Chapter 2

Addressing Adaptation in the EU Policy Framework

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Abstract:

Though the EU's climate change mitigation strategy has taken precedence over adaptation, there are signs this is beginning to change. With the publication of both a Green (2007) and a White Paper (2009) on an EU Adaptation strategy, the European Commission has taken the important step of initiating broad discussion and encouraging the *mainstreaming* or integration of adaptation strategies into the existing EU and Member state policy framework. Still, without extensive revision—in particular in the direction of ecosystem preservation, improvement and creation—and the parallel introduction of a Climate Change Commission mandated to pursue mitigation *AND* adaptation strategies in the Community interest, policy outcomes are likely to remain fragmented and suboptimal. Institutional divisions at the EU and national levels reinforce sectorally-driven climate strategies that only partially address the goals of either mitigation or adaptation. Among other policy suggestions, this chapter makes two broad recommendations. First, the EU and the Member states should seriously re-evaluate the approach to such policies as the water framework directive, Natura 2000 sites and biodiversity, afforestation, ecosystem services and ecosystem preservation. Second, significant institutional reforms could heighten EU commitment to the climate change agenda, reinforce its already significant international bargaining authority and broaden the focus and impact of the EU's growing mitigation and adaptation agenda. Rapidly changing climate dynamics leave little room to dally.

Key words:

Adaptation, Climate Change, EU, Water Framework Directive, Natura 2000, Afforestation

Table of Contents

2.1 Introduction

Rising temperatures, changing precipitation, increased flooding, droughts and other extreme weather events, the rise of invasive species, all conspire to encourage and ultimately require renewed attention to the challenges of climate change. Yet European Union (EU) strategies to address climate change – apart from its rapidly growing mitigation agenda – remain in their infancy. Thus far, the EU has focused almost exclusively on the mitigation of greenhouse gas (GHG) emissions with the goal of limiting the increase of the average global temperature to +2°C. To do so, the EU has set a target for emissions reductions of 20% based on 1990 levels by the year 2020 (30% in the event of an international agreement), to be met through reductions in carbon intensity, reductions in energy use, increases in energy efficiency and a rise in the use of renewable energy resources. Though a considerable amount of research on climate impacts and adaptation needs is gradually becoming available – much of it EU-funded – the ambitiousness of EU mitigation and research efforts has not been equally matched. To date, the EU has neither defined nor set a clear strategy for adaptation to climate change. Whether these initial observations foretell the future weighting of EU climate strategies remains an open question. While mitigation may continue to receive the greater amount of attention, the current rapidity of climate change suggests this adaptation must be addressed with equal vigour.

Currently at the White Paper stage in the development of an EU Adaptation strategy, the European Commission – along with the help of stakeholders and other experts from EU Member States – has already gone through several rounds of consultation and discussion. Launched under the framework of the Second European Climate Change Programme (ECCP II) in 2005, the adaptation agenda has gradually gained momentum, leading first to the Commission's publication of a Green Paper *Adapting to Climate Change in Europe* in 2007 and then a White Paper *Adapting to Climate Change: towards a European Framework for Action* in April 2009. With the publication of the White Paper, the EU has formally announced its intention to develop and formulate a formal Adaptation Strategy over the period 2009-2012 and to implement this EU Adaptation Strategy by 2013.

This chapter explores how adaptation to climate change is being approached at the EU-level and possible implications for Member States. Generally speaking, EU Member States have been encouraged to develop adaptation strategies on their own but have no legal obligations to do so. However, the completion of (and the *failure* to complete) national adaptation strategies will likely influence the relative success of an EU-level effort. Due in part to tremendous variation in climate impacts expected across the European continent, many more EU Member States must first complete the task of developing independent strategies in order to contribute meaningfully to the development of an appropriate EU-level strategy. Thus far, only eight or nine of the 27 EU Member States have done so.[1]

[1] For up-to date information on which countries have completed Adaptation strategies and which have not, see the EEA's National Adaptation Strategy registry: http://www.eea.europa.eu/themes/climate/national-adaptation-strategies. See also Swart et al (2009), Massey (2009) and Massey and Bergsma (2008).

In addition to a number of smaller claims, this chapter has two principal recommendations. The first is that the EU should go much further in developing an adaptation strategy. Though the intention of mainstreaming adaptation strategies into the existing policy framework as rapidly as possible represents a courageous effort, in many ways the EU needs to think far more broadly and carefully about the interconnected relationships across different sectors and to develop more comprehensive and deliberate strategies for responding to the climate challenge. Most importantly in this context, the EU should seriously consider extending its focus on an ecosystem services approach to an ecosystems approach which, in addition to defining the value of its services, is also designed to protect, improve and create ecosystems. Though there is already an extensive literature on the importance of ecosystems for human survival, the implementation of relevant policy strategies currently falls short. Moreover, piecemeal sectoral efforts, such as raising water use efficiency, afforestation, or shifting to renewable energy use – important goals in their own right – should be considered in the general context of the far grander goal of protecting, maintaining and creating ecosystems.

The second recommendation is that the EU should move rapidly to create a Climate Change Commission. There are many reasons for this recommendation, not the least of which is to strengthen and heighten the symbolic impact of the EU's already significant international role in the promotion of the climate agenda. In addition to this, the EU needs to devise a strategy to overcome the current fragmentation of policy efforts. This is necessary in order for the EU (and ultimately other countries) to pursue successful mitigation and adaptation strategies. Though increased coordination and communication across the different institutions of the European Commission and with national, regional and local level interests in the Member States are helpful goals, without the centralisation of a mandate to address mitigation and adaptation in a single institution, relevant but competing interests will be neglected or ignored. The outcome is a less coordinated, comprehensive or targeted adaptation strategy.

This chapter is organised as follows: the first section addresses the current state of play regarding the EU adaptation strategy, discussing first the Green and the White Papers on the EU Adaptation strategy, the role played by the Member States, current efforts at building a knowledge-base on climate impacts in the EU, and initial EU sectoral level efforts. The second section addresses the interconnectedness of adaptation needs across a wide range of policy areas and addresses policy choices with regard to water and biodiversity management. The third section provides a more detailed discussion of the importance of ecosystem protection, improvement and creation. The fourth section elaborates the reasoning behind the recommendation for establishing a Climate Change Commission and provides detail on the consequences of not pursuing this strategy. The fifth section concludes.

2.2 From the ECCP to the Green and White Papers on Adaptation

With adaptation to climate change, the EU faces a moving target fraught with considerable uncertainty. While IPCC (Intergovernmental Panel on Climate Change) scenarios up through 2007 projected atmospheric concentration levels and potential temperature change through 2100, *near-term* global warming and climate change was frequently not considered as severe or threatening. This view is changing. In September 2009, UNEP (the United Nations Environment

Programme) came out with the Climate Change 2009 Science Compendium (McMullen and Jabbour 2009), a publication intended to raise the level of awareness of recent literature suggesting climate change is happening far more rapidly than originally predicted. The actual extent and magnitude of warming and its related impacts are potentially much greater than originally reported. Under a *business-as-usual* scenario, Sokolov et al. (2009) project the world could reach temperatures of +5.2°C by 2100. Though this recent estimate is twice as high as one from 2003, Hansen et al. (2008) suggest similar prospects and the Global Carbon Project recently suggested the world is currently on course for the 6°C mark by 2100.[2] In particular, both the failure to address climate feedback mechanisms in the IPCC's 2007 Synthesis Report and an assessment process based on broad consensus presumably constrained many of the baseline IPCC conclusions, rendering them more conservative than some of today's findings.[3]

Many of the assumptions upon which the European Commission's analysis is based may thus be open to criticism – in particular regarding the global GHG reduction target required in order to achieve the EU's proposed +2ºC ceiling on global warming. Though the Commission's Green and White Papers on adaptation are based on IPCC guidelines, these are now considered conservative and out-dated. Authors focus, in particular, on discussion of the proposed atmospheric concentration target. Hansen et al. (2008) and Hansen, Sato et al. (2009), for example, argue humanity should aim far lower than the IPCC's proposed maximum atmospheric concentration target of 450ppm, suggesting instead that 350ppm (2008) or 300-325ppm (2009) is advisable. A much lower atmospheric concentration target also means countries will have to undertake far more significant emission reductions than originally proposed.

Despite the increasing urgency of climate change and global warming, to-date no single policy in the EU has been specifically designed to address adaptation to climate change. Though a relatively broad range of EU policies have potential relevance for adaptation or could be conceived as indirectly addressing adaptation, for the most part this has never been the direct intent of current EU legislation.

Though the findings of the broad range of climate impact studies cannot be reproduced here, thinking from the Green to the White Paper on the potential climate impacts and thus the related EU policy responses has evolved dramatically. Based primarily on the findings of the PESETA study,[4] the climate impact assessments in the Green Paper are relatively rudimentary compared to the analysis that emerges in the White Paper and the flurry of impact studies discussed below.

It is expressly difficult to point to individual triggers of the push toward an EU-level policy on climate adaptation. The emphasis on an EU-level strategy wells up from various directions in the EU and international policy arena (see also Swart et al, 2009: Ch.3). For one, the research community has contributed significantly to a rapidly expanding understanding of climate impacts and the potential need for policy-related responses. For another, the United Nations Framework Convention on Climate Change (UNFCCC) has likewise provided strong impetus and motivation for both individual signatory states and also the European Union to make progress on the

[2] See 'World on course for catastrophic 6° rise, reveal scientists' (*The Independent*, Nov. 18th 2009).
[3] On climate change feedbacks and potential tipping phenomena, see in particular Lenton et al (2008).
[4] The PESETA study was in fact incomplete at the time. The final conclusions of the PESETA study have only just recently been made available. See Ciscar (2009).

development of adaptation strategies through the requirement of National Communication reporting to the UNFCCC on adaptation efforts. Finally, both the rapidity of climate change and the increasingly frequent occurrence of potentially climate change-related events such as floods, droughts and other extreme weather events provide powerful motivation for the pursuit of adaptation strategies at the sectoral, regional and national levels, as well as the EU level. In this regard, sectoral level actors and stakeholders, related research communities and NGO's all provide potential pressure points for EU action on issues such as water management, flood control, the development of forestry policies and in other areas.

The current White Paper strategy is composed of four basic pillars that define a future course for the preparation and formulation of an EU Adaptation strategy. Compared to the original four pillars in the 2007 Green Paper, the White Paper reveals several shifts in emphasis (see Table 2.1).

[Insert Table 2.1]

The transition from the Green to the White Paper has resulted in an upgrading of the agenda to incorporate or 'mainstream' adaptation strategies into the framework of existing EU policies and thus a downgrading of the participatory agenda and the inclusion of stakeholders in the adaptation debate. Additional changes in emphasis between the Green and the White Papers involve the upgrading of the need for research and a solid information database on the impacts of climate change and the slight downgrading (at least in terms of the order of priorities) in the external dimension. In the White Paper, uncertainty is pushed into the background, perhaps paving the way for more resolute EU level action on adaptation research and the development of adaptation strategies. Thus, an emphasis on the development of a solid knowledge base has been pushed to the foreground of EU activities.

The shift away from the 'early action' feature in the first pillar of the Green Paper may be partly explained by the changing degree of urgency. It is awkward to classify policy efforts as 'early action' when the rate of climate change is rapidly turning these into 'reactionary' rather than 'anticipatory' measures. In a very real sense, the EU (along with the rest of the world) is significantly behind the game of climate mitigation and adaptation. Climate change and global warming are well upon us.

On the other hand, the Annex to the EU White Paper on Adaptation (European Commission 2009b) outlines the next steps in the EU strategy and, in particular, details where and in what sectors 'early efforts' – perhaps we should now be referring to the EU's 'first' efforts – at adaptation should be made. The points raised in the Annex provide a strong foundation from which to begin the work of integrating ('mainstreaming') adaptation into the existing EU policy framework. Annex 2 develops, in particular, three general 'cross-cutting issues', water, land and biodiversity/ecosystems while Annex 3 goes on to discuss the importance of eight different sectors and the EU's external dimension (or foreign policy concerns); Agriculture, forests and forestry, fisheries and aquaculture, energy, infrastructures and buildings, industry and services, health, coastal areas and finally the external dimension.

In the framework of Pillar II efforts, Annex 5 of the White Paper outlines a series of potential action points where the Commission and the EU more generally could immediately dig in and begin to elaborate an adaptation strategy. Without providing an exhaustive list, the White Paper notes that strategies for addressing the effects of climate change should be mainstreamed into the Natura 2000 framework, the consideration of River Basin Management Plans (RBMP) and the Floods Directive, the EU Maritime Policy and the Marine Strategy Framework Directive, as well as the Strategic Energy Review and the Common Transport Policy (European Commission 2009b: 127-8). In this regard, the Commission has also committed to proposing guidelines to assist Member States in considering adaptation-related goals in their implementation of a number of EU policies. In particular, the Commission has committed to proposing guidelines for mainstreaming or integrating adaptation in the Water Framework Directive (WFD) (by 2009), on health impacts (by 2011), on RBMP (by 2009), Natura 2000 sites (by 2010), for coastal marine areas (no date specified), as well as other areas (European Commission 2009a).

2.2.1 EU-funded research and resources

As suggested by the rapidly expanding amount of research on climate impacts and adaptation needs, just beneath the surface quite a bit has been going on at the EU and other levels. Both the assessment of vulnerability to climate impacts in Europe and the development of strategies for adapting to climate change are currently under significant scrutiny. The research community has been fully engaged in the research and development of a solid knowledge base for an adaptation agenda, both through the European Commission, as it clearly draws upon the work of the research community, as well as through individual Member state research projects on climate impacts and adaptation.

In important ways the EU, like the Member States, has been spurred forward by the UNFCCC requirement of reporting on adaptation efforts. The first large-scale EU level study on climate impacts and adaptation needs was coordinated by Martin Parry (2000) and conducted through the Jackson Environment Institute of the University of East Anglia.[5] The ACACIA project ran from 1998-2000 and provided the foundation for the impacts and adaptation section of the EU's 2001 Third Communication to the UNFCCC. The ACACIA work was further extended and broadened by Kunzewicz, Parry et al (2001) as part of the Adaptation in Europe contribution to the IPCC Third Assessment report. Though the Third Communication to the UNFCCC and the IPCC reports provide the first significant emphasis of EU reporting on impacts and adaptation, it precedes both ECCP WG II work on this topic as well as the Commission's later work on the Green and White Papers.

The study of climate impacts resulting from global warming and climate change has evolved significantly in recent years at the broad EU level, though in some cases research investments at the national level have been scaled down.[6] Though there is ultimately a relatively large gap between the ACACIA project (1998-2000) and later large-scale EU research projects, studies of regional and local level climate change impacts have been more numerous in recent years. This

[5] The only other somewhat larger scale project prior to the ACACIA project was the ESCAPE project completed in the early 1990s. See Rotmans, Hulme and Downing (1994).
[6] One commentator argued that this has been the case in particular in Finland in recent years.

gap is acknowledged by the Commission in its Fourth Communication to the UNFCCC. Since the ACACIA project,

> there have been no large-scale studies on adaptation at the EU level, although the European Commission recognised the need to undertake further research and to develop adaptation strategies in their working paper 'Winning the battle against global climate change'. Most of the policy action currently in this area is undertaken by individual Member States and will be reported in their Fourth National Communications. (European Commission 2006a, p. 106)

More recently, the EU has made significant progress with the preparation and publication of extensive background assessments. In particular, very substantial EU level reports on vulnerability and adaptation requirements have been prepared by the Commission's Joint Research Centre (JRC),[7] and the European Environment Agency (EEA 2008). In addition, studies have been sponsored by the Commission for Agriculture and Rural Development on adaptation to climate change in the agricultural sector (AEA 2007) and on impact and adaptation requirements in forestry (EFI-BOKU-INRA-IAFS 2008). A second report on Adaptation issues in Europe was also completed by Alcamo et al (2007) in the framework of the IPCC's Fourth Assessment. All of these studies have informed Commission work on the Green and White Papers. The earlier PESETA study by the JRC formed the principal foundation for the Green Paper and the EEA, JRC and DG Agriculture reports formed the basis of White Paper.

