable Development Unit of the NHS, ensuring that the health system is well-adapted to these impacts can bring significant short-term health and financial benefits. However, this requires preparing for possible disruptions in the supply chain of food, energy, clean air and water, considering possible impacts on staff, and renovating existing and building new premises so that they respond to risk assessments. Adaptation still needs to be integrated into organisational decision-making and into resilience and emergency preparedness plans, but the work has begun.

Providing people with the necessary information about changes to the environment and climate, and the resulting impacts on their health, helps to empower people to make healthier choices. Adaptation to the negative impacts of climate change, such as air pollution or lower water quality, can start with personal measures.

The technology sector can contribute to mitigating the effects of climate change by sharing data and best practices. Eye on Earth, an initiative of Microsoft and the European Environment Agency, is one example of a project that provides free, easy access to information on local air and water quality, as well as the risk of heat waves, for everyone in Europe. The interactive platform also takes into account feedback from people, and allows them to make healthier choices through the data it provides.[18]

There are enormous innovation and business possibilities across sectors, which can contribute to protecting health from negative impacts of climate change. For example, in the construction sector, there is already a market for improving infrastructure such as buildings to combat floods and heat waves, utilising energy-efficient cooling and external shading, and ensuring a constant supply of water and energy, especially for key buildings such as hospitals. On the other hand, increased UV radiation and an increase in cases of skin cancer will create growing demand for pharmaceutical companies to develop new treatments.

4.4 RECOMMENDATIONS

It is important to **raise awareness about the implications of climate change for human, animal and plant health** throughout Europe, at all levels of society and across sectors. As most health policies are implemented at national or regional level, the EU should raise awareness among member states and regions to better utilise existing information and knowledge about climate-related health impacts, for

[16] NHS Sustainable Development Unit (2009): "*NHS Carbon Reduction Strategy for England: Saving Carbon, Improving Health*". Cambridge, UK. p.8.

[17] NHS Sustainable Development Unit (2012): "*Sustainability in the NHS: Health Check 2012*". Cambridge, UK. p.10.

[18] Eye on Earth: www.eyeonearth.org

instance when developing national mitigation and adaptation strategies. Public authorities, policymakers, health professionals and citizens should have a basic understanding about the effects of climate change on extreme weather events, air pollution, outdoor allergens and diseases, and knowledge about necessary and cost-effective actions.

At the same time, more **studies are needed about the interlinks between the environment, climate and health**, such as the relationship between ambient temperature and air pollution, outdoor allergens, or respiratory diseases, both at EU as well as at national and regional levels. More calculations are needed about the impacts of climate change on health that go beyond direct and easily quantifiable economic impacts, and also look at productivity costs, for example. More information is also needed about how changes outside the EU, for example in water quality and quantity, can affect Europe. Scientists and economists have an important role to play in providing the required data and information, which can be used to support climate policies and measures, including adaptation, both at national and EU level. At the same time, more information and evidence is needed about effective adaptation measures, taking into account feedback from citizens. The EU should naturally support such studies.

Reducing and preparing for unwanted health consequences arising from environmental and climatic changes would benefit from **modelling and vulnerability assessments.** The EU and its member states should develop and utilise such assessments when formulating strategies and carrying out adaptation measures against extreme weather events, environmental disasters, and changing weather and environmental conditions, whether within infrastructures or health systems.

Response mechanisms must be improved across Europe. Member states need to strengthen health and social systems and services, so that they have the capacity to prevent, prepare for and cope with the potential impacts of climate change. Public health surveillance systems must be improved and vigilance is needed, for example with regard to tick distribution and associated diseases. However, it must be recognised that creating more effective response mechanisms requires strengthening collaboration between various sectors and services, and all stakeholders should be involved in planning and managing health and safety needs, both before and during incidents. For example, it is important to ensure that cooperation between public authorities and media functions during incidents such as heat waves and that communication reaches the general public. While improving preparedness and response capacities should start by basing action on existing measures and emergency planning, the EU should also encourage closer cooperation and sharing of best practices between member states.

The EU and national authorities should ensure that addressing climate change and related challenges becomes a key part of health and social care reforms. Health systems must take both mitigation and adaptation seriously, and thus contribute to making the system more sustainable. For example, the European health sector currently produces 4.2% of European greenhouse gas emissions. Greening the health sector and reducing its emissions would contribute to fewer life years lost to air pollution, fewer consultations for upper respiratory diseases, and much fewer days of restricted activity, thus bringing significant benefits for society and the economy as a whole. At the same time, health systems could benefit from preparing for the negative impacts of climate change. For example, health promotion and disease prevention is a cost-effective measure which can contribute to reducing healthcare costs and increasing Europeans' healthy-life-year expectancy, while preparing people for the negative impacts of climate change.

Adaptation measures and mitigation efforts must be promoted together. It is vital to ensure that adaptation efforts that aim to protect health do not accidentally increase negative health impacts, for example by increasing greenhouse gas emissions. The EU must encourage cooperation between member states about best practices, while at the same time ensuring that at least all EU-funded projects are climate-proofed.

The EU and member states should work to **improve EU legislation**, to ensure that health policies are climate-proofed and that climate policies are health-proofed. It is in everyone's interest to see health considerations integrated more effectively into all policy sectors. For example, regulation on construction and building standards should aim to protect and promote health. The CAP and cohesion policy should also support better adaptation measures that support health.

The EU and member states should look for different ways to **involve the industry in developing and implementing efficient adaptation strategies**. The industry can be an important partner in sharing best practices, research, data, information, technology and tools when preparing for adverse climate-related health impacts. For example, the whole of Europe could benefit from a sensitive European weather control system that provides member-state authorities with information about approaching extreme weather events.

Special attention must be paid to **vulnerable groups at both EU and national levels**. This requires identifying people at risk, assessing the health effects of climate change on them and possible adaptation measures, and helping them to prepare for and adapt to the negative impacts of climate change.

