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How can the European Union adapt to climate change?

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How can the European Union adapt to climate change?

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Executive summary

EUROPE MUST INCREASINGLY deal with the harmful impacts of climate change, regardless of its success in reducing emissions. These impacts have significant cross-border effects and threaten to deepen existing divisions. Cooperation on adaptation, which is mostly seen as requiring local or regional efforts, may be useful, but the role of the European Union is ill-defined.

WE GIVE AN overview of how climate change might change Europe and how it might affect people and the economy. We also discuss what sort of adaptation policies are being pursued at EU level and on what grounds. We argue that a stronger adaptation governance framework would benefit adaptation efforts.

WE FORMULATE THREE ideas to strengthen adaptation. First is a three-layered governance framework based on intensive cooperation to establish binding adaptation plans. Second is an EU-level insurance scheme against damages from climate change, with the size of national contributions tied to the achievement of targets in adaptation plans. Our final suggestion is to increase *ex-ante* adaptation funding by targeting more spending under EU regional and agricultural policies specifically to adaptation in the most vulnerable regions.

Recommended citation
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1 Introduction

The European Union's commitment to climate neutrality by 2050 is necessary and laudable, but even if it succeeds, global average temperatures may still rise to 2.4 degrees Celsius above pre-industrial levels by 2100, according to projections that assume other economies worldwide also achieve their official climate promises, as set out in Nationally Determined Contributions under the Paris Agreement (Stockwell *et al*, 2021). Even in the increasingly unlikely scenario that global warming is limited to 1.5°C, the EU will still need to deal with the consequences of more frequent and intense heat waves, droughts and floods, as well as rising sea levels. In addition to mitigating climate change, major efforts will have to be made to adapt societies, as signalled by the call at COP26 in Glasgow to allocate more international climate aid to adaptation and to disaster relief.

The EU is ambitious on tackling climate change, but most actions at EU level focus on mitigation. Adaptation – efforts to avoid, limit or manage the harmful effects[1] of climate change on human and natural systems – is mostly a regional and local issue. Nevertheless, the EU is also moving on this front, and for good reason. Science predicts that southern (and south-eastern) EU countries could be significantly more affected than their northern counterparts, which may exacerbate existing tensions within the EU. Furthermore, the all-encompassing effects of climate change touch on various policy fields that are within EU competences, and there are many cross-border aspects and instances of scale advantages. It remains, however, difficult to exactly delineate where and how the EU should step in, especially since adaptation to climate change still involves learning-by-doing.

The aim of this paper is to contribute to this debate, which will become increasingly important as climate change accelerates. To set the scene, we first give an overview of what may be ahead for Europe in terms of physical climate change and economic loss. We then discuss the arguments invoked to warrant EU intervention in terms of adaptation, and look at what the EU is currently doing in practise. Finally, we propose ideas to strengthen the governance of climate adaptation efforts in Europe, and to tackle remaining shortcomings.

2 Climate change's impact on Europe

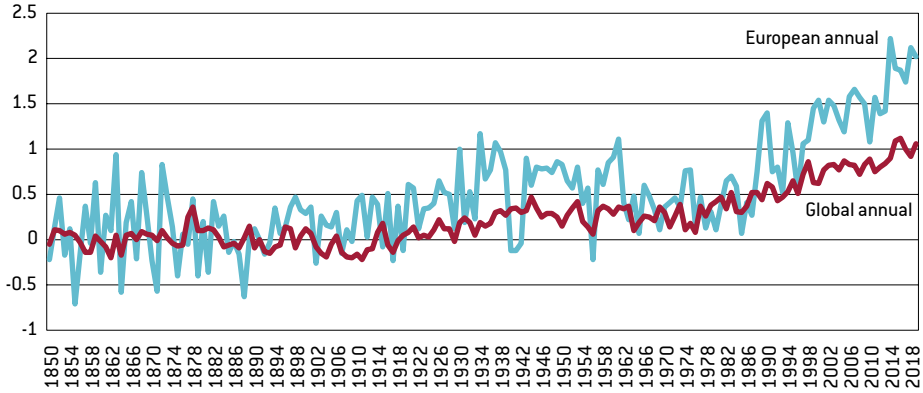
2.1 Physical effects

Global average surface temperatures have so far risen by 1.1°C since pre-industrial times (IPCC, 2021). Land temperatures in Europe have been rising much faster, to about 2°C above pre-industrial levels (Figure 1). This difference exists partly because global land temperatures are increasing faster than those above the ocean, but also because Europe is warming faster than some other regions (EEA, 2021a). With rising average temperatures, all of Europe is also seeing more frequent and intense extreme weather phenomena today than it did during much of the previous century. Europe is experiencing more summer heat waves, heavy precipitation and droughts, as well as rising sea levels (IPCC, 2021).

The specific impacts of climate change differ in different regions: all regions in Europe are seeing higher temperatures today, but the rise of mean temperatures has so far been fastest in central and eastern Europe, and in the very south, with more than 0.4°C of warming per decade on average since 1960 (EEA, 2021a). Unlike the rest of Europe, the south has not seen a clear increase in heavy precipitation and river flooding. Instead, it has suffered more from droughts, as has western Europe (IPCC, 2021).