Apart from national level projects however, there were a number of smaller scale research projects not mentioned in the EU's national communication that nonetheless deserve note. The PRUDENCE project, for example, aimed at developing better temperature and precipitation prediction maps of Europe, at significantly higher resolution (from 300km grids down to 50km grids, see Christensen, Rummukainen and Amanatidis, 2007).[8]

In the longer run, a significant amount of EU funded research is engaged in the analysis of climate change, its impacts and adaptation requirements. In preparation for the 15th UN Conference of the Parties meetings in December 2009 and an earlier conference in Geneva at the end of August, the European Research Commission compiled a document on EU-funded 6th and 7th Research Framework Programs on climate change. At 357 pages, the document lists a substantial number of EU projects. Though not all of these projects deal specifically with adaptation, the opening foreword explicitly points out that more knowledge is required in particular on, 'understanding of the climate system, on the evaluation of the impacts and on the identification and assessment of options for mitigation and adaptation' (DG Research 2009, p. 1). In total, the report covers 134 research projects to which €543 million have been dedicated. Moreover, this tabulation is not exhaustive, since research in other areas such as energy and transport may have spill-over or overlapping implications. Approximately half of this report on research covers projects dealing with impacts (Chapter Five), natural hazards and extreme events

[7] In particular, the JRC's then unfinished version of the PESETA project provides much of the foundation for the Green Paper and the Annex to the Green Paper. See for example the website of the PESETA project: http://peseta.jrc.ec.europa.eu/ and also the final report published in 2009 (Ciscar, 2009).

[8] The ENSEMBLES project, which followed up on the PRUDENCE project, has further refined the level of resolution to 25km and some regional projects manage even higher resolution projection maps. See Van der Linden and Mitchell (2009).

(Chapter Six) and adaptation (Chapter Seven). Though the balance of research investment may still favour climate change mitigation related studies, adaptation has become a significant focus of EU research.

2.2.2 The ECCP and the development of National Adaptation Strategies

Rather than the EU, the Member states have taken on primary responsibility for the development of adaptation strategies. The EU however has played an important part in this process and the decision to move ahead first with national-level adaptation strategies (NAS) was at least in part the result of decisions made within the framework of discussions organized by the European Commission. In fact, one of the express goals of the ECCP II initiated in 2005 was to oversee the process of developing National Adaptation Strategies in the Member States. The ECCP II was intended to help 'define the role of the community in adaptation', 'encourage Member States to draft national adaptation strategies' and to help Member states identify optimal patterns of resource allocation and efficient resource use (ECCP WG II, 2007; European Commission 2006a: 107-8).

The second European Climate Change Programme (ECCP II) addressing climate change was launched in October 2005. Organized by the European Commission for the Environment, this discussion forum included six sub-groups and five stakeholder working groups. Though the first ECCP round from 2000-2003 did not address adaptation, the fifth sub-group of ECCP II was responsible for addressing adaptation and was named Working Group II on Impacts and Adaptation (ECCP WG II).[9] Building in part on EEA impact and adaptation research,[10] ECCP WG II proceeded to organise stakeholder consultations based on a broad sectoral breakdown. These consultations covered nine separate economic sectors (from water resource management, agricultural and forestry, biodiversity, to the role of the insurance industry). In addition, a tenth sub-group addressed national level adaptation strategies.[11] Results for these sectoral reports were published in March 2007.

Among the more interesting outcomes of these meetings was the general expression of a stakeholder interest in limited EU level action and a preference for national level action on adaptation. ECCP WG II's sectoral stakeholder report on Building National Adaptation Strategies points out, 'in keeping with the subsidiarity principle, the development of National Adaptation Strategies falls within the remit of Member States, not the EU' (ECCP WG II 2007, p. 7). The report goes on to note that the, 'stakeholder meetings on climate change impacts and adaptation *recommended that the EU should not introduce any compulsory strategies on adaptation at this stage*'; it was instead suggested the EU should play a '*key supporting role* in

[9] See the Commission's webpage: http://ec.europa.eu/environment/climat/eccpii.htm, and http://ec.europa.eu/environment/climat/eccp_impacts.htm.

[10] The most important reports in this regard were EEA Report No. 2/2004 on *Impacts of Europe's Changing Climate: An Indicator Based Assessment*, and EEA Technical Report No. 7/2005 on *Vulnerability and Adaptation to Climate Change in Europe*.

[11] For more detail and access to the sectoral reports, see: http://ec.europa.eu/environment/climat/eccp_impacts.htm.

providing a long-term view and in encouraging information sharing, and providing tools' (ECCP WG II 2007, p. 7, author's emphasis). Though multiple options were considered – including mandating that Member States develop National adaptation strategies – the final stakeholder recommendation was for the EU to 'lend support to Member States developing National Adaptation strategies'.

A second round of public and stakeholder consultations was undertaken after the June 2007 publication of the Commission's Green Paper. A series of three international workshops were organised in 2007, a web-based consultation ran for a period of six months from July to December 2007 and written submissions were encouraged as part of a public consultation.[12] The public and stakeholder consultation process identified that a fairly substantial share of respondents thought more attention should be paid to adaptation needs and more recognition should be granted to variation in impacts across sectors and geographic regions. Though many felt it was unlikely that one response could be crafted to fit the needs of all Member States and regions, there was support for the idea that the EU could provide a 'framework for action'. In one category, only 44% of respondents thought the pace of action was sufficient.

In what ways stakeholders will be involved in future discussions and the elaboration of an EU-specific adaptation strategy is unclear. The EU's past record of involving stakeholders has however been favourable. Moreover, the logic of encouraging Member States to first develop their own NAS in advance of the EU suggests, these strategies will then somehow play into the development of an EU strategy. Some of the work of reviewing and assessing national-level strategies has already begun (cf. Swart et al. 2009; Massey 2009; Massey and Bergsma 2008).[13] Annex Four to the Commission's White Paper on Adaptation likewise provides a preliminary and very brief assessment and overview of the various National Adaptation strategies introduced to date in the Member States (European Commission 2009b).

Though the adoption of National Adaptation Strategies has not been mandated either by the European Commission or the European Council, this process has been encouraged and promoted by the Commission. Since signatory members to the UNFCCC are required – based on Article 4 – to develop national adaptation strategies, the UNFCCC has presumably also played a role – both with respect to individual Member states as well as with respect to the EU. In addition, the UNFCCC requires states to provide information on their adaptation efforts as part of their National Communications to the UNFCCC. To date, UNFCCC signatories – including both the EU and the Member states – have completed four National Communications, many of which have dedicated individual chapters to adaptation. Finally, some EU Member States – though a considerably smaller number – have also begun integrating adaptation strategies into their National Forest Plans (See e.g., Swart et al. 2009; Roberts et al. 2009).

[12] These points outlined in Commission documentation of the consultation process at: http://ec.europa.eu/environment/climat/adaptation/stakeholder_consultation.htm.

[13] Other projects have also attempted to catalogue NAS strategies across countries. One of the more interesting in the context of this chapter is the attempt to catalogue the NAS approach to biodiversity strategies (see the MACIS study paper; University of Oxford 2008). The CIRCLE group, though still at a very preliminary stage, is also involved in assessing approaches to adaptation strategies: http://www.circle-era.net/. The ADAM project (http://www.adamproject.eu/) has likewise attempted to assess and report on adaptation efforts in individual countries.

The EU has thus embarked on a deliberate strategy of encouraging Member States to develop national-level adaptation strategies. The Annex to the 2009 White Paper likewise commits to pushing Member States—in particular those that have not done so – to develop adaptation strategies (European Commission 2009b: 132).

2.2.3 Potential consequences of the national level approach

On the one hand, the specifically local nature of adaptation requirements in individual EU Member States argues strongly in favour of a strategy based first and foremost on the subsidiarity principle and the perceived requirements of individual states. On the other hand, at least three distinct factors point to the advantage of organising intervention and shared burdens at higher levels of governance. First, at least two different logics argue strongly in favour of a burden-sharing arrangement across the Members states of the European Union and for wealth and resource transfers to states that bear a higher share of the adaptation burden. For one, the specifically transboundary nature of CO_2 and GHG pollution means that the countries responsible for creating emissions are not always those that must pay the highest adaptation costs—in particular because these are at least to some extent geographically determined. For another, the uneven nature of climate impacts and their occasional geographic unpredictability – in particular in the case of extreme weather events – further argues in favour of burden-sharing across states and reliance on higher levels of governance (i.e. EU and international). Second, increasing returns to information sharing and the centralisation of some features of adaptation management also have likely benefits.

As arguments in favour of the centralization of adaptation policy at the EU level suggest, an emphasis on the early development of national-level adaptation strategies has some potentially negative side-effects. First, countries with adequate resources will tend to do a better job of developing strategies and will thus find it easier to gain strong footing in the development of any future EU-level policy strategy. Moreover, EU-level strategies will most likely be strongly influenced and perhaps determined by the negotiating positions of individual Member States. Where the interests of a specific set of Member states are better developed and further along, these will likely carry the day over the potential policy interests and adaptation needs of other Member states. Second, though the current EU strategy is focused to some degree on 'effectiveness and efficiency', this approach may not have that effect. Some countries – in particular late-movers – that are not successful in introducing their agendas may have to revise, rewrite or even reverse existing strategies in view of the adoption of an EU-level strategy. Both of these points can likewise incur significant implementation costs.

Though many authors have identified the less advanced, southern EU Member States as more vulnerable to climate change (Massey and Bergsma 2008; Alcamo et al, 2007; Parry 2000), many of the more developed and northern Member States are much further along in the process of thinking about and developing adaptation strategies. This fact harbours at least two potential but very different threats. On the one hand, since many of the Southern Member states are not as far along in the development of adaptation strategies, EU-level policy outcomes could potentially ignore many or some of the issues that are of particular importance to the adaptation needs of the

southern EU Member States. On the other hand, the view that northern states face fewer threats from climate change could unwittingly lull some Member States into inaction. Many in the northern EU Member states tend to downplay the threat of climate change and frequently think of the climate impacts as bringing potential benefits. Higher levels of precipitation in conjunction with warmer temperatures, shorter winters, longer summers and higher CO_2 levels are all seen as potential advantages. Thus, for example, growing seasons will likely be longer and both forestry and agriculture may benefit in the long run. This could, for example, lead northern Member states to be less enthusiastic about the need for Community action and community funded programs.

Other considerations are enough however to suggest however Northern states could be severely impacted as well and thus should have a strong interest in Community action. For one, greater precipitation in the north is also likely to mean a higher incidence of floods in northern regions and potentially also mudslides. For another, invasive or newly competitive species, for example, may represent serious threats in regions that undergo significant climate change but are highly dependent on a relatively small number of plant and tree species—such as the northern timber industry. The strongest example of this type of risk is represented by the mountain pine beetle in the Northwest American continent. Previously not competitively favoured, the mountain pine beetle now thrives on the slightly warmer temperatures and has destroyed many million hectares of timber across the US and Canada. Though no such widely destructive pest currently affects the forest industry in Europe, shifting temperatures and biomes mean the likelihood of such outbreaks will rise. Where these lead to widespread forest devastation, they have potential spill-over effects on the likelihood of forest fires and the reduced carbon sink potential of forests.

For a third, the likelihood of severe weather events does not appear to favour either northern or southern regions. Though events like the Gudrun storm of 2005 in Sweden (which damaged 85 million cubic meters of forest, almost one annual forest cutting) and similar but far less extensive events in Finland (two separate storms in 2001 damaged approximately 7.3 million cubic meters of forest) are relatively uncommon occurrences, the predictions are that their likelihood and frequency will increase (BFH-EFI, 2007: 33). To-date we know relatively little about what this might mean for the future of forest-based industries in these countries, for the carbon sequestration potential of Europe's forests more generally, or even for the increasing pressure being placed on the bioenergy potential of Europe's forests.

To some extent, individual Member States must accept responsibility for helping the EU develop an adequate EU-level adaptation strategy. The decision to first pursue the development of national-level adaptation strategies is a core feature of the current policy development process and was apparently endorsed by the wishes of individual Member states. In this sense, the failure of some Member states to carry through with the development of national-level adaptation strategies cannot easily be blamed upon the EU. On the other hand, the relatively slow development of adaptation strategies in some Member states is likely to weigh significantly on the breadth and quality of the final EU-level outcome.

On the other hand, as suggested above and as argued at much greater length below, the strong coordination of this process at the EU level is potentially beneficial to the development of a successful adaptation strategy. Moreover, though there was previously resistance to an EU-

driven approach, it is presumably time for the EU to significantly upscale its adaptation efforts and to centralize the policy-making process and lend a more significant mandate to national and regional efforts. After several significant rounds of information gathering and stakeholder consultation, the EU appears ready to pursue more significant efforts at implementation.

2.2.4 Sectoral policies and early warning systems in the EU

The EU is most advanced when it comes to building a broad range of knowledge and awareness of the potential climate impacts and the development of early warning and emergency response systems/mechanisms for handling climate-related events (such as severe weather events, forest fires and other emergencies). The EU is least advanced, on the other hand, when it comes to the detailed integration of Adaptation-related policy options and strategies both at the sectoral and of course also at the broader EU level.

In addition to the Green and White Papers, much initial work is also currently being done within individual Commissions in the EU. As the Green Paper points out, some individual Commissions have already begun analysing how and when adaptation to climate change can be integrated into the EU policy framework. Mid-term reviews, for example, were conducted in various Commissions with the goal of addressing the potential integration of climate impacts into sectoral level strategies. Though the word 'adaptation' is never actually mentioned in many of these reviews – an exception is the EU Action Plan on Climate change and Development – there is considerable attention to climate change and its potential impacts.

Of the mid-term reviews noted in the Green Paper, apart from the Action Plan on Climate Change and Development, the Commission's 2007 'Mid Term Review of the European Environment and Health Action Plan 2004-2010' goes furthest in discussing and attempting to address the impacts of climate change. However, at this somewhat early stage, the mid-term review only notes that work is being done to investigate how adaptation strategies can be incorporated into EU health sector policies and points to the fact that several EU-funded research projects investigating the health impacts of climate change were underway and would be emphasised in future funding rounds. A quick glance at the Commission Health and Consumer Protection's webpage on the dissemination of health information and data yields information on a considerable number of climate and adaptation-related projects, as well as links to a number of disaster and potentially weather-related early warning systems (see also above). The announced 2007-2010 research focus on the human and animal health effects of climate change suggests this will be the next area where the Health Commission will focus future policy efforts.[14]

According to the Green Paper, the mid-term review of EU industrial policy was supposed to address 'how industrial policy can contribute to adaptation efforts' (European Commission 2007a, p. 15). Yet not a single mention of adaptation or of addressing climate impacts in any other than the mitigation context appears in the final report. Though many possible climate impacts requiring potential adaptation efforts are likely in industry – related for example to water resource management, flood management or sensitivity to temperature changes – these receive

[14] The Health Commission's webpage clearly outlines its future emphasis on the health effects of climate change (see: http://ec.europa.eu/health/ph_threats/climate/climate_en.htm).

no discussion or analysis. The closest the report comes to noting adaptation concerns is in its expression of support for the Global Monitoring for Environment and Security (GMES) project and its potential to provide 'monitoring and control of climate change impacts' (European Commission 2007c, p. 13). However, as witnessed by a recent report from the World Business Council for Sustainable Development (WBCSD 2009), the business community is clearly interested in and concerned about potential future climate impacts.

The EU Action Plan on Climate Change and Development, on the other hand, devotes considerably more time and attention to adaptation. The Action Plan's second pillar aims to provide support for adaptation in developing countries and the plan highlights specific areas for adaptation-related projects (in particular related to forests, agriculture, water resources and coastal areas).[15] According to the Green Paper, the EU will spend a total of €50 million between 2007-2010 to aid developing countries in promoting dialogue and developing mitigation and adaptation measures (European Commission 2007a, p. 23). According to recent reports, the EU is considering dedicating considerably more financial resources to adaptation efforts in the developing world in the context of the Copenhagen international climate negotiations scheduled for December 2009. The EU's Copenhagen negotiation strategy does include measures intended to address adaptation in the developing world and the EU is currently offering to spend between €2-15 billion per year on developing countries for both mitigation and adaptation efforts. According to the UNFCCC Secretariat, the developing world faces potential adaptation costs of between €23-54 billion per year in 2030. Developing countries are not satisfied with this amount and are requesting far more.[16]

In general, the EU's major spending programs – the Common Agricultural Policy and Rural Development Funds, the Structural and Cohesion Funds and INTERREG (the cross-border cooperation fund) – all allow for spending on adaptation-related measures. What appears to matter more concerning whether or not individual Member States make use of these resources is the degree to which Member States and/or the EU have successfully highlighted and/or prioritised potential adaptation strategies at the national, local and in particular the sectoral level.

The timing of the EU's 2013 target date for the introduction of an official policy deserves some discussion. Though it is difficult to know how pre-meditated this is, the 2013 target date corresponds well both with the introduction of the EU's second major climate strategy (covering the years 2013-2020) and also more or less with the next EU Framework perspective period from 2014-2020. Thus in potentially interesting ways, the EU's timing both pairs efforts at mitigation with the introduction of an official adaptation agenda and simultaneously prepares the way for a potential shift of the EU's regional development and cohesion agenda over to one addressing both mitigation and adaptation. Debate over the future use of the EU's structural and cohesion funding is already firmly underway (see e.g., Begg 2009).

[15] In highlighting these areas for focused attention, the Commission's Action Plan leans on the UNEP/IVM *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies* (1998).