Chapter

5

ECONOMICS OF CLIMATE CHANGE ADAPTATION

5.1 FACTS AND FIGURES

As has been demonstrated in this paper, whether or not caused by man-made climate change, weather-related losses are increasing across the world.[1] Worldwide economic losses from weather- and climate-related disasters have increased in recent decades from a few billion USD in 1980 to over 200 billion in 2005.[2] As mentioned before, it is estimated that by 2100, extreme weather conditions could cost the world annually 20 trillion USD.[3] The reality is that it is becoming extremely expensive simply to react, rather than prepare, for the short-, medium- and long-term implications of climate change.

So far, Europe's approach has mainly been to pay for the consequences later. However, this is short-sighted and it can put a great economic and social burden on economies, societies, and the public and private sectors in Europe. Floods, storms and forest fires in Europe have caused and continue to cause significant problems, ranging from infrastructure damage to health problems. As noted by the Commission's White Paper on adaptation, "the costs of taking action to address climate change will be much lower than the costs of inaction over the medium to long term".[4]

These costs could be avoided by assessing and addressing climate risks and meeting these challenges with cost-effective adaptation measures. As demonstrated in this paper, there are a wide range of possible measures for both observed and anticipated risks. These can include, for example, altering farming practices and crop varieties, developing early-warning systems, building dikes against floods or building water reservoirs, enhancing water efficiency, and training professionals to operate in and manage changing circumstances. The cost of adaptation will naturally depend on the country, region and sector,

1 European Union Institute for Security Studies (2011): *"Global trends 2030-Citizens in an interconnected and polycentric world"*. p.80.

2 IPCC (2012), [Field, C.B., Barros, V., Stocker, T.F, Qin, D., Dokken, D.J, Ebi, K.L, Mastrandrea, M.D., Mach, K.J., Plattner, G.-K., Allen, S.K., Tignor, M. and Midgley, P.M. (eds.)]: *"Summary for Policymakers"* on "*Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*". Cambridge University Press, Cambridge, UK, and New York, NY, USA. p.7.

3 Kemfert, C.: *" Global Climate protection – Immediate action will avert high costs"*. German Institute of Economic Research (DIW) (28 April 2008), Weekly report No12/2005, Volume 1. p.135. Available at www.diw.de/documents/publikationen/73/diw_01.c.43084.de/diw_wr_2005-12.pdf , accessed on 10 September 2012.

4 European Commission (2009): *"White Paper on Adapting to climate change: Towards a European framework for action"*. COM (2009) 147 final. p.6.

but also on the ability of public and private actors to evaluate the real needs and to promote innovative solutions that can bring benefits for society as a whole. While significant investments in infrastructure and technologies will be needed, it should not be forgotten that low-cost adaptation options also exist, for example related to behavioural adaptations, such as using water more efficiently, planning land use more effectively or improving one's physical well-being.

A number of estimates have been made regarding the adaptation costs required for different sectors as well as globally.[5] For example, according to the UNFCCC, the total funding required for adaptation by 2030 could amount to 49–171 billion USD per annum globally.[6] However, it is important to recognise that these estimations have serious limitations. Many focus only on costly structural measures, such as improving infrastructures, and fail to give a value to less costly options such as those mentioned above. There is also a risk of double-counting expenditure, or as in the case of the UNFCCC report, of sectors including manufacturing, energy, tourism and ecosystems not being included in the calculations.

When considering the economics of adaptation, it must be borne in mind that adaptation costs should not be looked at in isolation but rather as part of a wider attempt to find the optimal balance between investments in mitigating climate change, investments in adapting to climate change, and accepting future climate change-related damage.[7] To understand the real costs and benefits related to adaptation measures, it is important to ensure that calculations value and take into account the possible short, medium- and long-term economic, social and environmental benefits of each adaptation measure.

5.2 FINANCING ADAPTATION TODAY: FROM POLICIES TO PROJECTS

It is obvious that in the current economic environment, which favours cutting rather than increasing expenditure, it will not be easy to mobilise resources for climate-change adaptation. At the same time, as noted throughout this paper, failing to invest may ultimately see costs soar to unsustainable levels. The reality is that both public and private funding will be needed to implement adaptation policies, plans and measures. However, it is of crucial importance to ensure that these efforts are supported by a policy framework that promotes smart spending and establishes incentives that encourage cost-effective investments in adaptation.

EU tools for action

The EU has several policies, programmes and financial instruments at its disposal which could provide an important basis for adaptation measures across Europe. Even though it is up to member states and regions to finance adaptation, the EU can play an important role in supporting their efforts.

The Europe 2020 Strategy puts great emphasis on creating a more sustainable and greener economy.[8] Creating a more resource-efficient Europe and meeting the 20/20/20 targets for climate and energy have been made into political priorities of the EU. This should be reflected in the upcoming EU budget for

5 Parry, M., Arnell, N., Berry, P., Dodman, D., Fankhauser, S., Hope, C., Kovats, S., Nicholls, R., Satterthwaite, D., Tiffin, R., and Wheeler, T. (2009): "*Assessing the Costs of Adaptation to Climate Change: A Review of the UNFCCC and Other Recent Estimates*". International Institute for Environment and Development and Grantham Institute for Climate Change, London, UK.

6 UNFCCC (2008): "*Investment and Financial Flows - To Address Climate Change*". UNFCCC, Bonn, Germany. p.183.

7 De Bruin, K., Dellink, R. and Agrawala, S. (2009): *"Economic Aspects of Adaptation to Climate Change: Integrated Assessment Modelling of Adaptation Costs and Benefits"*. OECD Environment Working Papers, No. 6, OECD Publishing. Available at www.oecd-ilibrary.org/docserver/download/fulltext/5ksm3715ql23.pdf?expires=1347003746&id=id&accname=guest&checksum=9689B79295FB1A52B398987E0B8BB6ED, accessed on September 10 2012.

8 European Commission (2010): "*Communication on: EUROPE 2020, A strategy for smart, sustainable and inclusive growth",* COM (2010) 2020.