1 This includes effects from both slow and fast-onset events.

Figure 1: Global and European average near-surface temperatures relative to pre-industrial period (°C)

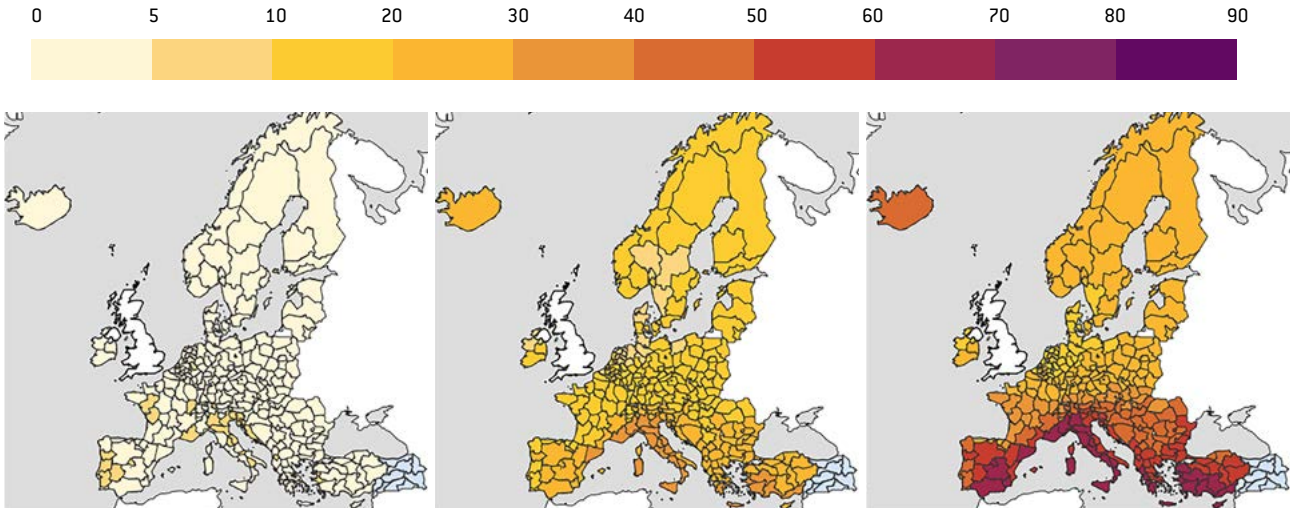


Source: Bruegel based on HadCRUT4 (mean) estimates reported by the European Environmental Agency (2021a).

Projections of different global warming scenarios for Europe teach us three main things about the future: that it matters greatly how successful efforts are to reduce greenhouse gas emissions, that all of Europe will be affected, and that in most scenarios, southern and south-eastern Europe will face the biggest impacts of climate change on multiple fronts.

Average temperatures will increase in all regions throughout this century, but patterns vary depending on the season. Winters will become warmer particularly in central and eastern Europe. Mountainous areas and the northern and southern edges of Europe will experience the largest temperature increases overall, especially in the summer, with mean temperatures that will be between 2°C and 2.5°C warmer than today by the end of this century, even

Figure 2: Annual number of health-affecting heatwave days between 1981-2010 (left) and between 2070-2099 under 3°C global warming scenario (middle) and a >4°C global warming scenario (right)

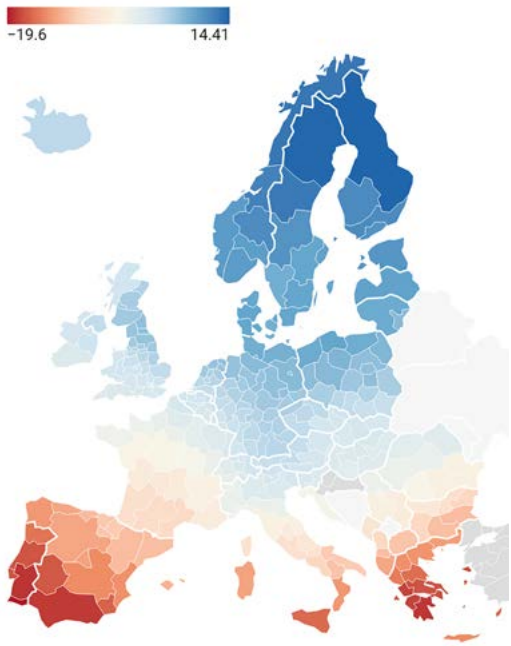


Source: Climate-ADAPT (2022b), based on Copernicus Climate Change Service data.

in a scenario in which global warming stays below 2°C[2] (Feyen *et al*, 2020; Climate-ADAPT, 2022a). Since southern Europe already has a warmer climate, it will be particularly affected by more frequent heatwaves that are harmful to human health (Figure2).

Precipitation will change too. In an optimistic emissions scenario compliant with the Paris Agreement (global warming stays below 2°C), most regions in Europe will see an increase in annual average precipitation, mostly in winter (roughly 5 percent to 10 percent more than today). Summer months may become dryer in the south however, particularly on the Iberian Peninsula. In a high-emission scenario (global warming >4°C) the contrasts will be much starker (Figure 3). The whole south will be much dryer throughout the year, with up to 20 percent less rainfall than today by the middle of the century and 30 percent less by 2100. Wildfires and droughts may therefore become increasingly frequent and serious problems for the Mediterranean region. Northern Europe on the other hand will become significantly more wet on average, even though in the summer many north-western regions, including France, Benelux, Britain and Ireland, will see less rainfall than today (Climate-ADAPT, 2022c). Rainfall that is more concentrated in time is expected to result more often in river flooding in these regions (EEA, 2021b).