[16] On the EU bargaining position, see (European Commission, 2009d). On bargaining developments at the negotiating table, see e.g.; 'Commission Unveils First Climate Aid Blueprint' (*Euractiv.com*, Sept. 11th 2009).

The EU's 2020 Climate Package concluded in December 2008 and addressing EU climate policy for the period from 2013-2020 has likewise dedicated resources to funding for Adaptation and the development of adaptation strategies. Countries will be permitted to use 50% of revenues from the sale (auction) of unused carbon allowances for goals related to adaptation. In addition, current EU rural development policy also has some funding available for the development of national adaptation strategies. The EU's current 2007-2013 Framework Perspective allows rural development spending for a broad range of different adaptation-related measures in forestry. These include: improving human potential (in particular with respect to active forest management), developing physical potential (in particular with regard to improvements in forest stand management), harvesting (such as efforts to improve machinery or modify harvesting to improve resilience, or reduce damage), forest management planning (in particular concerning change in management planning related to adaptation) and the sustainable use of forestry land (such as establishing and sustaining forest ecosystems with diverse tree composition, age and structure) (see European Commission 2009c: 72-3).

As detailed in part by the EU's Fourth National Communication to the United Nations Framework Convention on Climate Change (European Commission 2006a), the EU has developed a number of early warning systems intended to aid Member States in keeping abreast of and responding to natural, weather and of course potentially *climate-related* phenomena. Whether the strategy of developing early warning systems is only *good practice* or is specifically related to an increasing sense of urgency, attention to the development of early warning systems has spread almost like wildfire across the EU.

Thus, the EU's Fourth National Communication notes the development of the European Flood Alert System (EFAS) and the European Forest Fire Information Systems (EFFIS). Since the Fourth National Communication, however, the EU has introduced the Network of European Meteorological Services (the EU METNET), which provides up-to-date information on weather alerts in all European countries; the European Environment Agency's Ozone Map, which provides up-to-date information on ozone pollution for all European countries; the Water Information System for Europe (WISE) database on water and water quality in Europe; the DAISIE and NOBANIS projects, which catalogue the extent of invasive species in Europe; and the project on the Future Development and Implementation of an EU-level Forest Monitoring Systems (FutMon), which, according to its website, collects both 'quantitative and qualitative forest data related to climate change, air pollution, biodiversity, and forest condition'.[17] With the so-called SEBI indicators program (Streamlining European 2010 Biodiversity Indicators) the European Environment Agency (EEA) is attempting to improve the cross-country comparability of biodiversity indicators for a broad range of European countries, including the current 27 EU Member States.[18]

Finally, some of these monitoring projects, as for example the WISE database and the FutMon project, have been specifically extended to include more *climate-related* information (WISE), or have evolved out of similar projects introduced with a different intent (FutMon). The FutMon

[17] See the FutMon project website: http://www.futmon.org/Project.htm.

[18] See e.g.: 'Europe Must Grasp the True Value of Biodiversity' (EEA Highlight, Apr. 27th 2009).

project, for example, is essentially the outgrowth and extension of the ICP Forest Monitoring project, initially introduced in order to track the effects of pollution on the natural habitat.[19] Among other things, this project has closely tracked the incidence of defoliation, initially the result of acid rain and excess nitrogen use. Likewise of interest with regard to climate change and the incidence of droughts, the monitoring of forest condition (of which defoliation is one component) is being transferred to the FutMon project.

The EU's Fourth National Communication likewise lists a number of other EU projects as adaptation-related. In particular, the communication points to a Community scheme to develop preventative activities against fires (previously through the Forest Focus Regulation and now through Life+, DG Environment's environmental funding mechanism). Though strategies to improve forest fire protection have a relatively long history in the EU and clearly precede attempts to address adaptation, they have received renewed attention as a result of climate change and increasingly warmer temperatures, in particular in Southern Europe. The EU Common Agricultural and Rural Development strategy likewise now provides funding for the restoration of forest resources that have been damaged by natural disasters.

Increased attention has likewise been focused on civil protection in the EU. Council Decision 2002/792/EC (amended in 2007) ensures the coordination of assistance intervention in cases where this is necessary (including forest fires, floods). Moreover, the EU has provided assistance both in Europe and beyond. According to the Community Mechanism for Civil Protection's website, within Europe, assistance was provided to Portugal to help fight forest fires in 2003, 2004 and 2005, and help manage flooding in Romania and Bulgaria in 2005. Assistance has been granted to a significant number of external countries experiencing a variety of emergencies. The EU Solidarity Fund (Council Regulation (EC) No 2012/2002) likewise provides emergency funding and rapid Community response potential for situations classified as 'major disasters' (e.g., in 2003 Portugal received €48.5 million, while Spain received €1.3 million).

Attention to adaptation strategies however is typically lacking in the EU policy sphere. As noted above, there is no single piece of EU legislation that deals explicitly with adaptation. Though the EU has introduced a number of directives with direct or indirect relevance to adaptation, no current Directive can really be seen as an explicit and direct response to climate change adaptation. Thus for example Directives on flood management, on forest fire protection strategies, EU biodiversity commitments, the Natura 2000 program, the Water Framework Directive (WFD) and possibly the Nitrates Directive all have potential relevance for the EU's Adaptation agenda. Moreover, a number of upcoming Directives – such as attempts to introduce an EU Soil Directive and the Invasive Alien Species Act – are likewise of direct or indirect relevance to adaptation.

Though Directives such as the EU Floods Directive and occasionally the water framework Directive (WFD) are seen as potentially direct responses to adaptation, it is important to note the distinct difficulty in determining the impact on flooding that can be specifically attributed to anthropogenic climate change. As pointed out, for example, in the Flood Directive itself, floods are considered natural phenomena that are caused by multiple factors, only one of which is climate change (EU Directive 2007/60/EC). Though the WFD too has relevance for adaptation,

[19] See the website of the Forest Monitoring Project: http://www.icp-forests.org/index.htm.

the primary goal has been to ensure the quality of Europe's waters and waterways. A secondary goal, however, has been to introduce water payment schemes in order to ensure a more efficient use of available water resources. As an example of the *ecosystem services approach* currently advocated by organizations like the EEA – which attempts to place a market price on the use of ecosystems and the goods and services they provide[20] – this strategy dovetails neatly with attempts to manage the potentially climate-related problem of water scarcity, in particular in the southern European states where droughts are becoming ever more prevalent phenomena.

All of these Directives, however, provide excellent opportunities for the EU to begin integrating ('mainstreaming') adaptation strategies into the EU policy framework. At the same time the general EU adaptation strategy ultimately must address a broad range of linkages across a relatively wide range of different and potentially competing policy areas. This raises at least two basic dilemmas. First, as argued below, the existing EU policy framework may only inadequately consider all the competing policy linkages. It may well be necessary in this case to introduce a range of additional policy strategies in order to effectively address adaptation goals. Second, as argued below, the current strategy could ultimately be taken much further by expanding many sectoral strategies into much broader ecosystem-based approaches.

Finally, in the long run, there is no clear commitment in the White Paper to one large over-arching EU adaptation strategy. This raises important questions about how the problem of adaptation will be handled further down the line. It remains unclear, for example, whether the EU will attempt to develop a more concerted over-arching strategy—as it has for mitigation—or whether the EU will remain satisfied with its sectoral level efforts.

2.3 From policy linkage to ecosystem preservation

The monumental complexity of adaptation – in particular in some policy areas – is only just beginning to become apparent. What follows takes a detailed look at two general areas of adaptation, the thematic areas – as outlined in the Annex to the White Paper – of water and biodiversity/ecosystems. Due to time and space constraints, the third thematic element – 'land' – is not treated in this analysis.

[Insert Figure 2.1]

2.3.1 Water and policy linkage

A good example of the complexity of adaptation is provided by a detailed look at the first thematic area: water. The effective management of water resources is in fact a highly complex issue. Well beyond the traditional set of factors likely to impact rising water demand in coming

[20] In concert with the ecosystem services approach, the TEEB Project on *the Economics of Ecosystems and Biodiversity* attempts to provide initial estimates of these costs and their potential conversion into pricing systems. See the TEEB project website at: http://ec.europa.eu/environment/nature/biodiversity/economics/teeb_en.htm.

years—population and economic growth, increased demand for agricultural products, etc.—a broad range of additional considerations suggest the future governance of water will weigh heavily upon the political institutions of Europe and the Member States. Without concerted planning, the 'water wars' of Spain could easily become the water wars of Europe.[21]

A recent study from the EEA (2009a) on water resources and adaptation needs in the Alpine region points to the great complexity of pressures from and on the different sources and users of water (see Figure 2.1). In the context of climate impacts, reduced water availability and the increased potential for droughts – in particular in the water-constrained southern EU Member States—future competition over water resources is likely to be significant and potentially fierce. Almost all relevant sectors – from households to agriculture, industry, tourism, the energy sector and river navigation – are significant users of water resources and could experience significant constraints on water demand. As a result of climate change, water availability – in particular in summer – is likely to decrease substantially in some countries and geographical regions (see e.g. EEA 2009b). If one couples these observations with predictions of the potential impact on agriculture and the energy sector – typically the two biggest water users – one begins to get a sense of the enormity of the problems facing water resource management.

In France, a government report on the drought conditions in the summer of 2003 suggests it was the hottest on record in the last 100 years (see Ministère de L'Économie des Finances et de L'Industrie 2003). As the report notes, reductions in water supply in the rivers led to a 19% reduction of available hydroelectric power (10% of total power in France) and a 4% reduction in available nuclear power (84% of the total). At the same time, compared to the previous year, demand rose by 4.2%. These events led to a series of actions intended to help France keep pace with consumer demand, including appeals to consumer and industrial users to reduce energy use, a reduction of electricity exports and an increase in imports. In addition, several power plants took advantage of environmental derogations that allow warmed water releases above normally acceptable temperatures (four nuclear and two traditional power plants took advantage of these derogations). The situation was seen as critical and the state of demand in the wider European marketplace – also suffering from similar problems – was seen as quite tense. Some power outages occurred, but remained limited. In all, the 'exceptional measures' introduced to cope with these problems cost the French electricity company (EDF) approx. €300 million. The 2003 drought likewise impacted other countries in Europe (see below).

One of the more stunning features of the 2003 heat wave and the general response is the suggestion that such events lie entirely beyond the norm and are not likely to recur. Everything we now know suggests this is not the case. What we currently consider an extreme weather event producing drought conditions is predicted to become the norm in coming years. According to PRUDENCE study findings, the 2003 summer heat wave was characteristic of average seasonal (summer) conditions simulated for the period 2071-2100 in those regions.[22] And one can expect both a gradual progression toward that norm up to 2071, foretelling both more frequently warm

[21] See e.g., 'Drought Ignites Spain's 'Water War'' (Guardian.co.uk, Apr. 6th 2008). Though this single citation might give the impression that droughts in Spain are unusual circumstances, a quick news search will reveal repeated versions of the same basic water war issue on an annual basis since at least 2005.

[22] See the findings from the PRUDENCE project: http://prudence.dmi.dk/public/beniston.html.

and arid summers, as well as occasional and more frequent occurrences of 'outlier' drought events well beyond the 'extreme' 2003 conditions.

What this genuinely means for water resource management remains to be sorted out in individual countries and at the EU level. There is quite significant variation across countries both in terms of the projected temperature and precipitation changes, as well as in terms of the amounts of water used by different sources (i.e. agriculture, energy, industry and households). Thus, for example, in many of the southern and more agricultural Member States, agriculture can consume anywhere between 59% (Portugal), 72% (Spain) and 88% (Greece) of available water resources (see Italian-French Report 2006: Annex1, 6). Moreover, agriculture consumes far more water in the summer months, when both temperatures and energy demand are also likely to be at their highest points and water availability at its lowest point. On the other hand, as further specified in the Italian-French report, several countries use a very large share of their available water resources for cooling in electricity generation: France (64%), Germany (64%) and the Netherlands (55%). While most of the water used for cooling is eventually returned to its original source at higher temperature (94% in the case of France), these countries are still dependent on water source availability (and thus can be affected by droughts and the related 'low water events'). Northern Member States, on the other hand, are typically not 'water-constrained' and tend to use significant amounts of water in industry – in particular in water-intensive cellulose and paper production.

Several competing tendencies arise from climate change and its related impacts, all of which are likely to have significant impacts on water demand and availability. For one, as part of the EU's 2020 Climate Change Package extending the Kyoto Protocol, EU Member States will be obliged to find ways to continue reducing emissions by 20% based on 1990 levels (30% in the case of an international post-Kyoto agreement), reduce energy use by 20% and raise the share of renewable energy to 20% (the share of renewable transport fuels by 10%) by the year 2020. Requirements for further emission reductions can be expected up to 2050 and perhaps beyond.

In the attempt to keep up with rising energy demand under low carbon constraints, a significant number of countries are planning to introduce more nuclear power plants. Some (though not all) of these are southern countries, highly exposed to potential droughts. Though 'planned' projects can always be cancelled (they depend on shifting coalitions and political power arrangements), in February 2009 Italy announced a joint venture between the French EDF and the Italian ENEL to build four new nuclear reactors in Italy, as well as plans to build five nuclear reactors in France.[23] And many other EU Member States have been considering nuclear power as an option (including Germany, Poland, Hungary, Finland, Sweden and several others).

Renewable energy sources typically perform dramatically better with respect to water demand. Wind power and household solar PV systems, for example, do not consume or use water. Thus the current emphasis on renewable energy sources is a plus for most water-constrained countries.

[23] See 'Italy-France Deal Sparks Nuclear Revival' (*Euractiv.com*, Feb. 25th 2009). As an indication of the likelihood this goal will be fulfilled, one might look at the progress of a similar EDF plant being built in Finland. The project has experienced significant delays and is reportedly already three and a half years behind schedule. Currently it is schedule for completion in 2012.

However, the advantages of renewable energy sources are not consistent across all renewable energy types. Concentrated solar power plants that use 'wet-cooling' instead of 'dry-cooling' still use massive amounts of water (the water quantity/kWh is comparable to thermoelectric systems).[24] Moreover, concentrated solar power plants are most productive where sunlight is plentiful but water scarce and wet-cooling systems tend to be cheaper (often phrased 'more efficient') than dry-cooling systems.

Carrillo and Frei (2009) find that two further renewable energy sources are likewise linked to problems of excessive water demand. For one, the shift to biomass power generation – strongly promoted by the EU and some individual countries – does not by itself solve the problem of water use, since the cooling requirements that exist with fossil fuel-based electricity generation remain. However, where dry-cooling systems are introduced, such problems can be greatly alleviated. For another, the shift to biofuels also represents a very significant increase in water demand leading Carrillo and Frei to suggest that water-constrained countries instead import biofuels from more water-rich countries.

Like France above and Switzerland (see below), Germany also experienced drought-related reductions in electricity generation in the summer of 2003. Many traditional fossil fuel-based power plants were required to either dramatically reduce electricity generation or shut down completely. However, researchers argue that the recent retrofitting of several traditional fossil fuel-based power plants in Germany with dry-cooling systems (not dependent on water) resulted in fewer power plants being cut back or shut down as a result of diminishing water availability during the 2003 heat wave (BfG 2006, p. 185).

The extent to which energy demand constrains water resource availability depends to a great extent on the efficient use of available resources. Agricultural interests will also place significantly increased demand on water resources in the coming years. Rising temperatures pose very immediate problems for agriculture and forestry where these lead to reduced precipitation and water availability. Many of the southern EU Member States have thus far suggested they will adapt to water constraints by building further irrigation channels and water storage facilities (see AEA 2007). Hungary, for example, in its 3rd UNFCCC National Communication predicted it would be able to handle the climatic changes and that agriculture would not be substantially affected (Hungary 2002). Based on global climate models, early PESETA study findings on the climate impact on agriculture seemed to concur with this finding. [25] The map-based projections suggest that by 2080, Hungary could potentially experience increased agricultural potential between 10-30%, while Spain and Portugal and large parts of France and Italy should witness dramatic agricultural decline (-10 to -30% in most regions).

In addition to the global scale of the PESETA study, two additional problems weaken the findings on Hungarian agriculture. For one, in the data projections discussed above and reported on the PESETA website, there is no distinction between summer and winter temperatures. For another, as noted by the PESETA researchers, the findings ignore water constraints and assume

[24] Dry-cooling systems can also be used in traditional fossil fuel-based power plants. Where they are used, dry-cooling systems tend to reduce water use by some 80-90% or more. However, dry-cooling systems require more energy to power fan systems (cf. Sovacool and Sovacool 2009; Feeley et al. 2008; US DOE 2006).
[25] These results are published on the PESETA website (http://peseta.jrc.ec.europa.eu/docs/Agriculture.html).

that farmers will be able to 'use as much additional irrigation water and fertilizer as desired' (see PESETA website). Later studies of Hungary, suggest that future constraints on water availability could be more severe. The 2005 Fourth National Communication to the UNFCCC draws attention to the fact that even relatively small temperature increases of 0.7ºC can lead to a 60% decline in surface water availability in the Tisza catchment region, an 80% decline in subsurface water supply and a 74% decline in water available for irrigation (Hungary 2005, p. 93-95).