2014-2020, and funding should prioritise projects and programmes that contribute to creating a more sustainable Europe. The good news is that the European Commission's proposal for the next Multiannual Financial Framework (MFF) 2014-2020 has proposed that least 20% of expenditure should be related to climate action. While the EU budget can play an important role in addressing the climate challenge, and it should reflect the level of political priority given to it,[9] unfortunately, the battle is still ongoing and it remains to be seen how successful this greening of the EU budget will be.

The LIFE+ programme provides a platform for exchange of best practice among member states and can also support climate-change adaptation financially.[10] The Directive on LIFE+ states that one of the fields of action is "ensuring the adaptation of the EU economy and society, of nature and biodiversity, of water resources and of human health to the adverse impacts of climate change and qualifying such impacts".[11] The current programme was given a financial envelope of over €2.1 billion to be spent between 2007 and 2013.

The budget proposal for the LIFE+ programme from 2014-2020 includes a recommendation to increase it to around €3.6 billion.[12] The proposal includes a specific sub-programme of over €900 million, which would be devoted to climate action and would also support efforts to adapt and increase resilience to climate change.[13] The sub-programme can also be used to increase awareness, communication, cooperation and dissemination about both climate mitigation and adaptation actions. The LIFE+ Programme is also expected to boost support for small-scale climate projects, thus encouraging bottom-up action and measures by small and medium-sized enterprises, non-governmental organisations and regional actors.

The EU should naturally continue to use its programmes for research and innovation to support adaptation in Europe. The 7th Framework Programme for Research and Technological Development (FP7), which lasts until 2013, has supported research on climate change impacts, costs and adaptation options, for example, via research projects such as ClimateCost[14], CLIMSAVE[15] and RESPONSES[16]. Now all eyes are already on 'Horizon 2020', the EU's new programme for research and innovation. The European Commission has suggested that the programme should be allocated €80 billion for the period 2014-2020 in order to tackle societal challenges, such as those related to climate change.[17] Around 35% of the budget is expected to be climate-related expenditure.[18] The extent to which adaptation is reflected in the framework remains to be seen. However, it holds significant potential to help fill knowledge gaps and promote innovative and creative adaptation measures that would benefit society as a whole. Further studies are particularly needed to quantify the impacts of climate change on biodiversity, ecosystems and migration – which are not traditionally treated in economic terms – in order to understand both the

---

9 For more information on greening the EU budget, see e.g. Medarova-Bergstrom, K., Volkery, A., Schiellerup, P., Withana, S. and Baldock, D. (2011): "*Strategies and Instruments for Climate Proofing the EU Budget*". IEEP, Brussels, Belgium.

10 Medarova-Bergstrom, K., Volkery, A. (2012): *"Practical Options for Climate Change Mainstreaming in the 2014-2020 EU Budget"*. IEEP, Brussels, Belgium. p.3.

11 Regulation (EC) No 614/2007 of the European Parliament and Council of the European Union on regulations concerning the Financial Instrument for the Environment (LIFE+). Annex II: 2.1. p.11.

12 European Commission (2011*): " Proposal for a regulation on the establishment of a Programme for the Environment and Climate Action (LIFE)"*. COM/2011/874 final. p.8.

13 Kondrup, C. presentation: *"EU's financial instruments and prospects for adaptation"* at the 6th meeting of the EPC-KBF Climate Change Adaptation Task Force: "*Financing and Insurance*". European Policy Centre, 15 November 2011, Brussels.

14 ClimateCost: www.climatecost.cc/

15 The CLIMSAVE project: *"Climate Change Integrated Assessment Methodology for Cross-Sectoral Adaptation and Vulnerability in Europe"*: www.climsave.eu/

16 The RESPONSES project: www.responsesproject.eu/

17 European Commission (2011): *"Communication on: A Budget for Europe 2020 - Part I"*, COM (2011) 500 final, Part 1. p.11.

18 European Commission (2011*): " Communication on Horizon 2020 – the Framework Programme for Research and Innovation"*. COM/2011/808 final. p.5.

impacts and necessary mitigation and adaptation measures across sectors, and to evaluate the costs and benefits of adaptation strategies.

The EU's Cohesion Policy provides a framework for financing a wide range of projects in EU member states and regions, which aim to promote economic prosperity and social cohesion in the EU. The funding is channelled through five funds: the European Regional Development Fund (ERDF), the Cohesion Fund, the European Social Fund, the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF), all of which could be used to support climate-change adaptation.

The ERDF supports the shift towards a low-carbon economy in all sectors and supports investments in climate change and disaster resilience, and encourages infrastructure development that takes into consideration climate challenges.[19]

The Cohesion Fund supports the poorest member states and finances activities that benefit the environment.[20] It supports the shift towards a low-carbon economy in all sectors and investments in climate change and disaster resilience.

In 2007-2013, Poland received approximately €28 billion from the ERDF and Cohesion Fund, which was directed at minimising the negative effects of natural disasters, for example. This included building flood protection and improving water management. [21]

Greece received in 2007-2013 close to €2 billion through the ERDF and Cohesion Fund, which was directed at tackling environmental risks such as floods and fires, for example.[22]

The European Social Fund supports the shift towards a low-carbon, climate-resilient, resource-efficient and environmentally-sustainable economy through reform of education and training systems, and by aiming to create new jobs in sectors related to the environment and energy.[23]

In addition, the EAFRD aims to boost the competitiveness of agriculture and forestry, and to improve the environment, the countryside, quality of life and the management of economic activity in rural areas, whereas the EMFF supports, for example, developing sustainable and competitive fisheries and aquaculture, protecting marine environment and biodiversity, and adapting to the adverse impacts of climate change on coastal areas.[24]

Another programme that supports member states, regions and the private sector in their adaptation efforts is the EU Disaster Prevention Framework. The framework aims to improve the knowledge base by

---

19 Regulation EC/No 1080/2006 of the European Parliament and Council on European Regional Development Fund and repealing Regulation (EC) No 1783/1999.