Figure 3: Projected percentage change in annual precipitation by mid-century (2041-2070) by region, in a high global warming scenario (> 4°C)



Source: Climate-ADAPT (2022c). Note: refers to NUTS 2 regions; see https://ec.europa.eu/eurostat/web/nuts/background.

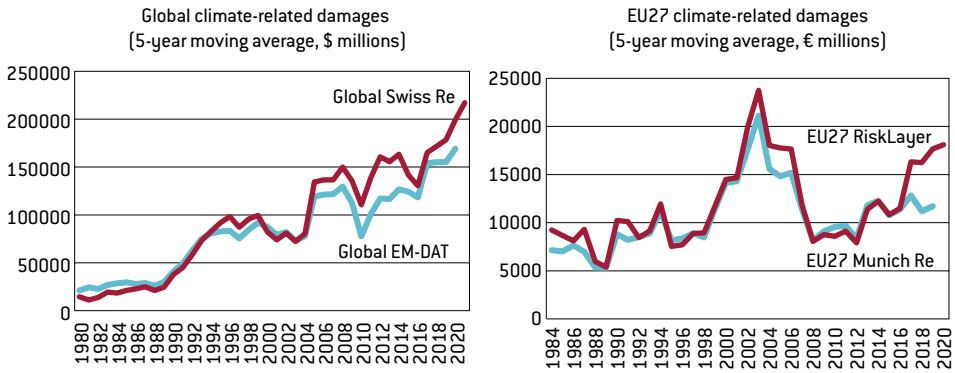
Even the frequency of extreme sea levels and coastal floods is expected to increase much more in the south than in the north. By 2100, sea-level surges that historically would occur once every century may return as much as several times a year along the Mediterranean and Black Sea coasts in a high emission scenario (>4°C), while they may happen once every one or two years along northern shorelines. In an intermediate scenario (3°C) the probabilities decline to around once a year and a few times each decade, respectively (EEA, 2021c).

2 For simplicity we use *likely* upper bounds of global average temperature increases by 2100 to refer to global warming scenarios that were presented in the Fifth Assessment Report of the IPCC (2014a). 2°C refers to RCP 2.6, a pathway in which CO2 emissions start to decline by 2020 and reach zero in the second half of this century. 3°C refers to RCP 4.5, in which CO2 emissions remain at current levels until 2050, after which they start declining. > 4°C refers to RCP 8.5, in which emissions continue to rise as before.

2.2 Damages and economic impacts

The fact that climate change is already underway is reflected in a clear upward trend in global estimated losses from climate-related disasters. There is, by contrast, not yet such a trend in the EU (Figure 4). The high variability in Europe over time arises from the fact that most historical damages in Europe were caused by a small set of big single events, such as storm Lothar in 1999 or the heatwave of 2003 (EEA, 2022). However, the yearly number of reported climate-related disasters in Europe is increasing. It is reasonable to assume that as both the frequency and intensity of extreme weather events grow, so will the material damages from such single disasters, especially as the value of exposed assets grows because of continued building on flood plains, for example.

Figure 4: Historic damages from climate-related natural events worldwide and in the EU, 5-year moving averages



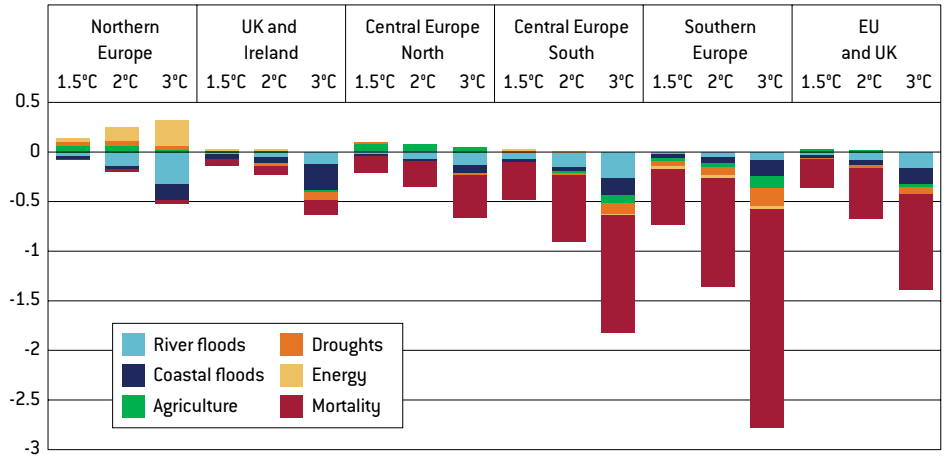
Source: Bruegel based on EM-DAT, CRED/UCLouvain (2021), Swiss Re Institute (2022), EEA (2022).

Estimates based on a static model by the European Commission's Joint Research Centre (Feyen *et al*, 2020) showed how much welfare loss the current EU economy could suffer if it were subject to different global warming scenarios, compared to today's climate (Figure 5). Feyen *et al* (2020) considered general equilibrium effects of damages from river floods, coastal floods, droughts, windstorms and human mortality from extreme heat, as well as declining agricultural yields and the impact of water scarcity on energy supply. Total EU28 (including the United Kingdom) welfare losses per year would be at least €175 billion with a temperature rise of 3°C, €83 billion with 2°C and €42 billion with 1.5°C.