Considerable uncertainties are attached to any of the projected findings on temperature and particularly on precipitation change. And, as suggested by other data from the PRUDENCE project (cf. Christensen and Christensen 2002), some degree of adaptation may be possible. For example, even with drought-like conditions in summer, heavier than average precipitation from more extreme weather events could be corralled in additional water storage systems for later use. Moreover, most of the model projections from the various studies cited above concur in that annual precipitation is not projected to change significantly.

Later studies however suggest that future constraints on water availability in Hungary could be severe. These projections have tended to emphasise warming temperatures, declining precipitation and the increased frequency of droughts and other extreme weather events. The most recent predictions stem from two parallel studies focused on climate impacts in Central and Eastern Europe; the CECILIA and the CLAVIER projects.[26] Temperature and precipitation changes in the Tisza basin region of Hungary – the principal agricultural region – are likely to be the most dramatic. Keeping in mind the 2005 Fourth National Communication findings on the strong relationship between temperature changes and declining water availability in the Tisza region, more recent nationally and regionally generated temperature predictions from the CECILIA study suggest change in summer temperatures in this region could reach +3ºC between 2021-2050 and as much as +5ºC between 2071-2100. Potential changes in summer precipitation are comparably stark.[27]

Hydrological estimates of the impact on water flow in the Tisza River (see Figure 2.2) do not currently suggest there will be dramatic changes. Annual flows for the period 2021-2050 are projected to fall by only about 2% in the lower Tisza region (and are projected to rise slightly in the upper Tisza region). Moreover, the seasonal impact is likewise projected to be relatively small – approximately 10% in the spring and 3.5% in the summer months (Pfeifer et al 2009; Matreata et al 2009). However, a number of differences between the CECILIA and CLAVIER studies are worth noting. For one, the ALADIN model used in the CECILIA study predicts higher temperature and precipitation changes in the Tisza region than the Clavier study REMO model. For another, the hydrological study does not provide estimates beyond 2050, though of course the CECILIA study does project temperature and precipitation changes for the period 2071-2100. Though such differences in modelling outcomes beg the question of the potential basis for comparison between studies of this type, a strong foundation for comparison is currently lacking.

[26] For information on the CECILIA project, see the project website at: http://www.cecilia-eu.org/. Information on the CLAVIER study is available at: http://www.clavier-eu.org.

[27] These findings are based on personal communications with the Hungarian Meteorological Association (OMSZ) and the graphs included below. For more general findings from the project, see Csima and Horanyi (2008).

Further, very little is currently known about potential future sources of change in water demand such as agriculture or the energy sector to the East of Hungary. The Tisza originates in Ukraine and meanders along the border region of Ukraine, Romania, Hungary and Slovakia before passing through the heart of the Hungarian agricultural region on its way to merge with the Danube in Serbia. Thus changing water use in these upstream countries could also influence future downstream water availability.

[Insert Figure 2.2]

What this means for agricultural production in Hungary depends significantly on the degree of preparation for more extreme drought events and decreased water availability more generally. To date, though Hungary has a plan in place to build several water storage and flood management reservoirs in the Tisza region, only one of them has so far been built. The basic point is that agriculture in the southern states of Europe may ultimately be somewhat more endangered than currently predicted. As is, studies already predict that agricultural production will generally have to shift to the North and East of Europe as well as across traditional seasonal scheduling frameworks. Yet remarkably little discussion occurs about how this might be achieved—in particular with regard to the geographic shift in agricultural production. Much as in economic general equilibrium models, where capital and labour are simply assumed to move to more profitable locations when economic systems careen out of balance (thereby seamlessly restoring the former balance), the same is essentially assumed about agricultural production with little or no discussion of the relative mobility of agricultural factors of production, or even of the consequences of massive land conversions (and their related carbon cost) in order to make available adequate supplies of arable land. However some authors have begun to investigate future land requirements in Europe (Rounsevell et al, 2005).

Water management of the alpine regions of Europe provides a particularly revealing look at the potential risks to agriculture, energy and water resource use more generally –in particular in the southern regions of Europe. The Alps currently supply some 40% of Europe's freshwater resources (EEA 2009b). As the EEA points out:

> Spanning the centre of continental Europe, the Alps play a crucial role in accumulating and supplying water to the continent. Recognised as the 'water towers of Europe', the mountains host most of the headwaters of the rivers Danube, Rhine, Po and Rhone; as such, they deliver vital ecosystem services both within and beyond the region, underpinning social and economic wellbeing in vast lowland areas. (EEA 2009a, p. 9)

Thus for the rest of Europe, the Alps are of great significance due to the invaluable water resources they provide. Moreover, the 2003 drought affected water resource availability very far afield. Thus due to the falling water level in the Danube, the Cernavoda nuclear power plant in Romania was required to shut down for just shy of a month and other hydropower plants along the Danube experienced reduced electricity output (EEA 2009a). Thus declining precipitation in and water flow from the Alps can have significant impacts on water availability in quite distant regions.

Switzerland was already strongly impacted during the 2003 drought, with agricultural water demand leading to conflicts with water protection authorities. In the longer term, Swiss farmers

were severely affected by the drought, which caused a reduction in harvests and a net decline in income of approximately 11% (EEA 2009a). Though the supply of available electricity was not strongly affected, this was largely the result of an increase in electricity generation from alpine pump storage facilities which, in turn, were strongly advantaged by significant runoff from melting snow and glaciers (BUWAL 2004). The performance of nuclear power plants in Switzerland had to be curbed by 25% for a period of two months, reducing annual electricity production by 4% (OcCC-ProClim 2007). Whether Switzerland or other alpine regions can depend on glacial runoff in the future is unlikely. Current projections suggest that glacier coverage in Switzerland will decline by 50% to 90% by the year 2050 (OcCC-Proclim 2007).

One of the more stunning findings to emerge out of Switzerland concerns the potential future demand for water from the agricultural sector. Fuhrer and Jasper (2009) note that the total amount of agricultural area requiring irrigation in Switzerland is likely to increase some eight-fold in the near future due to declining availability of water resources. Based on an analysis of the period 1980-2006, the authors find that agricultural areas totalling some eight to ten times the size of the currently irrigated area are already in need of increased irrigation. The authors further note that for the 1980-2006 period many agricultural areas in Switzerland remained dry for several weeks or even months and the longest dry spells surpassed periods of 60 days (in the more extreme cases from 150-200 days). Moreover, the average length of dry spells over the period 1980-2006 was rising in Central and Eastern Switzerland (with no obvious trend in areas already strongly affected by dry conditions in Western Switzerland). As the authors note, over time the types of agricultural products affected will range from the more water-intensive crops (potatoes and vegetables) to corn and grains, and ultimately to more exposed grasslands.

The relative importance of these findings extends well beyond the future challenges facing Swiss agriculture. Like the Hungarian example, they demonstrate both the broad geographic range of problems affecting agricultural production in Europe as well as their potential severity. Yet even countries that are comparatively water-rich already feel the effects of progressive climate change. With time these changes will have even more radical impacts on agricultural production in Switzerland and other countries. Irrigation will most likely be extended to a very significant share of agriculture in Switzerland, in other alpine regions and in other downstream regions in the coming decades and the type of agricultural produce planted will also change. The second major implication is that changing water resource use and management in the broader alpine region will ultimately affect water availability in downstream countries as well. If more water is used upstream in order to maintain Swiss and Austrian agricultural production or to service electricity generation, less water will be available downstream for agriculture, energy, household consumption and other purposes.

Generally missing from country-level analyses is a detailed discussion of the potential cross-border upstream and downstream impacts of changing demand for water resources and the potential rise in reduced water availability. While projections of potential water supply are available, these typically do not consider how water use habits will change in other countries. Thus, based for example on the Swiss case, rising temperatures are likely to give rise to decreased water availability, continually increasing irrigation in agriculture and increased stress on the water needs of power producers. All of this ultimately means reduced water availability further downstream. Yet, in the water-receiving countries, no attempts are made to measure the

extent to which available water supply will be altered by changing water demand in the upstream countries. In the event of future average temperatures similar to or even more severe than the 2003 drought, it remains unclear what the overall impact on water availability will be in most European countries. Moreover, the potential for droughts to occur in multiple years and what this might mean for water availability is likewise not known.[28] Yet these are both likely outcomes of future rising temperatures. There may be considerable room for future work on water availability for major river catchments globally and in Europe using the WATERGAP model (Alcamo et al, 2007).

2.3.2 The water management policy framework

The European Commission and other organisations such as the EEA tout the potential advantages of the WFD as a general framework for effectively dealing with adaptation in water resource management. For example, the EEA (2009a) notes:

> Existing European legislation, particularly the Water Framework Directive (WFD), is a good basis for cross-border water coordination and adaptive management. It paves the way towards further integrating climate change adaptation into European policies and implementing adaptation measures, also at a river basin scale where uncoordinated actions should be avoided. Within this context River Basin Management Plans (RBMPs), a key instrument of the WFD … must be coordinated with other sectoral policies (e.g., the Common Agricultural Policy) and secure broad public participation. … The Water Framework Directive is complemented by the Floods Directive and the policy on water scarcity and droughts, which provide a more specific framework for adapting to the key water-related impacts of climate change (e.g., droughts management plans, water scarcity and droughts information system). (p. 14)

Though the WFD was initially designed as a strategy for responding to water quality issues, the additional requirement that Member States also introduce water-pricing schemes by the end of 2010 has clear implications for the management of water quantity, scarcity and availability issues. The requirement that Member States jointly develop RBMPs as part of both the WFD and the Floods Directive is a further advantage, though there is no requirement that RBMPs necessarily address water supply issues. First draft RBMPs were to be submitted by 2008 and finalised in 2009. A second RBMP round is planned for 2015.[29]

Since the WFD is a very loosely structured instrument allowing individual countries to come up with relevant strategies for managing water resources on their own and only dictating a schedule for addressing very general framework issues, it was likely to be greeted with relatively strong support from EU Member States. For the most part, these seem to welcome the WFD framework as a suitable means for attempting to get a handle on water quality while at the same time not

[28] This potential is recognised, for example, by the Commission's JRC: 'the tendency for dry years to form clusters increases the magnitude of the drought threat. For example, any repetition of the sustained rainfall deficiencies that were a feature of a 25-year period beginning in the 1880s would, with present demand levels, represent a very severe challenge to water management throughout much of Europe' (JRC 2005, p. 130).

[29] The timetable for WFD-related submissions is available at: http://ec.europa.eu/environment/water/water-framework/info/timetable_en.htm.

significantly threatening national sovereignty. However, where the WFD may potentially fall short is in the successful foresight over and coordination of all the competing water use interests – cross-border/transboundary, national, sub-national and sectoral.

Ultimately the biggest problem with the development of country analyses – as opposed to regional or other international river basin approaches – is that countries highly dependent on water flows from upstream countries have only limited knowledge of the range of potential change in upstream water use and demand. However, for adequate assessments of future water quantity, these are crucial. Given the transboundary nature of many water resource management problems this may well lead to serious problems and potential future conflicts. By way of example, greater than 95% of the water in Hungary originates in other countries to the West and East.

The crisscrossing of water-use and related policy interests at the sub-national, national and transboundary levels is thus a cause for concern. The WFD framework may simply be inadequate to handling all individual Member state and EU water needs. Perhaps the biggest drawback of the WFD framework is its emphasis on 'water quality'. While water quality is certainly an important objective and one that should remain at the forefront of EU and Member state concerns, the downside is that other issues – in particular water quantity, scarcity and drought preparedness might be neglected or inadequately addressed.

Discussion at the 2nd European Water Conference, organised by DG Environment in April 2009 suggests such concerns are warranted. For one, most of the reported discussion on the WFD surrounds water quality issues. Very little discussion even raises the issue of water scarcity and drought management (see DG Environment 2009). In fact, based on the findings of one NGO present at the debate, only five of the RBMP surveyed by the organisation (out of a total of 17 submitted) set goals for reducing water use and only 2 of those were targeted at individual sectors (DG Environment 2009). While the potential for introducing water payment schemes could significantly impact water use efficiency, many complain that current proposals lack adequate transparency. Moreover, most assessments of water stress are ultimately based only on precipitation trends and fail to consider 'local level characteristics' (DG Environment 2009, p. 37). Though at least one current European study hopes to correct for some of these problems, the WATCH study focuses on global water use patterns.[30] In order to adequately inform national-level RBMP, such measurement issues need, for one, to focus on water use patterns in Europe and for another, to find their way into country level analyses. However, the SCENES project, which aims to develop and analyse a set of comprehensive scenarios of Europe's freshwater futures up to 2025, may point the way for future study.[31]

[30] See the website of the WATCH project on water and global change: http://eu-watch.org/nl/25222705-Home.html. It is furthermore unclear from the project description how much focus will be placed on the two primary sources of water demand (energy and agriculture). From the project deliverables produced as of this writing, only the global evolution domestic household water demand has been considered. Though future deliverables in Work Block 2 intend to consider other aspects of water demand (in particular agriculture and industry), the energy sector or power producers are not listed in this section.

[31] For more on the SCENES project, see the website: http://www.environment.fi/default.asp?contentid=342422&lan=EN.

While agricultural issues were strongly discussed at the 2nd European Water Conference, there was essentially no discussion of the impact of energy demand on water use, nor were any of the major energy sector stakeholders represented at the conference. To some extent, this deficit appears to be recognised in the first two key messages to emerge from the conference:

1. Water management is affected by many other policies. Therefore, it is important to look at the impact of economic activities on water and to coordinate with a number of sectors including agriculture, industry, energy production, tourism etc. The Water Framework Directive (WFD) and its focus on integrated river basin management plans is one approach to enhance sectoral coordination.

2. Since many important water decisions are not made by water managers, it is important to involve all stakeholders in the WFD management process in order to provide the proper answers to water related issues. (DG Environment 2009, p. 4).

However, it remains unclear how the WFD framework will be revised in order to encourage Member States to address these issues.

Finally, the currently poor record of implementation in the southern EU Member States raises alarm bells. According to DG Environment's assessment:

> There is a north-south divide in Europe when it comes to the individual national river basin management plans. In northern Europe most plans have been published, while southern Europe is lagging behind. This is an issue of concern, since southern Europe is an area with more visible and multiple water problems and one would expect efforts there to be more intensive to address them. (DG Environment 2009, p. 40)

In particular, given the problems outlined above – heavy agricultural water demand in the southern EU Member States, the rising potential for higher temperatures and extreme drought conditions, as well as the potential impact on electricity generation and planning – the need for consequent and extensive planning of future water use management is clear. However, even assuming the southern countries submit RBMP in the near future and all Member States successfully develop water pricing strategies, it remains unclear whether these will prove capable of setting an adequate framework for future adaptation planning. The basic problem is that the goal and related guidelines of the WFD were established well in advance of the current emphasis on climate impacts and adaptation requirements. This is likely to pose specific problems for individual countries since the legal framework for water pricing will most likely be passed through political systems well before it has been adequately adjusted to adaptation strategies.

The fact that water use is a cross-border, transboundary issue strongly supports the view that the EU can and presumably should play an important role connecting both water resource needs and the vulnerabilities of individual states. Moreover, given the increasingly complex awareness of the basic problems countries face, it is now necessary to connect these into a framework that can help individual Member States plan and coordinate future adaptation efforts in a far more decisive and comprehensive way. Certainly one key feature of such a strategy is the outlining of clear guidelines for integrating adaptation into WFD goals and strategies – the Commission has committed to developing guidelines for ensuring that climate goals are integrated into RBMP by

the end of 2009 (European Commission 2009a). But in the long run the EU could and presumably should go much further than this.

Though not currently under discussion, one strategy for immediate consideration is an EU Directive on Water Use Reduction (raising water use efficiency). Although EU-level climate negotiations have already focused on reducing energy use,[32] this effort needs to be extended to water use efficiency. Apart from the single basic problem of increasing water scarcity – in particular in Southern Europe – one of the strongest justifications for this is the simple fact that the water-energy nexus has important implications for both climate mitigation and climate adaptation goals. Energy is required to pump water from the source of supply to end-users and water is required to produce energy (primarily for cooling purposes). In the United States, for example, some 4-5% of electricity use provides the necessary energy for distributing and treating water and wastewater (see US DOE 2006). Similar amounts are likely used in Europe.[33] Thus improving water efficiency not only guards against the threat of water scarcity in the more water stressed regions of Europe, it also helps reduce energy use and thus greenhouse gas (GHG) emissions.