20 Council regulation EC/No 1084/2006 on establishing a Cohesion Fund and repealing Regulation (EC) No 1164/94.

21 European Commission, Regional Policy – Inforegio , Poland : *"Operational Programme : "Infrastructure and Environment"*. Available at http://ec.europa.eu/regional_policy/archive/country/prordn/details_new.cfm?gv_PAY=PL&gv_reg=ALL&gv_PGM=1212&LAN=7&gv_per=2&gv_defL=7#cont, accessed on 26 July 2012

22 European Commission, Regional Policy – Inforegio , Greece: *"Operational Programme: "Environment and Sustainable Development"*. Available at http://ec.europa.eu/regional_policy/country/prordn/details_new.cfm?LAN=7&gv_PAY=GR&gv_reg=all&gv_PGM=1076&gv_defL=7, accessed on 9 August 2012.

23 Regulation EC/No 1081/2006 of the European Parliament and Council on European Social Fund and repealing Regulation (EC) No 1784/1999.

24 European Commission (2011): *"Proposal for a regulation on the European Maritime and Fisheries Fund (repealing Council Regulation (EC) No 1198/2006 and Council Regulation (EC) No 861/2006 and Council Regulation No XXX/2011 on integrated maritime policy"*. COM/2011/804/final. pp.126-127.

working with the European Environmental Agency (EEA), reinsurance companies and academic actors regarding disaster data. The framework aims to assess and map risks, fill information gaps, and provide innovative solutions for financing disaster prevention. It also issues guidelines to member states and aims to improve the use of EU funding and disaster risk insurance. Moreover, the framework encourages international cooperation by supporting regional risk-pooling initiatives, for example the United Nations Office for Disaster Risk Reduction (UNISDR), by combining the knowledge, experience and resources of actors (businesses, experts, individuals) in order to share risks which would be too large to handle individually. The European Commission is expected to present shortly initiatives on innovative solutions for financing disaster prevention.

The possibility of creating a separate funding instrument for climate action is sometimes mentioned. However, as mitigation and adaptation should be cross-cutting, it is better to use the existing tools and ensure that they are mainstreamed across key sectors and policies.

The European Investment Bank (EIB) also funds projects and lends money, and it can provide technical assistance. So far the EIB has mainly focused on projects that support mitigation and it has only recently started to do more on adaptation. The EIB aims to mainstream adaptation across portfolios, sectors and projects, and ensures that it is taken into account in all relevant projects. This is done by mainstreaming climate action and taking into account three cross-cutting issues in all projects: 1) screening and managing each project's climate risks, 2) identifying energy-efficient opportunities, and 3) raising awareness at national level. One of the challenges confronting the EIB is that due to a wide range of different types of lending projects, they can be exposed to a variety of risks. Thus the Bank has noted that deciding on the sectors and regions in which to invest requires making specific vulnerability assessments and cost-benefit analyses.[25] A similar approach is also needed for other EU-funded projects.

The European Solidarity Fund (ESF) is an important complementary instrument for supporting climate-change adaptation. The ESF was created after the severe summer of 2002 in order to quickly respond to major natural disasters with clear operational guidelines. This fund does not provide finance for climate-change adaptation projects as such, but it is an instrument that guides investment decisions, helps to cover the costs of major disasters and prevents ineffective 'panic spending'.[26] What is important is that the beneficiary member state is obliged to include in the implementation report measures applied that will limit or even avoid future damage in the event of any repetition of similar disasters.[27]

For example, France received over €109 million in aid from the ESF after the storm 'Klaus' in 2009, and Poland received over €105 million from the ESF after flooding in 2010.[28] As a recent example, Italy's Tuscany and Liguria regions received over €18 million to help repair damage to businesses, homes and infrastructure caused by the October 2011 floods. [29]

It should be emphasised that the aim of EU support on adaptation should not be to spend 'X' amount of money on adaptation, but to encourage the development and implementation of smart and cost-effective adaptation strategies, products and services. While the EU can support member states', regions' and cities' adaptation efforts financially, in accordance with the priorities set in the Europe 2020 Strategy, its action should also promote smart and sustainable growth. Direct investments in building roads and

[25] Saich, N. presentation: *"The role of the European Investment Bank"* at the 6th meeting of the EPC-KBF Climate Change Adaptation Task Force on "*Financing and Insurance*". European Policy Centre, 15 November 2011, Brussels, Belgium.

[26] Council regulation (EC) No 2012/2002 on establishing the European Union Solidarity Fund.

[27] *Ibid.,* Art.8(2).

[28] European Commission (2011): *"The Future of the European Union Solidarity Fund"*. COM/2011/613/final. p.18.

[29] European Parliament News (2012): *"European Solidarity Fund aid totalling €18 million to repair flood damage in Italy".* Available at www.europarl.europa.eu/news/en/pressroom/content/20120529IPR45940/html/Over-€18-million-in-European-Solidarity-Fund-aid-to-repair-flood-damage-in-Italy, accessed on 6 September 2012.

dikes or in buildings will undoubtedly be needed. However, more should be done to use the financial instruments to support innovation and new approaches to adaptation, which hold the potential to turn into a source of welfare and growth, and into new products and services that could be deployed also outside the EU.

Moreover, financing of adaptation projects must be accompanied by clear criteria and conditions. In order to avoid maladaptation and unnecessary investments, all projects should be supported by region- or sector-specific assessments that evaluate the potential consequences of climate-change scenarios and needed actions.

As only 12 out of 27 member states have adopted national adaptation plans,[30] and Europe does not have standardised plans, they differ greatly in depth and analysis. This creates further questions with regard to financing at EU level. If a member state has not even adopted a national adaptation plan or carried out basic necessary adaptation measures, for example against floods, forest fires or heat waves, how far should the EU go to support its adaptation efforts? How can we ensure that more vulnerable regions and people are supported in the process and will not suffer as a consequence of member states' or regions' inability or unwillingness to act, due to the political costs and immediate budget consequences? Or in the case of the EU Solidarity Fund: how far should solidarity extend and can the EU be expected to pay for the consequences of inaction should a disaster strike in a country or region which could and should have been prepared?