Regions that are more affected by climate change are also likely to suffer greater material losses, particularly if these places are less prepared, as data from, for example, ND-GAIN (2022) suggests. The Commission's results confirm that southern Europe would be affected the most, with a yearly loss of 1.3 percent of GDP with 2°C of global warming compared to an average for the EU28 of only 0.7 percent[3]. The results are mostly driven by mortality from extreme heat, without which losses are more similar across different regions. Strikingly, Scandinavian countries could enjoy net economic gains, as increased energy output and agricultural production outweigh the impact of more floods. No region has net gains in a 3°C warming scenario, but the net losses for countries north of the Alps (0.2 percent to 0.6 percent of GDP) are clearly less than those incurred by southern and south-eastern countries, which would reach up to 2.8 percent of GDP.

3 Note that these are not projections of damages to assets, but losses in GDP. Estimates of future damages from the same study are higher, eg €111 billion per year from coastal flooding alone (EU-wide) in a moderate emission scenario without adaptation.

Figure 5: Estimated welfare loss from different future climate impacts if applied to today's economy, by region and level of global warming, as % of GDP



Source: Bruegel based on Feyen *et al* (2020).

These impact estimates are conservative according to Feyen *et al* (2020). They do not account for all possible climate impacts or tipping points (eg loss of labour productivity), and they only apply estimated climate change effects to today's economic output. Such a static approach does not take into account long-term effects that climate change may have on the growth rate of GDP, for example through reduced aggregate investment and political instability. Dell *et al* (2012) found robust evidence in historical data that temperature increases reduce short-term economic growth in poor countries, as well as evidence suggesting persistent effects on growth rates. Wealthy countries are not affected. Burke *et al* (2015) predicted that due to cooler baseline temperatures, northern countries may see long-term growth benefits in a high emission scenario, while countries that are on average already warmer may suffer from permanently lower growth, resulting in very big GDP *per capita* gaps (relative to a constant-temperature baseline) by 2100.

The debate on the existence of long-term growth effects from higher temperatures is still open, whereas negative short-term impacts on GDP (sometimes non-linear) are well established. Models that do not feature permanent growth impacts (but still permanent GDP effects) usually predict much smaller effects than those that do. For example, Kalkuhl and Wenz (2020) found output losses of 'only' 20 percent compared to the baseline in tropical regions by 2100. In general, numbers depend greatly on assumptions and specifications and precise estimates are clearly not possible (see Kahn *et al*, 2021). But most studies suggest that climate change is set to exacerbate international inequalities, including within Europe. Adaptation has not yet been sufficient to play a significant role in mitigating damages (Kahn *et al*, 2021; Burke *et al*, 2015), but will become increasingly important in the long run (Dell *et al*, 2012).

2.3 Sectoral impacts

The estimates above do not necessarily encapsulate the society-wide nature of the challenges arising from climate change. Increasing temperatures and drought will, for example, force farmers in most of Europe to switch to different crops or to irrigate their fields. International crop prices rising on the back of worsening climate impacts elsewhere may in fact have a positive effect on the production of certain crops in southern Europe in case of successful adaptation (Feyen *et al*, 2020). However, if adaptation fails, for example because there is not enough water for irrigation, yields and the value of agricultural land all across southern Europe could decline by more than half over this century (Van Passel *et al*, 2017).

Electricity production and distribution will have to adjust to the changing availability of water for hydropower and for cooling in thermoelectric power plants (eg see Behrens *et al*, 2017) as the north will become wetter and the south dryer, while more energy will be needed to cool houses in the south. Building renewable capacity and interconnections can reduce the risk of energy shortages (Feyen *et al*, 2020).

Another obvious impact will be on physical infrastructure. While droughts may reduce the traffic capacity of inland waterways, transport infrastructure including bridges, airports and seaports are vulnerable to inundations (Ciscar *et al*, 2018), as are of course buildings in flood-prone areas. Drainage systems and dykes will have to be upgraded to withstand larger amounts of water. Windstorms are not projected to inflict more damage on infrastructure, but in mountainous areas, higher temperatures will increasingly destabilise the soil, with consequences for infrastructure and dwellings (EEA, 2010).

Tourism will also be affected, as high seasons in the south will increasingly have to shift to spring and autumn. In the mountains, communities relying on winter tourism will increasingly have to turn to other sources of revenue, especially as the disappearance of glaciers will also make agriculture relying on melting water more difficult.

While not addressed in this paper, the damage done to forests and other ecosystems by, for example, more frequent fires and insect outbreaks, should not be underestimated (Feyen *et al*, 2020), not only because nature areas create opportunities for tourism, but also because they are important to human health and wellbeing, and because they serve as carbon sinks.

Finally, climate change will have direct impacts on human health and mortality, through excessive heat and vector-borne diseases (Feyen *et al*, 2020) as well as on labour productivity, with potentially far-reaching economic consequences (Chavaillaz *et al*, 2019).