The European Commission now argues that improvements in water use efficiency in Europe could effectively reduce overall water use by approximately 40% and agricultural water use by 43% (see Ecologic 2007). The magnitude of these numbers alone indicates tremendous unexploited potentials. Though which direction water demand is expected to move under a business as usual scenario remains somewhat controversial,[34] with concerted action water use efficiency could be dramatically improved. Under future drought-like conditions in Southern Europe, promoting the development and use of water-saving technologies appears more than essential. Given all of the above considerations, there is no justifiable logic why the EU should regulate energy use and not water use.

The failure to introduce a European Directive on Reducing Water Use could potentially lead to the awkward consequence that upstream countries benefiting from greater water availability face fewer incentives to introduce strong water-saving measures. This of course has the potentially ugly consequence that downstream countries depending on the flow of water resources from neighbouring countries have little impact on the upstream behaviour of fellow Member States.

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[32] EU level efforts to reduce energy use are governed by a number of different Directives and commitments. Most recently, as part of the Energy and Climate Change Package approved in December 2008, the EU committed to reducing energy use 20% by the year 2020. However, there is no single directive that lays down the specific strategy by which the EU and individual Member States will achieve this goal. That said, the Commission is currently focusing on revising and updating the 2002 Directive on the Energy Performance of Buildings (Directive 2002/91/EC). Other relevant EU legislation on energy efficiency includes Directive 2005/32/EC on the eco-design of energy-using products, Directive 2006/32/EC on energy end-use efficiency and energy services, the EU Action Plan for Energy Efficiency (COM(2006)545 final) and finally Directive 2004/8/EC on the combined generation of heat and electricity.

[33] Data for Europe is limited. However some European reports point to the importance of energy in water distribution and treatment. See for example Carrillo and Frei (2009) and WBCSD (2009: esp. 14-15).

[34] Compare for example the results of Flörke and Alcamo (2004) who project an 11% decline in water use between 2000 and 2030 with the EEA's (2009b) European Water Resources report, which suggests that water demand will likely increase in the coming years.

Further, one could rapidly develop an argument for why the EU should require all Member States to develop Drought Management and Water Scarcity Strategies (or Plans). The WFD does in fact encourage Member States to develop Drought Management Plans (DMP) 'when and where they are needed' and the Commission produced guidelines for interested Member States on how to develop them (European Commission 2008a). However, as with water-saving legislation, Member States that experience less immediate threats are far less likely to pursue such strategies. Nor is there any immediate requirement that cross border plans will be developed, posing potential threats for downstream Member States more susceptible to droughts. Presumably the most immediate reason why the Commission has so far resisted is that not all Member States are clearly affected by droughts and thus many Member States may have little need for such plans. However, as with forest fire management in the EU, this should not discourage the European Commission and the EU more broadly from pursuing a more unified strategy and taking advantage of the potential benefits of a 'Community' approach.

The emphasis on water use efficiency arising out of the WFD and potentially also the emphasis on water containment (and overflow options) arising out of the EU Floods Directive may further be inadequate when it comes to promoting additional water storage. Water storage should presumably be placed much higher on the Member state and EU agenda, since water scarce countries in particular need to be able to store sufficient water to make it through periods of significant and potentially extended drought. Though many countries have greatly extended their potential for water storage in the past few decades (among the European countries, Spain and Italy top the scale of newly constructed water storage facilities; cf. EEA 2009b), presumably far more water storage will be necessary, in particular the southern EU Member States due to significantly increasing temperatures and declining rates of precipitation. Since at least 1990, most of the more agricultural EU Member States, foremost among them Italy, Spain, France and Greece have been rapidly extending their crop irrigation potential (EEA 2009b).

There are at the same time potential limitations to continuously extending water storage and irrigation potential. Excessive storage is simultaneously noted as an ecological problem (EEA 2009b), and, in the long run, little resolution of the potential conflict between increased water scarcity and the potential to overextend water storage solutions is discussed.

In all of this discussion, the role of forests is severely neglected. Though the potential role of forests does receive some discussion in the EEA's (2009a) study of alpine water resources and in another study from the Institute for European Environmental Policy (IEEP) (Anderson et al. 2008: esp. vi, 46-50), forests – in particular in the context of their impact on the water balance, water purity and flood control potential – are not even mentioned in the either the WFD or the Floods Directive. According to the EEA:

> Forest soils, which have a higher water storage capacity than non-forest soils, reduce run-off peaks and local flooding. Moreover, forest vegetation stores water and delays soil saturation. Evapotranspiration from mature forests can remove a considerable proportion of storm rainfall. … Surface runoff can therefore be prevented or slowed to some extent, even in high precipitation events. At the local level the effect of flood reduction is particularly relevant for small watersheds and minor meteorological events. (EEA 2009a, p. 43)

While a number of studies point to the potentially negative effects of forests on the overall water balance (Zhang et al. 2007; Jackson et al. 2005), such studies may fail to adequately comprehend or measure the role of forest ecosystems and their impact in particular on the water balance, water supply, storage and cooling effects arising from forests' ability both to retain water and to promote evapotranspiration.[35] Rising awareness that forests could or may play a more important role emerges in a Commission report on the Implementation of Forestry Measures:

> Forests and forest management have an important role in the protection of water resources. The Fifth Ministerial Conference on the Protection of Forest in Europe (MCPFE, 5-7 November 2007, Warsaw, Poland: 'Warsaw Resolution 2 Forests and Water') stressed the role of forests and forest management in protecting water quality, managing water resources for the quantity of all waters, flood alleviation, combating desertification and soil protection as well as the importance of mountain forests in the reduction of landslides, erosion and effects of avalanches. (European Commission 2009c, p. 10)

The 2007 Warsaw Resolution on Forests and Water makes a number of broad commitments on the part of signatory countries to further investigate the relationships between forests and water and to improve the sustainable management of forests in relation to water (MCPFE 2007). In its first follow-up to the Warsaw resolution, the MCPFE held a conference on Forests and Water in Antalya, Turkey (May 12th -14th, 2009).[36] A similar approach is also being stressed in the framework of the UNECE Water Convention. Finally, the Finnish Forest Research Institute in collaboration with the European Forest Institute (EFI) in Joensuu, Finland is also organising a number of conferences on the issue of Forestry-Water interactions.[37]

Though some awareness of potential strategies that might be implemented to improve water storage (and potentially moderate floods) through more natural techniques—in particular by exploiting the natural advantages of forests—is beginning to emerge, far more could be done. Despite the growing awareness that forests can play a positive role, there is virtually no information currently available on how and where to plants forests in order to have the greatest effect on future water supply and flood moderation or control. Though the concept of forested buffer zones between agricultural fields and lakes and rivers as a means of purifying water

[35] Though research on the water balance is cutting edge, it is also highly controversial. Zhang et al. (2007) argue, for example, that the impact of increased forestation on water supply is negative. However, these authors fail to consider the impact of forests on groundwater supply. Moreover, how one should think of the impact of evapotranspiration on local precipitation events is likewise controversial. Though most authors simply view evapotranspiration as a loss to the local water cycle, others view the forest-water balance on a very broad scale in its broader ecosystem context.These authors tend to find more support for the view that forests support increased water supply and aid significantly in improving water balance (cf. Schwärzel et al. 2009; Sheil and Murdiyarso 2009; and IUCN 2009). Maes, Heuvelmans and Muys (2009) likewise suggest that evapotranspiration should potentially be seen as a *contribution to* the water cycle, with potentially positive implications for the water balance. However, the relationship between forests and the water balance remains disputed. For a recent overview of this debate, see Ellison (2010).

[36] Much of the documentation discussed at this conference is available at the conference website: http://www.mcpfe.org/www-mcpfe/forests_and_water.

[37] The first of these was held in Joensuu in September 2009 (conference website: http://www.metla.fi/tapahtumat/2009/koli/index.htm). The second will be held in May 2010 (conference website: http://www.efi.int/portal/news___events/events/extra/2010/JFNW2010/).

resources has gained some purchase, the strategy is still not widespread and receives no mention, for example, in important EU-level documents like the WFD and the Floods Directive.

The EU's Common Agricultural Policy and Rural Development Strategy is far from dealing adequately with many or most of the adaptation challenges noted above. Though DG Agriculture's European Agricultural Fund for Rural Development (EAFRD) addresses afforestation as a general strategy, no real connection is made between forests and potentially beneficial forest-water interactions. Further, although the connection between forestry and the larger context of biodiversity preservation is recognised in the EAFRD strategy (this connection is discussed in more detail below), as spending on Natura 2000 areas is permitted as part of Axis 2 spending on 'improving the environment and the countryside' (European Commission 2009c, p. 44), few countries have thus far taken advantage of available resources.

In two further areas, discussions have not even really begun with respect to the EU's Common Agricultural Policy (CAP). The first of these—and perhaps the most urgent—concerns agriculture and water use. As noted above, in particular in the more heavily agricultural countries, agriculture is the largest user of water resources. In addition, water-saving potential in agriculture is estimated at some 43% of current use. Yet the CAP does not currently have a strategy in place for promoting efficient water use. Moreover, the current EU policy emphasis on biofuels is likely to raise water demand in agriculture. The second area has to do with the future likelihood that there will be tremendous upheaval in the agricultural sector in Europe as a result of climate change, rising temperatures and the likely shifting of agricultural zones. While potential strategies have not really been discussed at the European level, this needs to be done. How will agriculture be organised in the future and where will various agricultural products be produced? Is or will adequate agricultural land be available in Europe once the shifting of agricultural zones has taken hold? And most importantly perhaps, how will potential strategies be formulated in order to facilitate the shift of agricultural production to these new agricultural zones?

Given the above energy-related discussion, the EU clearly needs to develop a more water conscious energy strategy. This idea has been around for some time. By way of example, a 2004 report on water use recommended, among other things, that tower cooling systems be required for electricity generation in order to reduce water use (Flörke and Alcamo 2004). Though dry-cooling systems have since upstaged and outdated tower-cooling systems, the general strategic approach is and should remain the same: attention to water use efficiency should be a requirement for all newly-installed electricity generation capacity. Dry-cooling or comparably water-use efficient cooling systems should become the rule and should be mandated in all fossil fuel and biomass-based thermoelectric power plants and concentrated solar power systems. Finally, far more consideration should be dedicated to the added advantages of other renewable energy sources (i.e. wind, solar, geothermal,[38] and tidal) that are not big water users.

[38] Geothermal power plants that do not use water re-injection systems can also use larger amounts of water. Thus re-injection, though more costly because it involves additional drilling in order to be able to re-inject water back into the cycle, should also be mandated.

The relatively severe energy problems that emerged during the 2003 heat wave will be repeated and eventually surpassed. Thus initiatives should be afoot to capitalise on the advantages and widespread availability of less water-intensive energy production and more water-efficient cooling systems.

Finally, policy efforts in general and work on the WFD in particular need to address a much broader context than is currently the case. The 2007-2009 Work Plan of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (under the United Nations Economic Commission for Europe) has opted to focus on 'Water and Climate adaptation in transboundary basins, including flood and drought risk management'.[39] In other words, this highly integrated, revised focus tacitly recognises the limitations of a more narrow focus on water quality, floods and flood risk management. The revised focus is far broader and attempts to address the broad range of climate and adaptation-related needs in the management of transboundary basins. This approach may suggest that specific advantages can be gained from a more comprehensive ecosystem-based or 'catchment basin' type approach. Moreover, the international framework tends to provide a stronger emphasis on cross-border cooperation, as demonstrated, for example, by recent Hungarian efforts to extend Ramsar wetland protection cooperation to Slovenia (Croatia and more recently Austria already participate). Though there is some indication that these more international cooperative arrangements are not always as successful as they could potentially be (see e.g., Czako and Mnatsakanian 2008), the general direction of such efforts is both exemplary and potentially crucial to the future success of adaptation efforts.

In contrast, some evidence suggests that the WFD approach may push in the opposite direction. In particular with respect to water and river basin management, the EU WFD first encouraged countries to create several water district agencies and then delegate these with the task of developing and managing plans to meet the requirements of the WFD. In this sense, the WFD framework is poorly articulated at the cross-regional, national and/or cross-border levels. While this may work well in some regions that are relatively self-contained, the effect could be far less beneficial in other parts of Europe where river or catchment basins cross multiple borders. In such cases, ideal plans for river or catchment basin management could and presumably should involve explicit cross-regional and/or international cooperation, including well-thought out estimates of potential future water demand, extensive analysis of future water availability/quantity (based on temperature and precipitation changes) and potentially also cooperative efforts to increase or improve available supply.

Concerted action on river basin management is presumably a requirement for the successful definition of strategies to manage not only water quality but also water quantity. Though the EU has not yet taken similar steps, as argued in the following section, there are many reasons to think it provides a more solid footing for future policy efforts. Moreover, as suggested in the approach taken to water in the above section, the role of ecosystems and the services they provide is of great importance. Not only do ecosystems produce and manage water balance and supply, they also help regulate water flow, thereby diminishing the frequency and severity of

[39] See the UNECE convention website: http://www.unece.org/env/water/cooperation/area422.htm.

flood events. Such an analysis suggests the role of ecosystems—in addition perhaps to the services they provide—should ultimately be placed at the centre of the analysis.

2.3.3 Biodiversity and ecosystem preservation

The treatment of biodiversity has gained new and added significance with the recent findings of the Stockholm Resilience Centre and the publication of an article on the Earth's planetary boundaries (Rockström et al. 2009). The authors identify nine planetary boundaries that reportedly define a so-called 'safe-operating space for humanity'. Among these nine planetary boundaries, climate change represents only one of three boundaries that have been overstepped. Apart from surpassing Hansen's recommended 350ppm CO_2 atmospheric concentration barrier (Hansen et al, 2008), the world has even more substantially surpassed the biodiversity loss indicator established by the authors. This barrier is set somewhat higher than the assumed natural rate of extinction, at 10 species extinctions per million per year. Though the barrier is 10 to 100 times the natural rate of extinction, current rates are well over 100 species extinctions per million per year (100 to 1000 times the natural rate). Finally, the authors note that the nitrogen cycle barrier has likewise been significantly surpassed. Humanity, according to the authors through the production of fertilizer and crop cultivation, now exceeds the combined natural rate of all natural forms of nitrogen production.

Though in principle the connections between biodiversity, ecosystem services and the larger concepts of ecosystem resilience and adaptation remain underdeveloped, there should ultimately be little quarrel with the basic concept that ecosystems and the services they provide build the foundation for humanity's social and economic well-being (Louman et al, 2009; MEA, 2005). Nor should there be significant debate over the fact that ecosystems in general, and ecosystem services in particular – such as the provision of a clean and bountiful water supply, clean air and carbon sequestration – are threatened by changing the climatic conditions occasioned by global warming.

The strategies necessary to protect ecosystems –such as the EU's Biodiversity Action Plan and the goals of the Natura 2000 project – are often not well recognised and their relative importance is not always readily accepted. One of the best examples of this fact is the difficulty the EU has experienced with the protection of biodiversity. As parties to the Convention on Biological Diversity, the EU has declared a commitment to halting the loss of biodiversity. Yet despite the goals of the 2006 Biodiversity Action Plan to halt the loss of EU biodiversity by the year 2010, EU member states have not made significant progress in establishing special protection areas (SPA) and special areas of conservation (SAC) and thus have generally failed to implement the Natura 2000 program of the Habitats and Birds Directives.

Recently European Environment ministers, based in part on an internal assessment of implementation performance in the establishment of Natura 2000 protected areas, expressed 'deep concern' about the current state of EU biodiversity loss and argued the EU was unlikely to be able to fulfil its 2010 commitment. The Commission's internal assessment pointed out, for example, that '50% of all species and 80% of habitat types in need of protection in Europe have

"unfavourable conservation" status'.[40] Based on the first evaluation of the EEA's SEBI indicators published in May 2009, the overall assessment was not very encouraging (EEA 2009).

While the 2007-2013 Framework perspective witnessed the firm integration of Natura 2000 goals and funding mechanisms into the EAFRD, NGOs such as BirdLife International and FERN continue to argue that farm lobbies are favoured over biodiversity and environmental concerns. Though these organisations note the potential advantages presented by the EU's rural development framework both FERN (2008) and BirdLife International (2009a) remain strong critics. The principal criticism concerns the failure to address biodiversity issues and to spend adequate resources on the development of Natura 2000 sites (cf. BirdLife International 2009b).