Role of the private sector

In July 2012 EU ministers for the environment and climate change noted in their meeting that the private sector can play a significant role in supporting and complementing government efforts in adaptation policies by providing financial support and technical expertise. In addition, public-private partnerships and insurance firms can play an important role in supporting national adaptation efforts.[31]

Many private sector actors already acknowledge the greater need for adaptation measures in their own operations, as well as in their own products and services. As noted in this paper, adaptation offers great business opportunities, ranging from information and consulting services to the development of new agricultural products and technologies, and from water management to creative construction projects. However, in order to promote a stronger role for the private sector, work remains to be done to create a market place for adaptation. Private stakeholders need more incentives to contribute to increasing climate resilience and to cooperating in the framework of public-private partnerships (PPPs).

Bringing together public and private funding in the form of public-private partnerships or public-private cooperation could help to fill some of the market gaps, to overcome public budget constraints and to finance Europe's investment needs. PPPs help to bring private finance and expertise to public projects, thus providing an important addition to national and regional adaptation projects. Cooperation between private and public-sector actors can also generate more research and innovative solutions. However, this requires both top-down support and efforts at the PPP level. The European Commission hopes to improve the framework for PPPs and has proposed different financing tools, such as EU project bonds, to facilitate the use of PPPs. At the same time, ideally all public-private partnerships should encourage the private actor to invest in adaptation. This could be done by incorporating the adaptation element into all contracts, for example, via technical climate-proofing for infrastructure or performance standards.

---

30 European Commission – European Environment Agency: *"European Climate Adaptation Platform – Adaptation strategies"*. Available at http://climate-adapt.eea.europa.eu/web/guest/countries, accessed on 9 August 2012.

31 Informal Meeting of Ministers for the Environment and Climate Change 7th and 8th July 2012: *"Cyprus Presidency concluding remarks on the discussions on Adaptation on the 8th of July"*. p.4. Available at: www.cy2012.eu/index.php/en/file/Y5RGhpLt8X_2nxXo9+AUZw==, accessed on 8 August 2012.

The role of the insurance sector is growing in importance. First of all, insurance plays an important role in smoothing the cost spikes that arise from weather-related impacts, and which individuals, businesses and governments have to pay. However, it should be noted that as the number of weather-related threats and extreme events grows and their impacts become more devastating, the cost of insurance premiums increases. Thus insurance already makes most sense in cases of low probability and high severity events, when it can be less costly than adaptation measures like building high dams. At the same time, insurance puts a price tag on risks and thus provides an incentive for stakeholders to pay more attention to prevention, mitigation and adaptation.

Secondly, insurance companies can provide guidance on cost-effective adaptation measures. Insurers will often only insure against threats if basic preventive measures are carried out, for example, against floods or fires. As the gap between insured and economic losses widens, it becomes ever more important to consider possible ways to prevent economic losses and to ensure that the most vulnerable people do not become the main payers for them. Insurance companies urge states, regions, cities and other stakeholders to pay more attention to prevention and adaptation measures, and thus slow down rising insurance premium costs.

The increasing impacts of climate change are also boosting business possibilities for insurance companies. They are already developing new products and services, deploying risk diversification – which allows them to take on climate-change related risks at lower capital costs – and providing risk-engineering services.[32] With extensive experience, they can help member states and regions to assess risks, assist with scenario-based risk management and evaluate the most cost-effective adaptation measures for them, thus helping stakeholders to define their adaptation strategies.

The biggest risks in the Hull region in the UK have been identified by reinsurance company Swiss Re as flooding, winter storms and storm surges. It has been estimated that the potential impact of these hazards could lead to total losses of between $55 and $96 million in 2030, depending on the severity of the scenario. After taking into account the uncertainties and quantifying the expected losses across the different scenarios, it was calculated that the potential losses could be partially prevented by taking measures with net economic benefits, such as awareness campaigns, emergency response training, the enhancement and repair of Hull's existing sea and river defences, and via mobile protection of household contents.[33]

Another cost-benefit analysis by Swiss Re shows that the state of Maharashtra in India can cost-effectively prevent almost half of its estimated losses due to draught by 2030. Actions to be taken include drip and sprinkler irrigation, drainage, watershed management, better soil practices, pest management and crop engineering. Combining risk prevention with insurance and risk transfer forms cost-effective adaptation that can cover up to 80% of potential losses.[34]

---

[32] Liedtke, P.M., Schanz, K.-U., Stahel, W.R. (2009): *"Climate change as a major risk management challenge- How to engage the global insurance industry"*. The Geneva Association. pp.10-11. Available at: www.genevaassociation.org/Portals/0/COP15_background_paper.pdf, accessed on 9 August 2012

[33] Spiegel, A. presentation: *"Assessing and addressing climate risks"* at the 6th meeting of the EPC-KBF Climate Change Task Force: Financing and Insurance, European Policy Centre, 15 November 2011, Brussels.
For more information: Spiegel, A.(2012): *"Hull, United Kingdom: A holistic approach to multiple hazards"*. Swiss Re. Available at www.swissre.com/rethinking/climate/Hull_United_Kingdom_A_holistic_approach_to_multiple_hazards.html accessed on 7 September 2012.

[34] The Economics of Climate Adaptation Working Group (2009): *"Shaping Climate-resilient Development – A framework for decision-making"*. Economics of Climate adaptation. pp.81-85. Available at http://ec.europa.eu/development/icenter/repository/ECA_Shaping_Climate_Resilent_Development.pdf, accessed on 10 September 2012

New forms of cooperation between the public and private sectors are emerging, which can help countries to finance disaster risks fully or partly through insurance mechanisms.[35] It is important for governments to act as regulators and ensure that the insurance market functions, thus allowing insurance companies to participate in absorbing disaster losses. On the other hand, governments can also be beneficiaries of the system and use private insurance solutions themselves.