Overall, climate change is likely to worsen social inequality (IPCC, 2014b), since poorer people are often more exposed and vulnerable to its effects because they work in more exposed sectors such as agriculture and tourism, because they have to perform physical labour outside, or because their houses are poorly ventilated or located in areas vulnerable to floods. Moreover, as risks rise, private insurance will become increasingly necessary yet more expensive, leaving those who may need it the most without coverage. The elderly are particularly vulnerable to extreme heat. There could also be an indirect gender impact, as women may be overrepresented in some affected groups. Globally, the people who will suffer most from climate change are most likely those who will be forced by loss of livelihood to migrate within their countries of origin, and are unable to move to less-affected countries (Lenaerts and Tagliapietra, 2022). Many empirical studies (see Mari-Dell'Olmo *et al*, 2018) suggest that climate adaptation plans should therefore consider vulnerabilities of different subgroups.

3 Why should the EU act?

As the basis for action on climate change adaptation, the European Commission invokes the EU treaties[4]. These state that the EU's environmental policy should, apart from protecting the environment, contribute to the protection of human health and the prudent and rational use of natural resources. Environment policy should be based on the precautionary principle and on preventive action. Given the significant effects of climate change on health and mortality, adaptation as a preventive policy can fall under this scope. The 2021 European Climate Law (Regulation (EU) 2021/1119) also calls explicitly for the EU and member states to make progress on adaptation, and contains provisions about mandatory adaptation strategies, assessments of progress, consistency of adaptation measures and adaptation mainstreaming[5]

4 Articles 191 and 192(1) TFEU.

5 Articles 5, 6 and 7.

The responsibility for adapting to climate change is thus shared by member states and the EU. According to the subsidiarity principle, the EU should therefore intervene where member state action is not sufficient to achieve the desired objectives, while leaving other decisions as close as possible to citizens. This is typically a question of scale advantages and cross-border spillovers, as well as of how other EU competences are involved.

An important example where scale plays a role is in the sharing of scientific knowledge. While local and regional governments have the best insight into local environmental, social and economic circumstances, they often lack the scientific capacity to identify vulnerabilities in the face of climate change, or to develop adequate policy responses. There is a clear benefit in pooling capacities at EU level to expand scientific knowledge on current and future climate impacts through, for example, satellite-based earth observation programmes, which are beyond the capacity of national governments. Knowledge generated at EU level can then be used as a public good by all and applied to local situations (top-down). As adaptation interventions are still about learning-by-doing, there is also an interest in sharing local experiences at European level, in order to accelerate the learning process (bottom-up).

The EU can also use its administrative capacity to develop standardised methods that can be used by local or regional governments to carry out cost-benefit analyses of interventions and *ex-post* evaluations of policies, and to track adaptation progress. This would facilitate decision-making and enable cross-country comparisons for research and policy purposes.

Emergency response to major climate-related disasters is a very practical example where scale can make a difference. National response capacities can easily be overwhelmed by large-scale floods or forest fires. Since time is often of the essence, pooling resources for fast and decisive interventions can avoid substantial damages and loss of life.

Adapting to climate change requires cooperation across jurisdictions when effects are not limited to a single area. River management for irrigation, navigation and energy purposes during droughts is best done in cooperation with countries upstream and downstream, as is the management of floods. Vulnerable ecosystems do not stop at borders, and neither do infectious diseases or invasive species.

Finally, some climate impacts are specifically relevant for EU policymakers as they affect the functioning of the single market or the EU budget, for example when essential transport infrastructure is damaged (ports, bridges, etc) or supply chains are disrupted. Moreover, different policy fields already within the EU's competences can play an essential role in supporting climate change adaptation, such as regional and agricultural policy, insurance and financial regulations, and even fiscal rules.

One might add to the arguments above that without EU intervention, it is very likely that climate change will lead to increasing economic divergence between member states, as we noted above. Solidarity could therefore be invoked as a political argument to preserve cohesion in Europe, especially to redistribute gains some member states may incur from the same natural phenomenon that harms other countries.

4 EU adaptation policies

Adapting to climate change is a society-wide challenge. This is reflected in the multitude of policies and initiatives that play a role at every level of governance. The EU's adaptation policies are guided by the 2021 strategy on adaptation to climate change (European Commission, 2021b). We discuss this together with some of the most notable policies through which the strategy is pursued, as well as the EU initiatives in place to react to climate-related disasters when they occur.

4.1 The EU strategy on adaptation to climate change

The first adaptation strategy was issued in 2013 and addressed three priority areas: encouraging national action, informing decision-making and promoting adaptation in key vulnerable sectors (European Commission, 2013). Progress was made in these areas through the adoption of strategies or plans by all EU members, the establishing of the Climate-ADAPT platform as a central source for adaptation-related information, and the integration of adaptation considerations into other EU policies.

The strategy was, however, judged to be only partly successful (European Commission, 2018). For instance, knowledge gaps were deemed to have been closed only partly while new questions arose in the meantime. Climate change risks and adaptation received more political attention, but participants in an EU consultation still noted a lack of commitment by governments (European Commission, 2021a). Moreover, the monitoring of actual progress remained elusive, and planning at local level progressed more slowly than hoped. More had to be done to integrate climate change adaptation into the EU's external policies, given the mounting evidence of the risk of international spillover effects through political instability, trade and migration.

The 2021 strategy seeks to fill these gaps (European Commission, 2021b). The European Commission aims to make adaptation in Europe "*smarter, faster and more systemic*" while trying to minimise the risk of negative spillovers from climate impacts outside of Europe.

