Technical Policy Brief:

Adaptation Economic Case Studies in Europe from the ACCREU project

ACCREU
Assessing Climate Change Risk in EUrope

Funded by the European Union

Key messages

ACCREU is a Horizon Europe research project focusing on the economic costs of climate change and the costs and benefits of adaptation.

The project is undertaking top-down modelling of the economics of adaptation in Europe, complemented by bottom-up adaptation case studies. The latter are based around a set of common adaptation decisions, known as Adaptation Decision Types (ADTs).

The project has undertaken 15 ADT case studies. These include a mix of adaptation decisions and options (grey and green, hard and soft), which include both incremental and transformational adaptation. The results of these assessments and relevant policy insights are synthesised in this policy brief.

The first key finding is that it was possible to undertake an economic appraisal of all types of adaptation. However, this often required more diverse and comprehensive approaches to a standard cost-benefit analysis (CBA). This included extended cost-benefit analysis and/or decision making under uncertainty, as well as the need to combine information sets or models for analysis. The level of complexity needed was higher for more transformational adaptation.

A second key finding was that in most cases – and especially when a comprehensive economic appraisal was undertaken – there was a positive economic case for adaptation, i.e., benefits exceed costs. This provides support to the case for scaling up adaptation in Europe.

The third key finding is that the methods used, and level of comprehensiveness, can influence the results of an economic appraisal. This is because adaptation often involves co-benefits and/or non-market benefits. Methods that explicitly include these benefits lead to different results and change the relative attractiveness of options. This highlights that capturing these benefits is critical.

A final key finding is that results and priorities can change when distributional effects or decision criteria are taken into account. As an example, adaptation options and priorities can differ when objectives are set on the basis of economic efficiency as compared to egalitarian principles that give greater weight to the most vulnerable. Similarly, the use of climate justice frameworks introduces equity dimensions that shift priorities.

The project also made additional analysis and synthesis of the barriers to adaptation. This identified that the key implementation barriers in the case studies were institutional and financial. These barriers also lead to incremental measures being favoured. Related to this, more transformational options generally faced greater barriers due to governance challenges, short-planning horizons and existing financing structures.

This analysis also looked at the enabling factors identified to overcome these barriers. This identified that the most important factors in the case studies were governance and financial, but interestingly, social and cultural enablers were also found to be important.

Finally, the project undertook a literature review to build up a wider set of case study material on the economics of adaptation. This confirmed that adaptation can lead to positive economic returns, but highlighted the large variation in BCRs across sites and contexts (even for similar options). It also found important differences between science-first and policy-first studies, and ex ante and ex post analysis, with the latter identified as a particular gap. The analysis also found that economic returns (societal) of adaptation are higher than financial returns (private), and thus even though there is a positive case for adaptation, there will still be challenges in scaling up investment.

ACCREU
Assessing Climate Change Risk in EUrope

Introduction

ACCREU (Assessing Climate Change Risk in EUrope) is a project funded by the HORIZON Europe Research and Innovation Funding Programme. The objective of the project is to develop a fully integrated framework for climate change impacts, mitigation, adaptation and the prospects for social and economic sustainable development, working directly with stakeholders using a co-creation approach.

This technical policy brief summarizes the adaptation case studies from the project, on the economic costs and benefits for different adaptation decision types in Europe. Full details are in the deliverable.

Adaptation assessment

Climate change will lead to economic costs. These are often known as the 'costs of inaction'. Adaptation delivers economic benefits because it reduces these economic impacts of climate change, but this involves costs. However, adaptation rarely reduces climate impacts completely, and there are residual impacts after adaptation (see schematic in Figure 1 below). This leads to a trade-off between the costs and benefits of adaptation, and the residual impacts after adaptation. It is possible to have more ambitious adaptation that reduces residual impacts to lower levels, but this is likely to involve much higher costs.

To investigate these adaptation trade-offs, ACCREU is assessing the economics of adaptation at three spatial scales.

Global level. The project is using Integrated Assessment Models (IAMs) for the global analysis of the costs of inaction, and the interactions and synergies between mitigation and adaptation policy to reduce these impacts.