5.3 RECOMMENDATIONS

The **EU knowledge base** on the impacts of climate change needs to promote greater urgency of action. This requires facts and figures on potential social, environmental and economic losses/benefits and costs of inaction. Although infrastructures and agriculture are often considered key areas for action from an economic perspective, giving ecosystems, natural resources, migration and health considerations values too – and taking them into account in the calculations – would promote a more truthful understanding of the impacts on society and the economy, and encourage adaptation.

By calculating the risks related to climate change and the costs of adaptation measures in different regions and sectors, member states, regions and businesses in Europe will gain a clearer understanding of the quantitative side of climate-change adaptation. At the same time, more studies and data are needed regarding low-probability, high-severity risks.

These calculations must be combined with examples of cost-effective adaptation measures, including not only structural changes but also soft measures, such as behavioural adaptation. Synergies and trade-offs between mitigation and adaptation efforts must be recognised and assessed. Developing indicators to measure the impact of adaptation efforts could help to compare best practices between member states and regions.

In addition, member states and regions need to be made aware of EU policies and programmes that can support their adaptation efforts, particularly financially. More examples of successful public-private partnerships are also needed.

The aim of the knowledge base must be to enable national and local authorities, together with businesses, to take smart and well-informed investment decisions and to implement cost-effective and sustainable adaptation measures. The EU needs to engage with member states, non-governmental organisations and businesses, including insurance companies, in building this knowledge base.

More **awareness-raising and communication** between the EU and its member states is needed in order to address fears related to calculating uncertainties and promoting adaptation. It is important to stress that regardless of the climate scenario, the necessary actions tend to remain the same. Cost-benefit studies need to be more effectively communicated and distributed more widely. More transparency via the European Climate Adaptation Platform and comparisons of existing practices could also help to promote a sense of urgency among regions and member states. Adaptation measures benefit industries, not least by lowering insurance premiums, and thus information sharing is needed among businesses too.

Financing adaptation projects requires **clear guidelines and criteria**. The EU must ensure that climate risk assessment and prevention is integrated into every project and activity it finances. These projects must be supported by assessments that take into consideration the potential consequences of climate-change

[35] Baur, E. (ed.) (2011): *"Closing the financial gap - New partnerships between the public and private sectors to finance disaster risks".* Swiss Re, Zurich, Switzerland, p.13. Available at http://media.swissre.com/documents/pub_closing_the_financial_gap_W1.pdf, accessed on 10 September 2012.

scenarios in that specific area, for that specific sector. All stakeholders must be encouraged to develop adaptation strategies, which consist of analysis of the economic, social and environmental risks, a preparedness plan, including managing assets and risks, and a 'to-do-list': what needs to be done and by whom at a time of crisis.

Adaptation to climate change must be **mainstreamed** across all relevant EU policies and instruments for financial assistance. This starts with ensuring that the Multiannual Financial Framework for 2014-2020 supports both mitigation and adaptation, and that regional and local actors can access and fully benefit from relevant programmes.

At the same time, it is vital for the EU and its member states to cooperate in using the **market and regulatory mechanisms** to steer the market towards the development and deployment of products, services and processes that support adaptation. They must overcome the challenge of short-term decision-making, which undermines long-term benefits. Regulation and standards should be used to provide member states, regions and private-sector actors with incentives to invest in adaptation. The starting point is to climate-proof EU policies and EU-funded projects and to ensure that they are in line with mitigation and adaptation objectives. For example, building regulations should consider both the aims of mitigation and adaptation, and environmental impact assessments for national and EU projects should take into account not only the current but also the future environment. In addition, policy instruments such as price signals, financing schemes via public-private partnerships, and regulatory and research and development incentives can encourage greater participation from private actors. Public policy should also be used to overcome market imperfections such as high insurance premiums for poor households, which are often located in areas that are most vulnerable to the impacts of climate change.

The needs of the most vulnerable sections of society must not be forgotten. Society's most vulnerable groups will require information, investment assistance and subsidies for insurance. Member states and regions that run the risk of suffering the most should be encouraged and guided to take action.

People must be provided with the necessary **skills and training** to make informed investment decisions, to carry out adaptation projects and to know what is expected of them in cases of extreme weather events. The European Social Fund can be a valuable instrument to fund the required skills and training.

Chapter

6

SUMMARY OF RECOMMENDATIONS

As the European Commission works on the EU Strategy for Adaptation and the EU aims to finalise its budget for 2014-2020, a number issues should be borne in mind with regard to adaptation in Europe. The EPC-KBF Climate Change Adaptation Task Force's discussions on the impacts of climate change and the importance of adaptation for agriculture and natural resources, infrastructures and Europeans' health and well-being – as well as the economics of climate change adaptation – led the Task Force to conclude that the following eight measures should be promoted:

- **Building the knowledge-base**
  - Europe must learn from past experiences and from other regions, and gather more evidence about the possible impacts of climate change, and especially about low-probability, high-severity risks, on different regions and sectors.
  - Europe needs to build a knowledge base on cost-efficient adaptation measures and make the case for adaptation, while demonstrating the urgency of action. EU member states and regions must understand the costs of inaction. More information is needed about 'bad' adaptation measures that can have unwanted consequences.
  - Europe needs to invest in and utilise early warning systems and improve monitoring of environmental catastrophes and changing weather patterns, not only in Europe but also outside its borders.
    - A role for research institutes, member states and local authorities, institutional actors such as the European Commission and the European Environmental Agency (EEA) and private sector actors.

- **Building capacities to act**
  - People must be provided with the skills and training required to make the right decisions with regard to adaptation, from investment decisions to acting in the event of an emergency. Response capacity must be improved across society and across sectors.
    - A role for member states, local authorities and employers, but also for the EU.