*Smarter adaptatio*n refers to further expanding the knowledge and data necessary to make informed adaptation choices. This concerns on the one hand the promotion of further research into climate impacts and modelling, and into assessment tools for adaptation projects. On the other hand, it is about generating harmonised and granular data on climate risks and damages and making them publicly available, a longstanding recommendation (Lopez Piqueres *et al*, 2020). Such data may be useful for local cost-benefit analyses and could raise awareness and interest, which are still lacking among citizens and policymakers (European Commission, 2021a).

Faster adaptation is necessary because adaptation continues to be a secondary priority for some governments according to observers, resulting in weak subnational policy action (European Commission, 2021a). There is also a lack of public and private sector investment in concrete adaptation solutions. The Commission therefore wants to speed up the rollout of innovative initiatives, including with EU funding, to improve and monitor insurance coverage, and notably to improve the management of fresh water and reduce water use. Overall however, the proposed actions rest mainly on developing guidance, standards and best practices, supporting (sub)national policy development, and integrating adaptation into a few regulations, such as the EU's classification of what constitutes 'green' investment[6]. The strategy therefore does not make clear how the Commission intends to create concrete progress more quickly.

More systemic adaptation means, among other things, supporting the improvement of adaptation plans by stimulating cooperation between regions and countries and creating a harmonised framework for monitoring, reporting and evaluating progress on adaptation. It also means taking into consideration social aspects of adaptation, such as reskilling workers and protecting them from climate impacts. Climate change resilience is to be integrated into national fiscal frameworks and EU fiscal governance. Finally, systemic adaptation entails the Commission encouraging the use of nature-based adaptation solutions, such as urban green spaces or green roofs.

The last aim of the new strategy is to boost international climate adaptation. The focus here will be mostly on Africa, small island states and the European neighbourhood, which may reflect the primary spillover channels the Commission is worried about. Support will be given to administrative capacity and policy planning and assessment, in much the same way

6 As set out in the EU taxonomy for sustainable activities; see https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en.

as the Commission intends to help regional and local governments in Europe. In addition, the need for scaling up adaptation finance is featured much more prominently, by using EU instruments for external action and by leveraging private sector investments. A third element is to boost adaptation diplomacy.

4.2 EU funding for climate adaptation

EU funding for adaptation is not provided through any specific instrument but is spread over many different policies. The European Agricultural Fund for Rural Development, which falls under the Common Agricultural Policy, has a sizeable portion of its resources dedicated to adaptation. Also important is the EU's regional policy. The Cohesion Fund and the European Regional Development Fund respectively have at least 37 percent and 30 percent of funds earmarked to broad climate-related measures in the 2021-2027 Multiannual Financial Framework (MFF). Because there is not always a clear separation between mitigation and adaptation measures, and because official tracking estimates tend to overstate contributions to climate targets (Nesbit *et al*, 2020), it is difficult to say exactly how much funding is dedicated to adaptation, but numbers from Olesen *et al* (2017) and European Commission (2018) suggest that from 2014 to 2020, between €14 billion and €62 billion was allocated by the EU Structural and Investment Funds, which comprise the three mentioned funds, the European Maritime and Fisheries Fund and the European Social Fund.

Money also goes to innovative adaptation projects under the Horizon Europe programme, and through the €5.4 billion LIFE programme, which unlike other funds is dedicated entirely to the environment and climate action. Most recently, EU countries allocated around €16 billion in grants and loans from the Recovery and Resilience Facility to climate adaptation projects for the period from 2021 to 2026 (Lenaerts and Tagliapietra, 2021). Finally, the European Investment Bank is expected to significantly increase its financing for climate change adaptation worldwide, under its new adaptation plan.

Given the estimated annual investment needs in Europe, which are poorly understood but could be anywhere between €35 billion to more than €500 billion (EIB, 2021), it should be clear that EU funding alone will not suffice to make Europe resilient to global warming. Numbers on overall adaptation spending in Europe are also hard to come by, but member states and the private sector[7] both have large roles to play.

4.3 Disaster response as part of adaptation

Adaptation policies in the strict sense are preventive, meant to reduce the exposure and vulnerability of people, assets and ecosystems to the consequences of climate change. But not all damages can be avoided, especially those of severe fast-onset events, so adaptation to climate change must entail strengthened capacities to respond to more frequent and severe natural calamities.

The EU Civil Protection Mechanism (ECPM)[8] was established to help European countries deal with large catastrophes (including non-climate related) both before, during and after events. For example, data from the Copernicus satellite is used to complement member-state information systems, something that might otherwise be beyond the means of individual countries. Countries can also call upon the European Civil Protection Pool, via which they can provide teams and equipment at short notice (the EU budget bears 75 percent of the costs). An additional 'rescEU reserve' of firefighting aircrafts (among other things) was created in 2019 to add to the capacity of the ECPM when several member states are hit by disasters simultaneously, which would stretch the capacity of the Pool.

Funding is also available for post-disaster assistance. Since 2002, the European Solidarity Fund can make available grants of up to €500 million (2011 prices) per year in case of major or regional natural and health disasters, such as the earthquakes in Italy in 2016-2017 or during

7 The private sector is almost invisible in adaptation spending statistics (Buchner *et al*, 2021).

8 For more information, see https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection_en.

the early weeks of the COVID-19 pandemic. This fund, which falls under regional policy, is only intended for non-insurable damage and not to compensate private losses or long-term redevelopment. Furthermore, it is meant for mid-term relief; grants are awarded after a lengthy process involving approval by both the Council of the EU and the European Parliament.