European level. The project is also using a number of sector models, running these for consistent scenarios to look at the costs of inaction in Europe, and the costs and benefits of adaptation. The results from these models are then fed into cross-economy Computable General Equilibrium models.

National to local adaptation. Complementing the scales above, the project is undertaking a series of adaptation case studies. These range from national to local level and investigate the economics of adaptation.

The framing of adaptation

While all three aggregation levels above explore the same issues (in Figure 1), there are important differences in the way they consider adaptation.

The global and European models start with future climate change scenarios (Representative Concentration Pathways, RCPs). These provide climate pathways that cover futures consistent with the 2°C goal through to high-end (4°C) scenarios. These are combined with socio-economic scenarios (Shared Socio-economic Pathways, SSPs) which consider differing future population, economic development, technology, policies, etc.

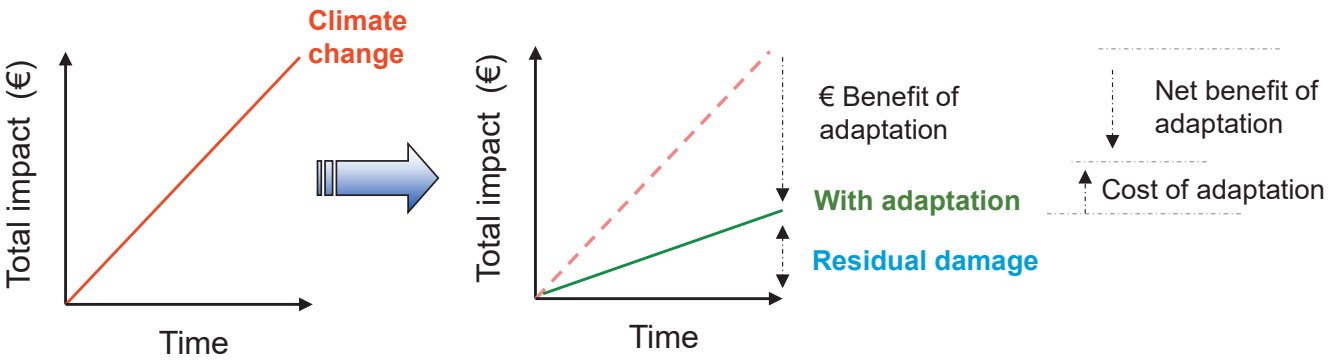


Figure 1. Schematic of the costs and benefits of adaptation.

This is often called a '**science-first approach**' because it starts with the climate models, and then undertakes a step-by-step analysis, where the output of one step is an input to the next (Figure 2, top). For example, the climate model outputs are combined with socio-economic data in a sector impact assessment model to assess physical impacts such as flood damages. These can then be quantified in monetary terms within the model. This approach is typically used for medium and long-term assessments of climate change.

This can be extended to adaptation (see Figure 2, top right). In this case, the model can look at the costs and benefits of adaptation (e.g., of dyke protection) to reduce the flood impacts. This process can be repeated to look at different climate scenarios, or different adaptation objectives (e.g., economic optimal versus protection levels), by re-running the model multiple times.

However, while the science first approach provides key results, it often does not provide the information needed for real-world adaptation decisions. This is because of several reasons. First, real-world adaptation is more concerned with decisions that have to be taken now (not in 2050) and these decisions have to be grounded in the current policy landscape.

Second, the impacts of climate change, and thus the benefits of adaptation, primarily arise in the future, and this makes it difficult to justify up-front costs (today) in economic terms. This means there are often more complex decisions about what to do when.

Finally, there is high uncertainty about future climate change, which makes it difficult to make a single decision now, when faced with multiple different futures, because of the risk of under or over-investing in adaptation.

To address this, an alternative approach is often used for adaptation, the '**policy-first approach**' (Figure 2, bottom). This frames the analysis from a policy question and supports early decisions that are made under uncertainty. This is more relevant for the adaptation case studies in the project.