Though one can argue EU Member States have made significant progress toward improving the quality and degree of biodiversity protection.[41] Most EU Member States are still quite far from achieving the ultimate goal of 'halting biodiversity loss by 2010'. In the words of Jacqueline McGlade, executive director of the EEA, designating relevant areas across Europe for the goal of habitat and species protection 'is only the first step'. McGlade points out that only a small share of Europe's habitats and species are currently in acceptable condition. Most are in 'unfavourable conservation status' and are potentially in need of 'ecological restoration' – in particular agricultural habitats.[42]

In this context, the EEA argues that Europe has not yet fully grasped the importance of biodiversity. In order to maintain biodiversity and ecosystems, these must be more fully integrated into key sectors – in particular into agriculture, forestry and fisheries.[43] The EEA and European environmental ministers are currently promoting an ecosystem services approach to handling biodiversity that is likewise promoted by a relatively broad range of other European and international actors. The International Union for Conservation of Nature (IUCN), the International Union of Forest Research Organisations (IUFRC) and the Ministerial Conference on the Protection of Forests in Europe (MCPFE) are all integrating the ecosystem services approach into their core strategies. The concept of the ecosystem approach was first introduced in the framework of the Convention on Biological Diversity (2002) and the United Nations Forum on Forests (UNFF 2003). The MCPFE has been one of the principal organisations attempting to integrate the ecosystem approach into sustainable forest management practices in Europe. The EEA and European environmental ministers are pushing for 'ecosystem goods and services' to be better integrated into the national and EU-level frameworks, seeing this as one strategy for improving the degree of biodiversity protection in the EU. The ecosystem services

[40] See; 'Ministers 'Deeply Concerned' by Biodiversity Loss', (*Euractiv.com*, June 26th 2009).

[41] The EEA's Core Set of Indicators Data (CSI data) suggests many EU Member States have done relatively well in fulfilling some of their basic commitments to the Habitat and Birds Directives. For example, a broad set of EU countries have at least 'proposed' sites that would be sufficient to protect habitats and species. Moreover, the total amount of surface area dedicated to species and habitat protection in Europe has multiplied some 6- or 7-fold between approximately 1996 and the present (cf. the CSI 008 Assessments, various years).

[42] See McGlade's speech on the Status of European Biodiversity at the Athens conference on Biodiversity Protection—Beyond 2010, (Apr. 27th 2009).

[43] See: Europe Must Grasp the True Value of Biodiversity (EEA Highlight, Apr. 27th 2009).

approach essentially attempts to place a market price on the use of ecosystems and the goods and services they provide.

The protection of ecosystems and the services they provide in the context of climate change is a complex problem and one that is not easily reduced to pricing systems for individual ecosystem services. While, as noted above, a dramatic increase in water use efficiency would certainly be a welcome evolution – efficient pricing mechanisms are one important strategy for achieving this goal – ecosystems themselves and the biodiversity they contain are likewise coming under increasing pressure from climate change. In this sense, prices on ecosystem services are ultimately only half the battle. In the long run, EU strategies could be far more broadly focused. For example, unless the revenues from such pricing mechanisms can somehow be funnelled back into what should perhaps remain the primary target of such strategies – the maintenance, preservation and even creation of ecosystems – such strategies are likely to fall far short of their goal.

How the EU, its Member States and other countries will manage this challenge remains unclear. The challenge of ecosystem maintenance and preservation is often not well understood – in particular in the context of climate change. What we know and think of as ecosystems today are likely to change substantially in the coming years as climate change progresses. Whether current EU strategies are up to the task depends significantly on how they are revised in order to respond to the climate challenge. As elaborated below, perhaps the two greatest challenges in this context are 1) coming to grips with current biodiversity emphases on 'species permanence' and the need for flexible arrangements, and 2) elaborating strategies for moving from piecemeal, patchwork strategies (afforestation, biodiversity protection and species preservation, water quality, etc.) to more grand-scale ecosystem-based strategies. Moreover, the costs associated with elaborating more adequate strategies are likely to be greater than previously estimated – though the rewards may also be higher –raising important questions about how the EU and Member States will manage to support an already significantly underfunded objective.

2.3.4 Permanence vs. flexibility

Though less frequently discussed in the literature on adaptation and climate change, 'biome shift' – the concept that the biological spheres in which flora and fauna thrive will migrate as the climate becomes warmer – is a real and increasingly visible problem raising all kinds of important questions (see Loarie et al, 2009). What is the potential range of biome shift over the next century? What is the potential for migration of flora (and fauna) across the shifting geography and borders of biomes? What does biome shift imply about tree-planting practices in forestry and what is the potential adaptation and/or migration potential of the existing forest stock? How much do current planting strategies need to change in order to keep pace with shifting biomes and what is the general magnitude and scope of necessary interventions? What does the concept of biome shift imply about conservation strategies – in particular since these are typically based on the concept of permanence rather than unstable and shifting bio-spheres? To what extent is the public sphere required to take action – either with regard to forestry or to nature conservation – in particular given the potential magnitude and scope of the necessary interventions?

The potential for biome shift is a direct outcome of global warming and climate change. Rising temperatures, changing precipitation patterns, shorter winters with less snow melt and longer summers with increased evaporation potential all affect the nature, character and location of existing biomes. Though the forecasting of the potential extent of biome shift is still in its infancy and the related uncertainties are high, it is already possible to predict the potential range of biome shift with some accuracy. Current predictions suggest that Europe's biomes could shift anywhere between 100-500 km to the Northeast by the year 2100.[44]

Just how responsive flora and fauna may be to biome shift remains open to question. Birds may provide a relatively good example. The migration patterns of many types of birds have already shifted along with historical temperature changes. Tingley et al. (2009), for example, find that of the 53 bird species they studied in the US, 48 exhibited tendencies to adjust their migratory patterns based on species-specific preferred environmental phenomena (sensitivity to either moisture or temperature). Shifting migratory patterns are also prevalent in Europe. The EEA's climate impact report, for example, notes the migratory patterns of birds could shift some 550km to the Northeast by the year 2100. Moreover, the study notes significant potential difficulties in making such migratory shifts for many species, in particular due to the rate of climate change, habitat fragmentation and the like (EEA 2008).

Such observations immediately raise questions about the suitability of existing biodiversity protection strategies. Concepts of species permanence and the preservation of existing biodiversity typically seem to guide policies addressing the goals of nature conservation and species protection. The concept of biome shift, however, ultimately requires significant re-thinking of such approaches. Where species are likely to migrate based on the movement of biomes, it becomes impossible to preserve existing biodiversity when wildlife protection areas are established in fixed locations. On the other hand, it is relatively difficult – given the relative population density of most European Member States – to shift the location of special protection areas.

Similar problems arise when considering attempts to protect and preserve the existing range of flora. Again, shifting biomes ultimately mean that the future range of flora (and fauna) will not be the same in the coming decades. Changing temperatures and precipitation rates will lead to change in the existing flora (and fauna) and to a north-easterly movement of existing species. More compelling still is the occasional observation that not all flora will be able to keep pace with the rate of climate change, suggesting that human intervention will be required in order to preserve many species and to aid the shift of biomes. Current EU and Member state practice has been to define so-called 'special protection areas', 'sites of community interest', and 'special areas of conservation' in fixed locations. Moreover, the designation of such fixed sites has typically been pursued with the intent of preserving existing biodiversity and safeguarding species permanence. This approach presumably results primarily from the fact that many of the

[44] Not surprisingly, there is considerable disagreement over the potential range of biome shift. The Commission's White Paper, for example, notes a range of 500-1000 km (European Commission 2009b). Other estimates (on which the Commission's report draws) mention somewhat smaller ranges. For example, DG Agriculture's report suggest a potential range from 100-400km (EFI-BOKU-INRA-IAFS 2008) and the EEA's Adaptation study suggests the potential may shift as much as 550km for birds and some 100-500km for forests (EEA 2008).

ideas regarding species protection were conceived quite some time ago. The EU's Birds Directive, for example, was introduced in 1979, long before all of the discussion on global warming and climate change. Later subsumed in the Habitats Directive (1992) – all 'special protection areas' under the Birds Directive were to be included as 'habitats' – this directive too still precedes much of the global warming and climate change discussion, in particular the context of adaptation.

Thus ultimately, the EU has much to do in order to rework existing legislation on the basis of what we now know and are still learning about the impacts of climate change. Current perceptions of the consequences of climate change – at least where biodiversity is concerned – often seem mired in notions of lost permanence rather than biodiversity migration. This point is tremendously important, since the key question now is what biodiversity migration really means – how many species will it affect, what will be its range – and what are the consequences for conservation practices – should we follow existing species with the establishment of new protection areas, or help new species to migrate to existing protection areas?

Finally, the basic approach of creating fixed protection or conservation areas may itself ultimately be open to question – in particular where these have been created to protect and preserve certain types of species. However, the potential for re-locating conservation areas is likewise highly problematic. For one, establishing conservation areas is a relatively complex political, economic and social problem involving considerable time and negotiation. For another, existing spatial geography exhibits many limitations. Few would currently envision tearing down existing urban settlements, for example, for the sake of conservation goals.

The EU has however made some progress in attempting to respond to these challenges. First, Policy Area No.3 (Objective 9) of the EU's Biodiversity Action Plan focuses on biodiversity and climate change. The EU strategy recognises the threat to biodiversity posed by climate change and encourages states to take action to protect Europe's biodiversity, pointing out the importance of the relationship between biodiversity and adaptation. In particular, the Biodiversity Action Plan encourages states to 'improve the resilience and connectivity of protected area networks' and to 'assist those species and habitats most at risk' (European Commission 2006b, p. 11; see also European Commission 2008b, p. 23) . Second, several large research projects have recently attempted to assess the importance of climate change and adaptation requirements in the context of protecting the EU's biodiversity. In particular, two large projects (BRANCH and MACIS)[45] have attempted to analyse potential climate impacts on biodiversity and to provide policy recommendations. In general, these studies find that concepts of species protection need to be more flexible and adaptable to the dynamics of biome shift and species migration.

Both studies likewise point to the problem of species mobility across existing biomes and argue that ways need to be found to improve the adaptive potential of existing species. Recommendations include creating greater interconnectedness across existing conservation areas (Natura 2000 networks) in order to aid mobility, extending existing areas and/or creating new ones in order to help some species adapt. Moreover, analysts propose the concept of 'mobile sites' in areas where natural conservation areas can be eroded by natural processes (such as

[45] On the BRANCH project see; http://www.branchproject.org/. On the MACIS project see; http://macis-project.net/index.html.

coastal sites). These studies also point variously to the concepts of 'migration', 'ecological' or 'biodiversity corridors'. Much like the concept of promoting interconnectedness, this approach attempts to address the necessity for facilitating species movement and thus adaptation. The corridor concept has in fact already been introduced in some Member States. In particular the Danish NAS proposes this strategy.

Finally, both of these studies point to the potential role Strategic Environmental Assessments (SEA) and Environmental Impact Assessments (EIA) could play in promoting broad scale and horizontal attention to adaptation issues if these goals were firmly integrated into the SEA and EIA Directives. And the Commission has likewise committed to developing guidelines 'to ensure that climate impacts [and adaptation needs] are taken into account in the EIA and SEA Directives' (European Commission 2009a, p. 13). Though the phrase 'adaptation needs' does not appear in the original, it should presumably be worked into the text.

As a further illustration of the problems raised by the biome shift phenomenon, invasive species and how they will be treated in future EU policy is potentially highly problematic. For one, invasive species have typically been considered pests that enter into an environment in which they do not belong. Climate change and biome shift require that we radically redefine the way we think about pests in general and invasive species in particular. Two basic problems occur with climate change. On the one hand, the survival and competition potential of some species are changing as a result of the changing climate. As a result, some species that previously posed no risk at all to the environment, forestry or agriculture have now become pests. However, these species are not 'invasive' in the true sense of the word, since they have always been present. Climate changes have simply altered their competition potential and thus upset the previously existing natural balance. A good example of a newly competitive species in the North American continent is the mountain pine beetle, which has laid waste to an area more than twice the size of Ireland.[46]

A second category of problems concerns species that are by definition 'invasive' but are not per se 'pests'. Biome shift ultimately means that significant shares of new species will come to inhabit regions where they were previously unheard of, and currently well-known species will move further along with the shifting biomes. Current legislative efforts with regard to Invasive species demonstrate some of the difficulties of coming to terms with these issues. EU legislative proposals, for example, still bear the title the *Invasive Species Act*. Yet clearly the term 'invasive', as suggested above, misrepresents the reality of the problem to be addressed. The DAISIE project has thus far catalogued more than 11,000 species that are alien to but present in Europe. Only approximately 10-15% of these species represent potential threats in economic and/or ecological terms. Though the emphasis of the EU's efforts on invasive alien species focuses primarily on protecting European 'biodiversity', invasive species are potential threats to both flora and fauna throughout Europe. Forests too can be laid waste by the invasion of alien species as in the example of the mountain pine beetle.

To date, although the EU and individual countries have legislation in place intended to protect national and European level biodiversity, thus far no harmonised EU level approach has been put

[46] See, Beetles, Wildfire: Double Threat in Warming World, (*Associated Press*, Aug. 23rd 2009).

into place for monitoring and controlling invasive species and the effect of these on European biodiversity. Current efforts from the European Commission have thus far focused on the development of a European-wide 'early warning and information system' focused on reporting new and emerging species. Additionally, the Commission has proposed expanding the current list of banned species to cover other newly discovered invasive species. Other considerations include the development of legal measures for handling invasive species and the potential establishment of an independent agency. Most recently, the Environmental Council of Europe issued a statement on invasive species and drew attention to the potential importance of Natura 2000 regions for the preservation of European biodiversity (see Council of the European Union 2009). The Commission has been called upon to develop a strategy to respond to the issue of invasive species by 2010 and to continue to develop inventories on invasive species.

2.3.5 The biodiversity policy framework

A quick review of two EU policy areas (Natura 2000 goals and the EU's Common Agricultural and Rural Development strategy) reveals some of the difficulties of responding adequately within the current EU policy framework. For one, the integration of the adaptation dimension in the Natura 2000 framework is likely to confront serious complications. The EU and the Member States (like many other countries)[47] exhibit considerable difficulty moving ahead with even the comparatively simple project of protecting existing levels of biodiversity by establishing Natura 2000 regions. Given current experience with the basic project, adding the adaptation dimension to the Natura 2000 goals is ultimately likely to be immensely complicating.

The principle complication – as outlined by the discussion of the consequences of biome shift – is that too little is currently known about how best to adapt Natura 2000 objectives to climate change. One possible strategy, of course, is to loosen up the original habitat objectives and to address issues of permanence and flexibility in ways that more clearly define both what can be achieved with Natura 2000 protection areas, as well as what the ultimate goals really are. In the longer term, species permanence, for example, within currently designated Natura 2000 habitats will presumably not be possible in many (perhaps even most) cases.

Second, the legal framework for species protection in Europe will require relatively radical change and reform. By way of example, most EU Member States strictly control the type of tree and to some extent plant species that can be planted in any specific country. Thus, for example, sections 6-9 of the 2008 Swedish Forestry Act provide very significant restrictions on the types of trees that can be planted and typically prohibit the planting of foreign species, including those from other EU Member States (Ellison et al. 2009).

With respect to the EU Natura 2000 policy framework, some – including the Commission's White Paper – have suggested that adaptation to climate change can be easily integrated into the management of Natura 2000 sites. Further, some have argued that Articles 3(3), 5 and 10 of the Habitats Directive provide a framework for integrating adaptation (MACIS 2008: 10). For example, Article 3(3) allows Member States to improve the 'ecological coherence of Natura 2000' sites, while Article 5 allows the Commission, in cooperation with the Member state, to

[47] See e.g.; Efforts to sustain biodiversity fall short (*Nature*, Nov. 19th 2009).

play a caretaker role in situations where 'priority habitats' or 'priority species' are not adequately protected (by unanimous vote of the Council). Article 10 allows Member States to intervene in potential migration corridors in order to improve the potential for species movement.

Such proposals however seem to ignore the enormity of the basic problem of biome shift and what this ultimately means for species preservation. Very few questions have been raised about the potential for Natura 2000 regions to provide an adequate basis for biodiversity protection and the bio-diverse resilience of future forests, flora and fauna. From the total land area in Europe, Natura 2000 habitats represent only a very small share. Though the Natura 2000 networks were originally conceived as a strategy for protecting Europe's biodiversity by providing areas where the broad variety of Europe's species would be guaranteed to survive, it is far less clear what will happen in the context of climate change and biome shift. In some senses, researchers and analysts appear to be looking at Natura 2000 habitats as a means of protecting and ensuring the resilience of Europe's environment. This however, is a much more extended goal and there is little certainty that the comparatively small area of terrain currently covered is adequate to the task.

Presumably a complete re-evaluation of Natura 2000 site designations should be undertaken in the context of climate change and, where necessary, Member States should consider the potential designation of new and/or additional sites in order to meet the goals originally set out by the Natura 2000 project. Though this is ultimately a much larger project, thus far no mention has been made of such a strategy. However, in order to create an adequate framework for species protection and potentially preservation in Europe, it is presumably necessary. The EU's Common Agricultural Policy and Rural Development Strategy, on the other hand, has yet to integrate or even adequately consider all of the potential linkages between forests and the goal of ecosystem protection. Though DG Agriculture's EAFRD addresses afforestation as a general strategy, only two basic goals are currently served: 1) the planting of forests in order to promote future bioenergy potential, and 2) the planting of forests in order to sequester carbon.