- **Communicating and raising awareness about adaptation**
  - Both top-down and bottom-up channels of communication are needed to make member states, public and private actors and citizens aware of the short-, medium- and long-term benefits of adaptation. Efficient communication provides policy- and decision-makers with evidence of possible damage costs and the net benefits of action, and gives them a basis to decide on the adaptation measures required.

- ➢ The EU's Climate Adaptation Platform should play an important role not only in providing guidance, sharing existing adaptation practices and distributing cost-benefit studies, but also in promoting a sense of urgency among governments, regions and businesses.
- ➢ Adaptation projects should also take into account the interests of citizens, and thus become creative projects for the whole community.

- **Mitigation and adaptation should be mainstreamed together across policies**
  - o Regulation and standards should be used to provide member states, regions and private-sector actors with incentives to adapt. Climate-proofing EU policies and EU-funded projects means making sure that they meet the objectives of mitigation and adaptation policies. This requires recognising and addressing the synergies and trade-offs between climate change mitigation and adaptation.
    - ➢ Role for EU, member states, regions, local authorities

- **Financing adaptation projects requires clear guidelines and criteria**
  - o EU financial instruments, such as the Cohesion Fund and the CAP, should be reviewed so that they support the most effective mitigation and adaptation measures, and reward forward-looking actions.
  - o Financial adaptation assistance should only be given to projects which are supported by assessments that take into consideration the potential consequences of climate-change scenarios in a specific area, in a specific sector. Good adaptation strategies consist of a preparedness plan, knowing how to manage assets and risks, and having information on what needs to be done and by whom at a time of crisis. They also consider the potential economic, social and environmental impacts of the adaptation measure. Financing adaptation must focus on both soft and hard measures.
    - ➢ Role for EU, EIB, member states, private sector

- **Encouraging innovation and creating a market place for adaptation**
  - o Europe needs a coordinated approach to climate change adaptation, which is not only top-down but also encourages bottom-up participation in the development of adaptation strategies and measures. When possible adaptation measures should aim to be creative projects that bring together policymakers, academic researchers, private companies and NGOs, and create co-benefits for society and contribute to more sustainable growth.
  - o The EU should use policy instruments such as price signals, financing schemes via public-private partnerships, and regulatory and research and development incentives to address market failures and encourage private sector to contribute to strengthening adaptive capacities, preparedness and response actions in Europe. The timeframe for investment should be optimised to ensure that not all investments are made at once.
    - ➢ Role for EU institutions, public and private actors

- **Sharing the burden and taking into account the needs of the most vulnerable in society**
  - o The EU should pay special attention and target member states, regions and sectors that run the risk of suffering the most. This should start with knowledge-sharing and assistance with national and regional strategies.
  - o National and regional adaptation strategies but also the EU's forthcoming adaptation strategy should promote social justice. They should consider both the negative and positive implications of adaptation measures for society, the economy and the environment, and they should ensure that

those who would suffer most from the potential impacts of climate change have the knowledge and the tools to adapt and to act, including access to insurance and investment assistance.

- ➢ Role for EU, member states, regions, businesses, citizens

- **Setting a vision for adaptation**
  - The EU must create a vision for adaptation and should consider setting indicators for good adaptation measures. The starting point is to ensure that member states, and if possible regions, finalise their adaptation strategies. To support this, the EU should provide member states as well as regional and local authorities with indicators that would enable them to develop cost-effective adaptation measures for a given region or sector, which take into consideration their vulnerabilities but also the possible benefits and adverse effects of these measures.
    - ➢ Role for EU, member states, regions

Chapter

7

CONCLUSION

While the climate challenge has fallen off the political radar amid the focus on the economic crisis and fiscal consolidation, the reality has not changed. The climate is changing, which is visible through extreme weather events such as heat waves, floods and storms, changing weather and environmental conditions such as longer warm periods and rising sea levels, and more frequent environmental disasters such as forest fires. The impacts of these changes are already being felt in Europe, across different regions and sectors – and if global warming continues at its current speed, the implications will become even graver economically, socially and environmentally.

In order to tackle the climate change challenge, Europe needs a vision for the future. It needs short, medium and long-term objectives, in order to fight the causes and adapt to the consequences of climate change. Action cannot wait. Mitigation and adaptation must be included in the broader economic and social narrative for Europe.

Without action, the resulting costs for the economy and society may become intolerable and result in an even greater economic crisis. Nevertheless, finding the right balance between reducing greenhouse-gas emissions and preparing for the consequences of climate change on the one hand and promoting cost-effective and innovative mitigation and adaptation efforts on the other can become a source of growth, employment and increased competitiveness for Europe. Thus the EU must provide direction and promote the necessary framework for action.

It must be stressed that without a major effort to tackle the causes of climate change, adaptation costs may put a significant burden on economies and in the long-run mitigation will be less costly than adaptation. However, even the best mitigation efforts will not prevent forest fires or floods, which climate change can cause and which are already affecting us today. Europe must wake up to the challenges and possibilities that cost-effective and creative adaptation efforts can bring.

As shown in this paper, measures to adapt to both observed and anticipated impacts of climate change can be diverse. They can include preparing more effectively for disasters by, for example, organising awareness campaigns, monitoring changes, strengthening people's capacities and skills, implementing early-warning systems, making structural changes such as building dams, sea walls and water reservoirs, and changing behaviour and practices by, for example, transforming land use, altering farming practices and crop varieties, enhancing energy and water-use efficiency, and promoting health. While not all adaptation measures need to be costly, it is obvious that as the impacts of climate change become more severe, preparing for acceptable levels of risk can also require significant investments, especially when developing and managing infrastructures.

Thus adaptation should be seen as an opportunity to innovate and to find ways to tackle the greatest vulnerabilities in a cost-effective manner. Co-creating solutions by involving local, regional and national

policymakers, researchers, NGOs, and public and private actors can encourage innovation, bring down the costs of adaptation and strengthen ownership and acceptance of these measures. One good example is multi-functional dikes, which when unused can function as roads or as areas for recreation and sports, thus providing value for societies from the first day of investment.