5 Proposals for stronger adaptation governance

More must be done to prepare Europe for a warmer climate. There is a notable absence of binding, precise and measurable targets for both EU-level adaptation policies and for the framework governing national and sub-national adaptation action. Targets are needed to accelerate adaptation efforts by reluctant governments, according civil society organisations, which point to similar demands by the European Parliament and the Commission's own assessment that progress is too slow (EEB, 2021). It is also not clear how the EU will address the pressure that climate change could put on existing fault lines between northern and southern/south-eastern member states. In this section we therefore set out some ideas to strengthen European adaptation governance.

5.1 A multi-layered governance framework to structure cooperation

Under the EU Energy Union governance regulation (Regulation (EU) 2018/1999) EU countries are required every decade to submit 10-year integrated national energy and climate plans (NECPs), which should also be updated halfway through each cycle. The regulation also requires progress reports from member states every two years. The European Commission assesses progress and issues recommendations. The regulation contains a requirement to describe adaptation goals, but only insofar as they apply to emission reduction commitments. Adaptation therefore seems to play only a secondary role in the NECPs.

The European Climate Law requires EU countries to adopt and implement national adaptation strategies and plans. These must be regularly updated and communicated every two years in reports dedicated to national adaptation actions. Every five years starting in 2023, the European Commission will then assess collective progress by member states.

Looking at the legal requirements, one can conclude that in none of these reports are member states asked to set binding, measurable adaptation targets for which they can be held accountable.

A lack of action can also arise because governments at every level must play a role in adaptation. Without a clear division of tasks, governments can avoid responsibility, shifting the burden onto each other. This also happens when local governments are expected to implement adaptation plans without adequate funding, for example local building moratoriums that require compensation to be paid to landowners. Matters are made even more complex as horizontal cooperation across neighbouring jurisdictions is often needed to ensure consistency and to avoid maladaptation (for example when building flood defences creates problems further downstream). Finally, better top-down and bottom-up information flows are needed to make sure that scientific knowledge can be used at local levels, while local experiences can feed back to policymakers higher up or can be shared with other jurisdictions.

A governance framework for adaptation action based on three levels could clarify tasks. It could facilitate and structure cooperation and the exchange of information between jurisdictions and different governance levels and allow for the introduction of binding, verifiable targets.

At the highest level, the European Commission and other relevant EU bodies such as the European Environment Agency should remain mostly responsible for helping to generate,

collect and spread scientific knowledge (such as satellite imagery and model simulations). They should provide a platform through which national and sub-national governments can share ideas, experiences and adaptation practises in a structured way, so that, for example, local governments can find out easily what similar places (in terms of urbanisation, climate, vegetation, geography etc) are doing. The sharing of information and its use for governance purposes would benefit from uniform measurement of damages and risks, and from methods to perform cost-benefit analyses, *ex-post* evaluations and assessments of progress. These should therefore also be developed at European level, best in consultation with member states. Disclosure requirements on governments could then be put into place accordingly. The EU should also expand its emergency intervention capabilities and continue to mainstream adaptation into other policy areas.

As the guardian of the general adaptation governance framework, the European Commission should engage with member states, using its expertise to help them establish binding ten-year national adaptation plans with clear and public targets, which are consistent with the plans of neighbouring countries. This would be a step further than what is demanded by the European Climate Law[9]. The Commission has a coordinating and informing role: it is up to countries themselves to decide on the level of ambition and to propose overall targets, such as the degree of private insurance coverage, depending on how they see priorities. This should not mean, however, that no incentives should be put in place to push for more ambition. The Commission should also be allowed to require the inclusion of strategic interventions that have EU-wide relevance, such as for the protection of key infrastructure.

National adaptation plans should serve as a guide for local government action and should set the ambition level. Detailed knowledge of local circumstances and national/European expertise needs to be combined to formulate very concrete interventions, while avoiding maladaptation because of an excessive focus on single impacts.

This framework is meant to be flexible and cooperative rather than overly rigid and hierarchical. However, agreed adaptation plans should be formal and we propose a link to an insurance instrument.

5.2 An EU insurance and solidarity fund to incentivise and help member states

The framework from the previous section would impose binding targets to enhance accountability but would allow member states to choose their own ambition levels. To push lagging member states and regions towards more decisive action than currently, we propose an incentive scheme, while accepting that EU countries are unlikely to be willing to accept large and structural fiscal transfers to compensate for long-term climate-induced damages.

To reduce the threat of a climate divide, the fiscal risk of damages after climate-related disasters could be shared. The European Commission estimates that without adaptation, annual damages in Europe from floods alone could reach up to €144 billion by 2100 (from €9.2 billion today), even with only 2°C of warming (Feyen *et al*, 2020). Damages will be partly covered by private insurance, but it often falls to governments (sometimes by law) to contribute significantly to compensation spending, even in countries with extensive and mandatory coverage.