As a mitigation tool, the CAP's afforestation strategy has been a particularly slow moving vehicle. In a relatively long period of time, the EU has only managed to re- or afforest a very small area. Adequate data on actual afforestation and reforestation is difficult to come by. The Commission's White Paper on Adaptation, for example, notes that over the past 15 years, forest area in Europe has increased by some 13 million hectares (European Commission 2009b: 81). While afforestation efforts account for a share of this increased forest cover, it is not exactly clear how much. The ECCP working group on forest sinks notes that:

> Between 1990 and 2000, afforestation and reforestation activities have extended the total EU forest area of 113Mha by 340,000ha/year or 3%, resulting from nearly equal surfaces of planted forests (in many cases through support from the 2080/92 afforestation scheme and the rural development regulation 1257/99) and natural forest expansion. The Group estimates that, if this process continues at the same rate during the present decade, it may result in a sequestration potential of approximately 3.84Mt C/yr. (14Mt CO_2eq/year) during the first commitment period. In case of a sustained afforestation trend and taking into account an extended EU of 25 Member States, a technical sequestration potential of 34Mt C/year (125Mt CO_2eq) may be reached in the long term. (ECCP WG FS 2008, p. 4)

Roundly criticised by the European Court of Auditors (ECA 2004) and a number of NGOs (cf. Birdlife International 2009a; FERN 2008), the EAFRD strategy has done relatively little to promote either the goals of biodiversity or ecosystem protection, nor has the program been very efficient at extending forest cover and sequestering carbon.

However, while in the 2007-2013 framework perspective EAFRD funding was also made available for Natura 2000 areas, to date most EU Member States have thus far not made extensive use of the available funding opportunities (European Commission 2009c). BirdLife International (2009b) recently criticised both the EU level funding mechanisms available for Natura 2000 areas as hopelessly inadequate (giving rise to significant funding shortfalls), as well as criticising individual Member States for failing to take adequate initiative to ensure that available EU funding is actually allocated for biodiversity preservation: 'Natura 2000 and biodiversity conservation is simply not identified as a priority for EU funds in most countries' (BirdLife International 2009b, p. 7).

These points are significant for at least two important reasons. First, the fact that the EU has only been able to re- or afforest 3% of EU forest area in a 10 year period[48] raises compelling questions about how and even whether the EU and individual Member States will be able to handle the problem of biome shift. Though it is not immediately clear from current studies just how intensive a strategy is necessary in order to respond to biome shift – we do not currently know to what extent trees, for example, will be able to keep pace with this shift – this shift will ultimately affect very broad expanses of European forests. At the very least, very large swathes of forest and wooded areas will be at increasing risk. At the worst, large areas in European forests could suffer from significant dieback – especially in areas where forests are composed of reduced numbers of species. The potential size of these areas far surpasses the capacity of current EU-level afforestation strategies, though a good share of these areas likewise falls under the forest management practices of public and private owners in individual Member States.

2.4 From the water towers of Europe to ecosystem preservation

While adaptation of course needs to be integrated into the framework of individual sectors, one of the greatest weaknesses of current efforts and approaches suggested by the above discussion of water, biodiversity and ecosystem services is the overall interconnectedness of issues across sectors. A thorough discussion of water and potential adaptation strategies requires a relatively thorough discussion of climate impacts, agricultural practices, energy use, changing water demand structure in different geographic regions of an individual river basin – in particular across the borders of individual countries – and finally, consideration of the ecosystem services which both produce and manage water flow.

In this sense, a more holistic and integrated approach to adaptation in and across individual sectors may ultimately be a requirement for policy success. Though at least some of the

[48] If we take the larger figure of 13 million hectares of increased forest cover noted above, which includes re- and afforestation under the EAFRD as well as other afforestation projects, this sum amounts to just over 11.5% of the total EU forest cover in a 15-year period, a considerably larger figure.

discussion in the accompanying documentation to the White Paper recognises the potential value of such concepts as 'Green Structure' approaches (European Commission 2009b), as ways of improving ecosystem resilience (by improving biodiversity) and exploiting ecosystem services (such as cleaner water, air and cooler temperatures), such ideas are not well integrated into the larger EU policy context. Nor does the White Paper provide much of a model for achieving this goal.

Adequate responses to the threat of climate change, biome shift, biodiversity loss and the weakening or disappearance of ecosystems and ecosystem services are difficult to craft in the EU policy context. The general problem is not made any simpler by the fact that though there are a number of different contexts in which it is possible to begin to address these issues, the strategies that emerge are, for the most part, only partial, piecemeal or even sectorally-dependent responses to issues that should potentially be viewed in a much larger overarching context. Thus, for example, Natura 2000 and biodiversity commitments are not quite the same thing as the preservation of ecosystems and ecosystem services. Similarly, as noted above, while afforestation strategies tend to target carbon sequestration and/or future bioenergy production, they generally fail to consider such issues as the impact of forests on the water cycle, their potential value as flood management tools, their larger impact on cooling, their relative impact on biodiversity needs or—and perhaps most importantly—their potential to help create or extend important ecosystems.

[Insert Table 2.2]

As illustrated in Table 2.2, most current EU policy strategies only target single or possibly dual policy goals. Similar claims can presumably be made about national level strategies (such as National Parks or Forest preserves). With a more integrated and holistic approach, many of these policy tools could be adapted to address a much broader range of policy interests. Moreover, the benefits from doing so are presumably far greater than if policy strategies only target single or dual policy goals. Individual policy efforts may not always be able to address all of the potential targets raised in Table 2.2 above – for example, flood management or increased precipitation may not always prove meaningful depending on the ecosystem in question. At the same time, the broadening of potential policy goals has the capacity to greatly improve the quality of the outcome with respect to a broad range of adaptation-related needs and interests. Thus, for example, forests can be employed to pursue multiple goals, not just those of carbon sequestration and/or bioenergy generation.

While the EEA's current strategy of trying to raise the value of ecosystem services by imposing prices and charging for them may go some way toward strengthening support for ecosystems, there are some limitations of this approach that should also be taken into account. In the long run, the Economics of Ecosystems and Biodiversity (TEEB) strategy is more of an end-of-pipe strategy: it places a price on the 'outputs' of ecosystems, but it does not per se strengthen the commitment to the actual ecosystem that produces those outputs[49]. Thus, for example, with respect to water-pricing strategies, the TEEB approach raises the 'value' of water and will

[49] The TEEB project attempts to estimate the costs of ecosystem services and propose relevant pricing strategies. A similar strategy is already being elaborated under the Water Framework Directive, which requires Member States to introduce water pricing systems for national water resources by 2010.

thereby likely have a substantial impact on water use efficiency (assuming of course that individual Member States introduce adequate plans). But TEEB as such does not strengthen protections for the ecosystem that produces the water, though other policy features, such as the water purity requirements of the WFD may indirectly achieve some of these goals. This should not be seen as an argument against TEEB, but rather as a defence of the notion that more is really necessary in order to adequately protect and improve the quality of existing ecosystems and/or to create new ones.

Likewise, the proposal to broaden and strengthen use of SEA and EIA assessments certainly seems advisable and on a relatively broad scale – e.g., in the assessment of structural and cohesion fund projects, large scale infrastructure projects and large scale agricultural or energy-related projects. However, it does not represent a sufficient strategy. The principal difficulty is that while afforestation strategies, for example, might benefit from some degree of climate-proofing, this in itself is no guarantee that the goals of biodiversity preservation or ecosystem maintenance and improvement will be addressed. Afforestation, as a strategy, already fulfils a number of climate-proofing requirements – it provides future potential bioenergy production and longer term carbon sequestration. In this sense, though afforestation strategies may easily comply with a number of important climate goals, SEA or EIA assessments do not guarantee the goals of biodiversity preservation or improvements in ecosystem service production will be served.

More generally, the EU has not been very successful at coordinating strategies across competing issue domains. Thus, for example, though the re- and afforestation strategies under the EAFRD and biodiversity goals under the EU Biodiversity Action Plan are theoretically compatible due to the potential for biodiversity goals to strengthen future forest resilience, they appear to generate little cross-institutional cooperation and coordination. If the goals of biodiversity and forest resilience cannot even be adequately integrated into the comparatively small scale EU afforestation strategy – where it is presumably/potentially beneficial – then we should also be raising questions about the ability of EU policy to successfully integrate the far more comprehensive adaptation and ecosystem services strategies into the existing EU policy framework.

The extent to which the climate-related goals of forest and ecosystem resilience are utterly disconnected and disassociated from the more marketised (or commodified) aspects of forest system management (in particular the pursuit of bioenergy strategies and, to a lesser extent, carbon sequestration, cf. Ellison and Keskitalo 2009) is potentially suggestive of a broader dilemma lying at the heart of EU (and potentially also national-level) governance mechanisms that may itself need to be addressed. The following section focuses on the concept of institutional constraints and adaptation strategies.

Though land use, the third thematic area defined in the White Paper, is not discussed in this chapter, land use and land use change represent perhaps some of the largest potential impacts on ecosystems and their related services. In the long run, land use and land use change cannot (or at least should not) be discussed without reference to this general adaptation-related context. Moreover, land use and land use change clearly overlap significantly with the first two areas, since decisions to build dams or extend residential areas have immediate implications for water-related issues, biodiversity and ecosystem services.

2.5 On the governance of adaptation: goal conflict and institutional confusion

As demonstrated in Ellison and Keskitalo (2009), EU strategies are frequently subject to a form of goal conflict that presumably results from relatively significant divisions across different horizontal and vertical levels of competence. Thus for example the introduction or pursuit of policies in one institution – for example DG Agriculture or DG Environment – can potentially conflict with policies pursued by another DG (horizontal). And of course goal conflict can also occur between EU and national level policies (vertical). Understanding the impact of the existing institutional structure is crucial to building the foundation for improved strategies for addressing both climate change mitigation and adaptation. To the extent that the existing institutional structure both determines and reinforces the fabrication of sectorally-defined, piecemeal policy solutions, models for reform gain increasing significance. Moreover, as argued in what follows, without significant institutional reform, it is unlikely the EU will be able to develop and introduce more holistic models for climate change mitigation and adaptation.

The problems of such horizontal and vertical forms of multi-level governance (MLG) are well illustrated with the example of forestry policy. With regard to forestry and forestry policy, policy outcomes exhibit strong coordination of interests around two poles: on the one hand the agricultural, energy and industry oriented Commissions/Ministries appear to favour strategies related to bioenergy, biomass and afforestation, while on the other hand environmental ministries, the EEA and environmental agencies (such as the Swedish Environmental Protection Agency (SEPA) tend to favour more environmentally oriented goals such as biodiversity, the promotion of Natura 2000 natural conservation areas and a more general emphasis on ecosystems and their related services.

Some preliminary conclusions as well as identification of potential evolutionary development paths can be drawn from this very brief synopsis of institutional divisions and policy fragmentation. One is the persistence of institutional rivalry and competition across different decision-making bodies at the EU and also national levels. These divisions are reinforced by variation in the relative resource endowment of individual institutions. The result of these divisions is policy fragmentation. The continued emphasis on business-as-usual decision-making pathways would continue these problems and potentially impede the development of more coherent forest policy. However, decision-making approaches that would support more coherent policy could also be developed. The institutional approach and logic developed in Ellison and Keskitalo (2009) can easily be extended to the question of integrating adaptation into EU policy more generally. Similar goal-conflict related problems are likely to occur where attempts to address adaptation come up against competing goals – either as a result of ongoing climate mitigation efforts or as a result of other existing policy strategies.

Problems in forestry are of course only one example of such potential goal conflict. Where adaptation is concerned, the potential for such goal conflict is also high. As one important example of this, climate mitigation options pursued in particular by DG Energy and Transport strongly favour bioenergy strategies that promote the use of wood (and other forms of renewable energy use) in order to substitute for fossil fuels. While potentially not contradictory to

afforestation interests – one logic for afforestation is to build the potential for future forest use in areas such as bioenergy – bioenergy goals may ultimately conflict with biodiversity goals. Moreover, the combination of afforestation and bioenergy interests – in particular where these favour the use of fertilizers, monocultures and rapid rotation energy crops – may be doubly detrimental to biodiversity goals. Adaptation interests on the other hand are far more likely to emphasise the benefits of environmental features like biodiversity – in particular for future forest resilience and potentially also for future forest regeneration. And, as suggested above, adaptation strategies could potentially go much further to emphasise the role and importance of ecosystems and the services they provide.

One alternative for the more effective coordination of interests involves the promotion of improved communication across the different EU Commission units and between the EU and other national and local levels of policy-making. At least two recent articles promote models along these lines. Mickwitz et al. (2009) recommend a number of instruments to bring about greater policy integration (communicative, organisational and procedural instruments that ultimately attempt to give greater place and prominence to the climate debate in national agendas, institutional arrangements and assessment and consultation procedures). On the other hand, Glück et al. (2009) highlight and promote the advantages of multilevel governance, decentralisation and participatory decision-making processes.

Institutional mechanisms do exist at the EU-level that are supposed to help reconcile the competing claims with respect to forestry and the use of forest-based resources. The *Inter-service Group on Forestry*, established in 2002 'to facilitate cooperation and coordination of forestry-related work between relevant Commission services' (EP 2006: 3), is technically responsible for insuring that forestry policy is coordinated across some 11 to 13 EU-level Directorates General (DG). Chaired by DG Agriculture, this body has two main purposes: to ensure the flow of information and to seek agreement across departments. There is also an Inter-service Group on International Forestry Issues responsible for the preparation of Commission positions on international issues. To what extent the general Inter-service coordination strategy is successful is controversial. Birdlife International argues, for example, that the work of the Inter-Service Group on Forestry as well as DG Agriculture's Standing Forestry Committee (SFC) should ultimately be opened up to NGOs. In addition, the power and position of DG Environment should be elevated in order to more successfully introduce forestry issues (see e.g., BirdLife International 2006).

The European Economic and Social Committee (EESC) argues that forestry and its potential role in climate mitigation and adaptation could be utilised to far greater and more significant effect than is currently the case. Moreover, the EESC argues that far more needs to be done with regard to developing responses to the need for adaptation – in particular in forestry (EESC 2009). Whether the failure to emphasise and improve forestry policy is explicitly the result of institutional divisions is not discussed in the EESC Opinion. However, other EU-level organisations have explicitly criticised this point in the past (ECA 2004, p.10). The Commission, on the other hand, demonstrates considerable resistance to the idea of institutional reform and argues that a stronger legal footing for forestry policy in the EU is not feasible without greater interest from Member States.

Ellison and Keskitalo (2009) ultimately ask whether the governance structure surrounding this complex of issues – both at the EU and the national level – is well equipped to handle the increasing proliferation of actors, their related interests and the increasing potential for goal conflict. The coherent coordination of interests around a defining agenda needs to be able to overcome divisions created by the vested interests of competing actors – in particular where institutional divisions reinforce these divisions and vested interests become institutionally segregated. In such cases, more radical solutions may be necessary.

Perhaps the most important conclusion to arise from the goal conflict analysis is that the introduction of additional consultation procedures or proposals to extend and further promote decentralisation in decision-making processes may be entirely inadequate (necessary but not sufficient) to resolving such deeply-seated and broadly-situated institutional divisions and policy fragmentation. Two observations are central in this regard: first, institutional divisions that reinforce and further segregate the representation of vested interests in policy outcomes are unlikely to be overcome by the promotion of attempts to simply increase coordination across different actors. Second, vested interests are present at all levels – including the local level. Thus an emphasis on decentralisation likewise may not be able to overcome such divisions. Assuming the basic problem regarding the coordination of adaptation strategies is the fact that there is too much institutional division across relevant policy domains and thus ultimately poor coordination and fragmentation of policy output, then at least one relevant proposal might be to coordinate adaptation policy at the EU level under one single Commission. Thus a more compelling alternative may be to create a Climate Change Commission and place principal competence for adaptation within that framework. This would have the advantage of correcting the current degree of decentralisation and fragmentation of forestry policy. Further, this would place the principal focus on forestry firmly within the context of climate change.

Creating a Climate Change Commission may help to resolve some of these dilemmas. The specific role of a Climate Change Commission should ultimately be defining strategies for responding to the challenges of global warming and climate change. Since these of course involve both mitigation AND adaptation, the creation of a Climate Change Commission might also heighten the degree of attention dedicated to the adaptation side of the debate, both in the context of forestry and in other adaptation-related policy areas.

While it is difficult for the European Commission to proceed with substantial reform without the support of the Member States, such a strategy would seem to make sense on a number of levels. For one, the EU's role in the pursuit of climate policy has been tremendously important in the international arena. Without the leadership role played by the EU, it is unlikely that the Kyoto Protocol covering the period up to 2012 or ongoing negotiations over a new agreement to cover the period 2013-2020 would have gone as far. The most important commitments to emission reductions under the Kyoto Protocol have been made by EU Member States.