Smart and effective adaptation efforts build on evidence about the possible impacts of climate change and learn from past adaptation experiences both in the EU as well as outside its borders. They take into consideration the potential consequences of climate-change scenarios as well as existing vulnerabilities in a specific location or sector. Good adaptation strategies include a preparedness plan, knowing how to manage assets and risks, and having information on what needs to be done and by whom at a time of crisis. They also consider the potential economic, social and environmental impacts of the adaptation measure.

For all these adaptation efforts, whether they take the form of a policy or a project, it is essential for the EU and the member states to identify those populations and groups that are most vulnerable to the adverse impacts of climate change. For example, older and young people, the disabled or less wealthy citizens stand to suffer most during extreme weather events. The less wealthy are also more likely to lack insurance to protect them against environmental catastrophes. The authorities must pay attention to building the capacities of the more vulnerable groups to handle the negative impacts and ensure that adaptation efforts target also their needs.

While adaptation projects are normally implemented at local or national level, involving all levels of government from local to European level – and receiving support from the private sector in the form of financing and expertise – is the key to successful adaptation. As argued in this paper, the EU can and must play a stronger role in creating a policy and financing framework which encourages a multi-stakeholder approach to adaptation. This includes funding research, sharing best practices, coordinating national activities, integrating climate change concerns and adaptation into existing sectoral EU policies – for example on water, construction, energy and floods – improving impact assessments, providing incentives for private sector actors to participate, and ensuring that future instruments, such as the Multiannual Financial Framework for 2013-2020, including the CAP and Cohesion Policy, support both mitigation and adaptation objectives.

The EU Adaptation Strategy, which is expected to be adopted by the European Commission in the spring of 2013, is an important attempt to put the issue on Europe's political agenda. The EU can have a significant role in adaptation, and the strategy should provide a clear framework for action.

Adaptation policies and measures cannot wait. The EU can provide information, guidelines and an institutional framework for adaptation, and then it is up to the member states and the regions to show their commitment and to act. In the end, adapting to the climate change challenge is a political decision which can bring significant economic, social and environmental benefits to society.

Annex 1 - Members of the Task Force

This publication summarises and builds on the discussions, which took place within the EPC-KBF's Task Force on Climate Adaptation. During the course of the project, representatives from over 60 organisations participated in and contributed to discussions on various aspects of climate-change adaptation. The EPC would like to thank all the members of the Task Force for their participation and for the time and energy they devoted to this work.

ADEME (French Environment and Energy Management Agency)
BASF - The Chemical Company
Bremen Representation in Brussels
BUSINESSEUROPE
CEFIC (European Chemical Industry Council)
Central Denmark EU Office
Central Europe Energy Partners
ČEZ GROUP
Confederation of EU Yeast Producers (COFALEC)
Convention of Scottish Local Authorities (COSLA)
COWI Belgium
Daimler
Delegation of the Government of Catalonia
East Sweden Region
Embraer (Empresa Brasileira de Aeronautica)
Ernst & Young
EU-Representation Office of Carinthia
Eurochambres
Eurocities
European Climate Foundation
European Commission
European Fertilizer Manufacturers Association
European Investment Bank
European Parliament
European Trade Union Confederation
European Trade Union Institute
Finmeccanica / Telespazio
General Electric (GE)
GSK (GlaxoSmithKline Consumer Healthcare Europe)
Hanse-Office
Hill & Knowlton International Belgium
IBM
Institute for Environmental Policy (IEEP)
Ile-de-France Europe
Johnson & Johnson
Kreab & Gavin Anderson Worldwide
Lancaster University
Microsoft
Mission of Japan to the European Union
Mission of Norway to the EU
Mission of Switzerland to the EU
Mission of the Republic of Croatia to the EU
Mission of the Republic of Macedonia to the EU
Mission of Montenegro to the EU
Mission of Ukraine to the EU
North Sweden European Office
Office of the Northern Ireland Executive
Permanent Representation of Austria to the EU
Permanent Representation of Poland to the EU
Province of Limburg
Representation of the Free State of Bavaria to the EU
Scottish Government EU Office
South Finland - EU Office
Das Land Steiermark
Suez Environment
Swiss Re
The European Trade Union Institute
Turkish Industry and Business Association
UKCIP
ULB (Université Libre de Bruxelles)
United Nations Development Programme (UNDP)
West Norway Office
World Health Organisation (WHO)
World Bank Group
WWF European Policy Office

Annex 2 - Contributors to the Task Force Discussions

The themes addressed in this publication were initially discussed at the meetings of the EPC-KBF Task Force on Climate Change Adaptation in 2010-2012. The EPC would like to thank the speakers who reflected on the current climate challenges, ongoing developments with regard to adaptation, and the co-benefits that tackling the climate change challenge could bring for Europe, and thus gave valuable input to the discussions.

The speakers were:

Hazel Baird	NHS European Office
Rosário Bento Pais	European Commission
Joan Canton	European Commission
Claudio Catalano	Finmeccanica
Laure Chabuis	European Commission
Thomas De Lannoy	European Commission
Claus Hvashøj Jørgensen	COWI
Agnes Kelemen	European Commission
Christian Kirchsteiger	European Commission
Claus Kondrup	European Commission
Bettina Menne	WHO Europe
Florence Mourey	SUEZ Environment
Philippe Pochet	European Trade Union Institute (ETUI)
Patrick Pringle	UK Climate Impacts Programme
John F. Ryan	European Commission
Nancy Saich	European Investment Bank
Antony So	Microsoft
Andreas Spiegel	Swiss Reinsurance Company
Hilkka Summa	European Commission
Pascale Taminiaux	King Baudouin Foundation
Nikolaus van den Pas	European Policy Centre (EPC)
Denise Van Regenmorter	Katholike Universiteit Leuven
Natasha Walker	Facilitator