Expected government payments exceed the yearly capacity of the current European Solidarity Fund for post-disaster assistance (see section 4.3), which compensates only a small share of total damages (European Commission, 2022). Significantly enlarging the fund's capacity to cover an agreed set of public costs can soften the fiscal blow for affected countries. EU member states are all exposed to various extreme impacts, creating a rationale for all to

9 We do not propose to integrate them into NECPs because adaptation is not secondary to mitigation but should be consistent with it. We therefore think the revising and reporting schedule (five- and two-yearly) should be aligned with that of the NECPs, while the Commission should publish individual progress assessments every five years, rather than the current EU-wide assessment mandated by the regulations.

be insured against catastrophic impacts. The returns on repairing infrastructure and providing emergency housing and aid are also much more obvious to voters than those on climate adaptation investments, even if the latter may in fact be quite significant (Global Commission on Adaptation, 2019). Committing more funds here might therefore be much more feasible politically.

The fund should be financed by national contributions, based on a conditional mechanism which incentivises adaptation investments ex ante. Countries that do not implement adaptation measures would pay more into the fund than countries that implement strong adaptation measures. When a disaster occurs, money can be reimbursed to the affected member state.

An exact recommendation for the fund's capacity is hard to give as it would depend on the agreed scope of eligible damages, but one might imagine an annual capacity of several billion euros by 2030, growing with nominal GDP (which means more exposed value). However, it does not need to be large enough to compensate for all damages in particularly bad years, and a certain percentage of self-payment should always be required.

If compensated damages in a certain year (as legally defined) exceed the fund's basic capacity, the EU could issue bonds to cater for such systemic shocks. The interest and repayment burden can be distributed between member states in the same way as the financing of the fund itself.

The advantage of combining a fund with a borrowing capacity for systemic shocks is that markets will only be called upon for insurance against massive climate risks. If climate risks become more frequent, the fund will become increasingly important and intertemporal insurance will be less important relative to constant payments from the fund for incurred and repeated damages.

The mechanism to divide contributions to the fund and interest payments among member states serves the second purpose of this proposal, which is to incentivise countries to invest in climate change adaptation, by making contributions depend on the achievement of targets as set out in the proposed national plans.

Adaptation plans must contain binding and verifiable targets. These could be proposed by countries at the beginning of a ten-year cycle, for five-year periods. The Commission could then be asked to give an objective assessment of their level of ambition, after which the plan is approved by the Council. Depending on whether the targets achieve a certain reference level, to be agreed in advance (for example in terms of estimated damages prevented), the Council decision could then also tie reductions of a country's contributions to the achievement of the targets. National contributions would initially include a risk premium to reflect countries' actual risk, which would decline as countries take steps to reduce climate vulnerability to a feasible extent. The system could thus evolve from risk-driven to solidarity-driven (eg based on GDP).

5.3 Financial resources for disadvantaged regions and key interventions

The proposals above may still not be sufficient to ensure adequate adaptation action in the most disadvantaged regions, particularly those in the south, which will suffer disproportionately from climate change. Yet, as explained above, political support for sharing the investment burden for *ex-ante* adaptation seems unlikely.

For the next EU budgetary cycle, we recommend more resources targeted to adaptation through the EU's regional and agricultural policies. One could for example decide to increase the minimal share of climate-related spending, and within that category decide to focus mostly on mitigation in north-eastern regions, while focussing on adaptation in southern regions, including in the Balkan region. This would not undermine economic convergence or rural income support, given the supposedly high returns on investment of adaptation and the vulnerability of agriculture. Communicating the two numbers separately would also increase transparency. Better still would of course be to pursue to the maximum synergies between mitigation and adaptation, for example through nature-based adaptation solutions.

Another solution could be to propose an EU financial instrument for the protection of a limited list of infrastructure, supply chains, ecosystems and perhaps heritage sites that are of EU-wide relevance, such as seaports, energy linkages or corridors for migrating species. The Commission would then be able to require the inclusion of these elements in national adaptation plans, as suggested in section 5.1, and would provide the necessary funding in return.

6 Conclusion

As the first effects of climate change are becoming apparent, it is already clear that they can become severe, depending on how far temperatures rise, and that not all EU countries will be hit to the same degree. The drought that hit Portugal and Spain in the winter of 2022 is an ominous example of what could be in store for most countries south of the Alps. Impacts will also differ between economic sectors and social groups, and will be counted in percentages of GDP and lives lost.

Adapting to climate change is mostly a matter of regional and local action, but there are several reasons why the EU should also play a role. These involve scale advantages, territorial spillovers and impacts that relate specifically to the EU's other competences, such as ensuring the functioning of the single market. This is reflected by the two adaptation strategies the European Commission has adopted so far, and by its efforts to create an EU disaster-response capacity.

These strategies have driven progress at EU level. However, a lack of knowledge, awareness, political priority and funding among some (sub)national policymakers continues to lead to weak policy implementation. The current EU strategy does not address this sufficiently, as binding, measurable targets are absent and not demanded from member states. More cooperation among governments is needed to strengthen policymaking and define tasks. The threat of climate-driven divergence between member states remains unaddressed.

We make three suggestions in response to these problems:

1. Create a three-layered governance framework based on intensive cooperation and information-sharing to establish binding adaptation plans;
2. Set up EU-level insurance against damages from climate change, with national contributions tied to the achievement of self-chosen targets in adaptation plans;
3. Increase *ex-ante* adaptation funding by targeting more spending under EU regional and agricultural policies specifically at adaptation in the most vulnerable regions, and by setting up an EU financial instrument for the protection of infrastructure and value chains that are of EU-wide relevance.

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