Elevating EU climate strategy to Commission status would simply recognise and reinforce the EU's current leadership role in the climate debate. Moreover, it would make it possible to further mobilise both expertise and resources on a single climate agenda. Though there is currently discussion at the EU level about creating a Climate and Energy Commission, this strategy may not be the most advisable goal. This proposal has been strongly criticised by some, in particular

for attempting to shift policy competence at a strategically difficult time (just prior to the Copenhagen negotiations).[50]

The logic of the 'goal conflict' argument ultimately finds fault with this proposal. The principal issue raised in this context concerns the concept that policy choices are strongly influenced both by the institutional location in which they are developed and by the prominence of interests embedded within that context. The institutional structure promoted with the potential introduction of a Climate and Energy Commission would lend far too much weight to the Energy sector. In fact, far too much of the EU climate strategy has tended to focus attention on the energy sector and has given far too little consideration to other potential policy areas (in particular building-related energy use, forestry, transport and ultimately adaptation itself). On the other hand, the potential elevation of the climate agenda to Commission status – with a mandate for focusing on both mitigation AND adaptation – is potentially far more appealing.

Many advantages potentially arise out of the centralisation and control of the mitigation and adaptation agenda in a specifically Climate Change Commission. For one, centralised coordination provides a framework in which competing interests can more easily be made to confront each other and potentially find resolution. For another, it would heighten the sense of commitment to the issue over which the Commission has been granted competence and raises the sense of fiduciary responsibility. Third, centralising coordination would likely reduce the degree of policy fragmentation or potential for goal conflict. Moreover, it could potentially provide a more successful arena for broadening the scope of commitment from many of the currently targeted options (afforestation, flood protection, biodiversity preservation, etc.) to the maintenance, preservation and creation of ecosystems (as outlined in Table 2.2 above). Finally, centralisation of climate policy at the higher EU level can further require and promote greater cross-border coordination and planning, thus potentially discouraging free-rider behaviour where cross-border issues are concerned.

Centralising control for mitigation and adaptation strategies at the EU level in a separate Climate Change Commission may pose potential threats to local and even national level interests. Some are clearly concerned about the potential consequences of increasing centralisation.[51] However, the call for greater centralisation of the EU climate strategy in a Climate Change Commission should not be seen as contradictory to the parallel calls for greater cross-sectoral and horizontal coordination, decentralisation and participatory decision-making processes. In important ways, these are complementary and not contradictory strategies.

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[50] See e.g., MEPs Angry at Plans for Energy Shake-up (European Voice, May 14th 2009); FERN's *EU Forest Watch* newsletter (June 2009, Issue No. 139) and the letter from EU GLOBE members (May 18th 2009).

[51] Pekka Pesonen, a former state secretary at the Finnish Ministry of Agriculture and Forestry warned against the dangers of an overly aggressive degree of centralisation in forestry policy and argued that policies should remain national in character due to national-level variation in approaches to forest policy. In his view, the adoption of common rules could potentially lead to contradictions with national-level policy strategies. See Call for more EU co-ordination on forest policy (*Euractiv.com* 2007). Though forestry policy may seem a skewed example since it is not firmly integrated into the EU legislative framework, it is highly illustrative of the way in which vested interests have come to inhabit sectoral-institutional frameworks and the difficulties in sharing policies cross-institutionally (cf. Ellison and Keskitalo 2009).

Ultimately a significant amount of flexibility and foresight must be written into any EU-level adaptation agreement in such a way that potential conflicts over policy strategies and competence at the national and local levels are not significantly compromised. In many ways, the general structure of the EU water framework directive provides a good example of how this can be done. The WFD sets a very general framework with general guidelines and principles which individual countries are then required to implement and adopt in concert with national and local level needs and interests. While the WFD is certainly not perfect and many still wish it had gone much further (examples of how it might be improved have also been discussed herein), the general concept of providing a very general EU-level framework with considerable room for national and local level flexibility is well-represented in this directive.

2.6 Conclusions

Typically the strongest argument in favour of the development of adaptation strategies has been the observation that even if states are able to stabilise or begin to reduce world CO_2 and other GHG emissions, some degree of climate change has already been built into the system. The concept of 'committed greenhouse gas warming' or 'committed climate change' has begun to find a common currency in the larger global warming and climate change literature (cf. Parry et al, 2009; Ramanathan and Feng 2008; Meehl et al. 2005, Parry et al, 1998) and essentially begins to define a lower bound for climate impacts that will (or are extremely likely) to occur given current atmospheric concentrations. Though estimates of such lower bounds have typically not begun to work their way into estimates of future climate impacts, these should ultimately begin to define a minimum level of preparatory action required by all EU Member States.

Climate change and the twin goals of mitigation and adaptation are THE challenge of the 21st century. As it has for mitigation, the EU must define a more unified, cohesive and overarching agenda for approaching adaptation. The relative complexity of defining strategies for adaptation, however, provides a strong foundation for arguing that the general commitment to adaptation should be expressed in very general and broad terms and should presumably be aimed at protecting the stability of ecosystems and the services they provide. Though the details of adaptation strategies must be worked out within the relevant sectors, their overall agenda should potentially be expanded in order to target a broader range of potential adaptation outcomes (as proposed in Table 2.2 above). Further, regional variation in climate impacts, vulnerability and adaptation requirements argues that a significant degree of flexibility will be required across EU-level legislative efforts and national-level Member state and local implementation. Sensitivity both to general adaptation needs in different sectors and to national and local-level requirements of adaptation must be worked into EU-level strategies.

At the same time, one should not be afraid of the potential advantages of more EU-centralised action on adaptation. The fact that failure to act on adaptation-related issues in one country has potential consequences for other neighbouring countries provides a strong foundation and motivation for the EU to intervene in a far more concerted fashion than it has to date. But perhaps more importantly, the potential for goal conflict across multiple sectors and across EU- and national-level decision-making bodies argues that responsibility for adaptation (and also

mitigation) strategy should be housed and highly centralised in one EU-level institution – presumably a Climate Change Commission. The goal of centralising responsibility for adaptation strategy in one institution should ideally favour the coordination of policy goals in two important ways: 1) across issues areas (e.g., energy, agriculture, water and land use) and 2) across individual Member States.

At the very least, this chapter has outlined a number of alternative solutions to the current mainstreaming model proposed by the European Commission. These range from the potential introduction of new Directives—such as a Directive on Water Use Reduction, an EU mandate for Member States to Develop Drought Management and Water Scarcity Issues and the development of a water conscious energy strategy—to increased emphasis on forest-water interactions and the development of ecosystems in Afforestation strategies. In addition, this chapter has emphasized the importance of developing long run strategies that strongly consider interaction effects across different cross-sectoral adaptation and other policy efforts. Though this discussion has been far from exhaustive and has failed to address many issues—in particular the third theme in the White Paper on land use—it has strongly underlined the importance of ecosystems and their preservation for human survival. Favouring the centrality of ecosystems with a more holistic approach to climate change mitigation and adaptation may be the key to a successful strategy. If it is necessary to adopt new institutional structures in the EU and elsewhere in order to achieve these goals, they should be given due consideration.

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Tables

Table 2.1 Differences between the EU's Green and White Papers on adaptation

Green Paper 2007	**White Paper 2009**
1) Early action to integrate adaptation into existing and new policy structures and funding programs and develop new policies	1) Building a solid knowledge base on the impacts and consequences of climate change in the EU
2) Integrate adaptation in *external* dimension	2) Integrating adaptation into key EU policy areas
3) Fill knowledge gaps: reduce uncertainty by improving the knowledge base and by integrating climate research	3) Employing a combination of policy instruments to ensure effective delivery of adaptation
4) Participatory, inclusive framework involving major stakeholders (European society, business, public sector) in preparation of comprehensive and coordinated strategies	4) Increasing international cooperation on adaptation

Table 2.2 Potential and actual targets of individual sectoral policies

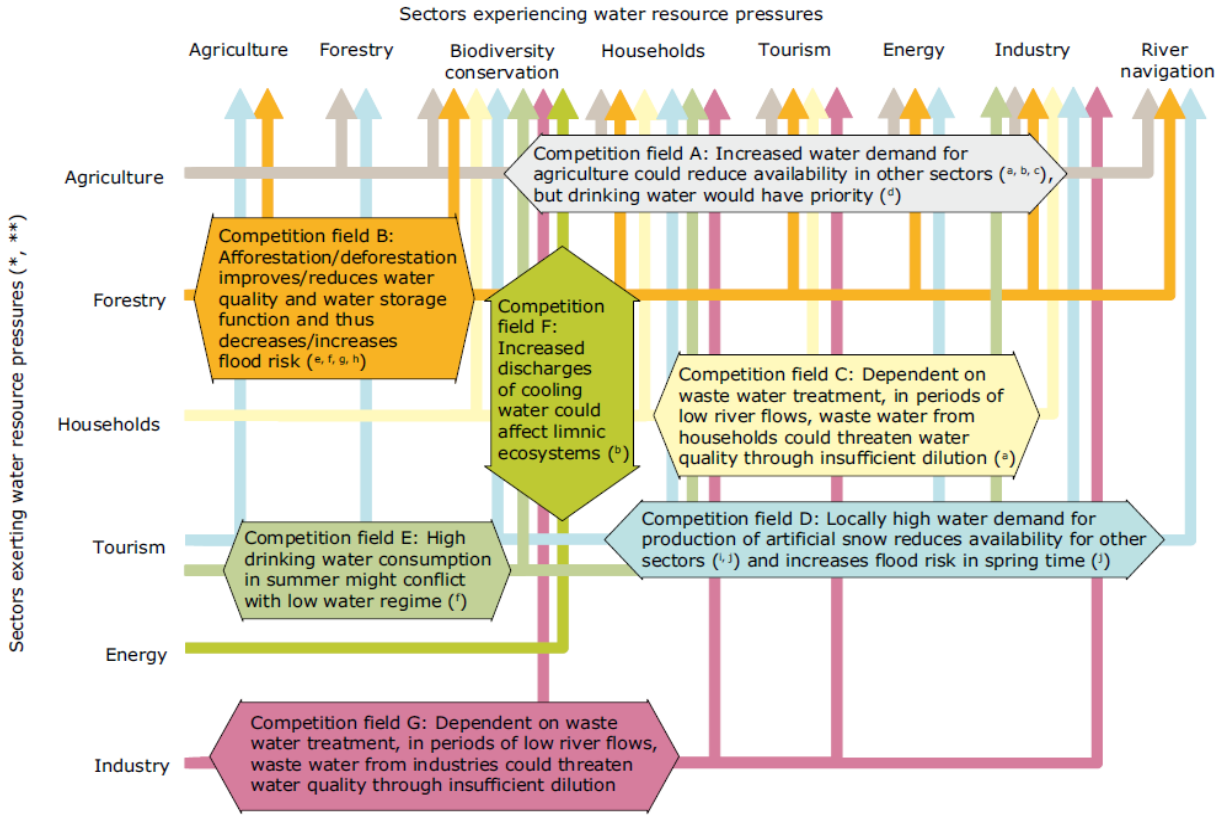
Sectoral Policy	Actual Targets	Potential Targets

Afforestation	• Bioenergy
	• Carbon sequestration
		• Ecosystem creation/preservation
		• Biodiversity protection
		• Species preservation
		• Water cycle management
		  ○ Quality/Purity
		  ○ Supply/Quantity/Balance
		• Flood management
		• Precipitation
		• Soil Retention
		• Cooling
		• Air purification
		• Combating Desertification
		• Carbon Mitigation

Natura 2000	• Biodiversity protection • Species preservation	
WFD/RRBMPs	• Water quality • Water quantity?	
Floods Directive	• Flood management	
Ramsar areas (wetlands)	• Wetlands preservation • Water purity	
Ecosystem Services	• Economically-driven use of ecosystem services	

Figure captions

Figure 2.1 Policy overlap in water resource management, reproduced from EEA 2009a.

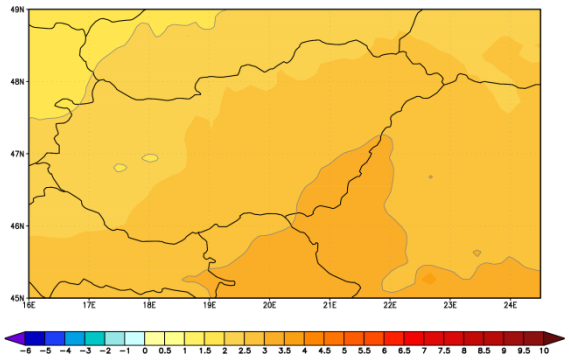


* River navigation is not considered as a sector exerting water resource pressures as it uses but does not consume water.

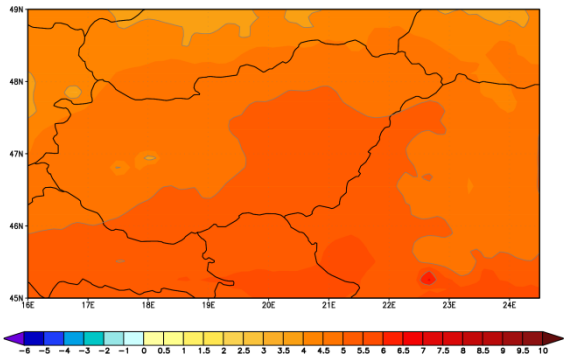
** Biodiversity conservation is not considered as a sector imposing water resource pressures as it does not actively change water use pattern but rather can be considered as a sector exposed to water competition.

Figure 2.2 Change in summer temperatures, precipitation and river flow compared to 1961-1990 reference period*

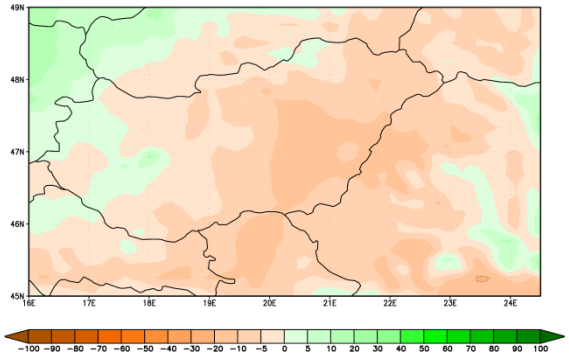
Summer Temperature Change 2021-2050



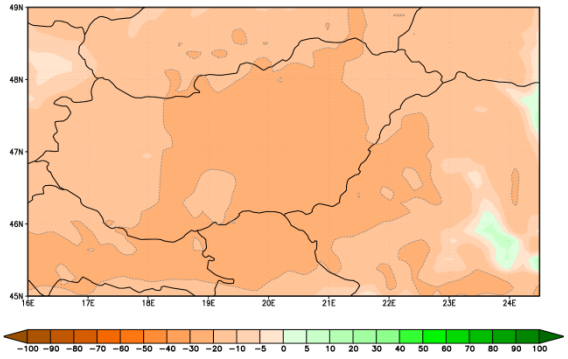
Summer Temperature Change 2071-2100



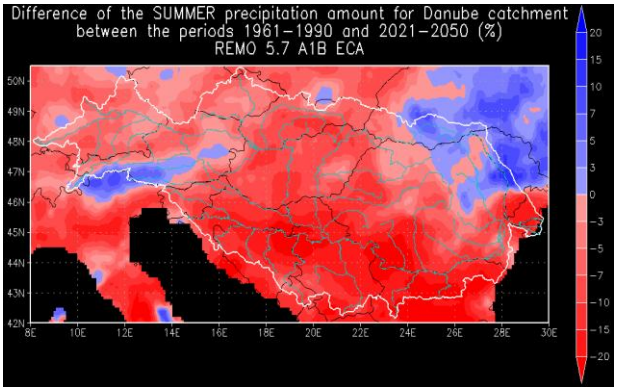
Summer Precipitation Change 2021-2050



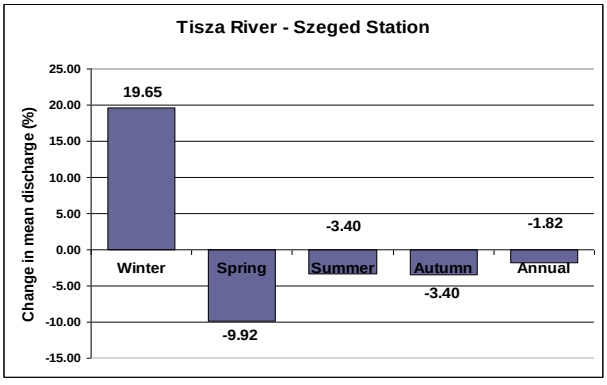
Summer Precipitation Change 2071-2100



Summer Precipitation Change 2021-2050



Change in Mean Water Flow – 2021-2050



* The first four graphs in Figure 2.2 have been graciously provided by the Hungarian Meteorological Institute (OMSZ) and the last two by the Hungarian Water Services (VITUKI)