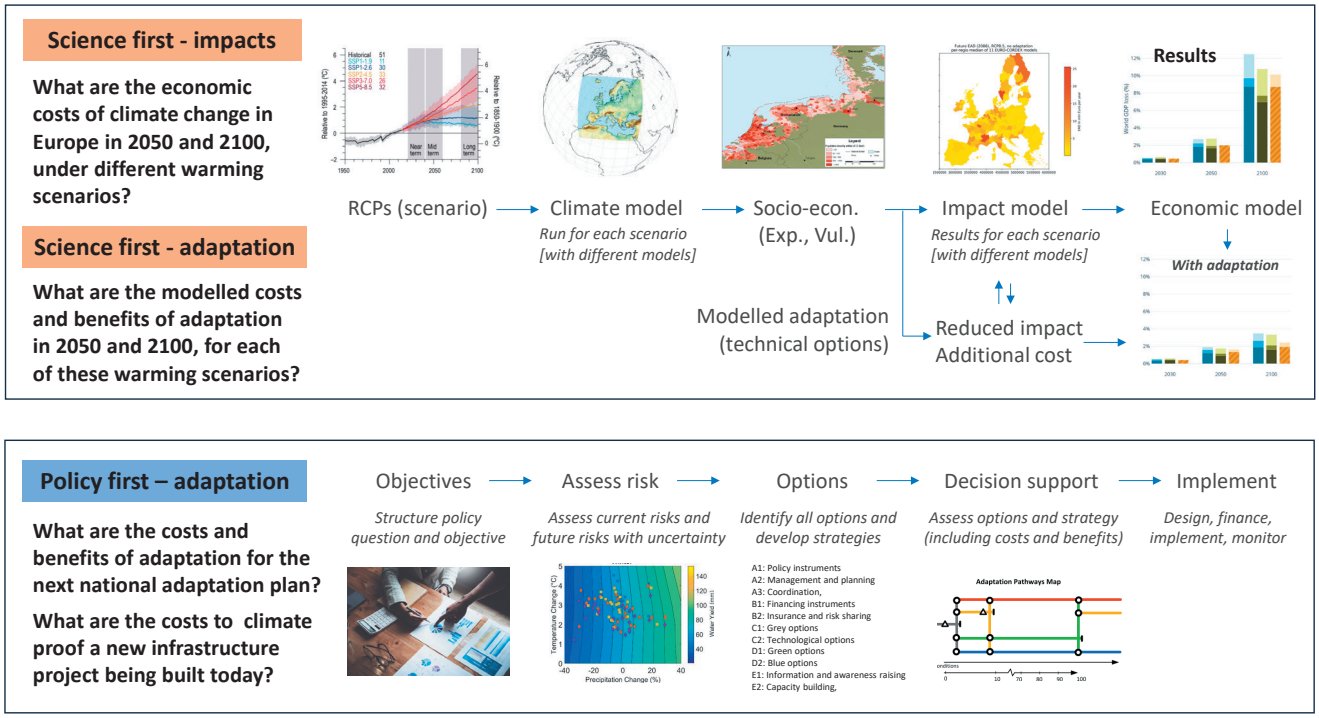


Figure 2. Alternative framings of impacts and adaptation.

ACCREU adaptation case studies

A series of adaptation economic case studies have been undertaken to demonstrate the policy-first approach. However, this creates a new challenge, because there are an extremely large number of possible decisions to consider. To address this, ACCREU has developed **Adaptation Decision Types (ADTs)**, which reflect seven common adaptation decisions for Europe which cover the five cross-cutting themes of the European Mission on Adaptation (i) critical infrastructure; ii) water management; iii) land-use and food systems; iv) health and wellbeing; v) ecosystems and nature-based solutions). 15 individual case studies were undertaken, involving a mix of incremental and transformational adaptation, soft, hard, and green measures, and different aggregation levels.

The case studies were all undertaken in collaboration with 'deep engagement' stakeholders, as part of the ACCREU co-production approach. This involves an iterative process where the project team worked on joint case studies to produce research with policy synergies. These stakeholder partners included national and regional government, business, and civil society organizations. The interim results were discussed at a series of seven ADT workshops. The overall set of case studies were then analysed to identify actionable insights on the **economic appraisal** of adaptation options, as well as broader themes of barriers and enablers.

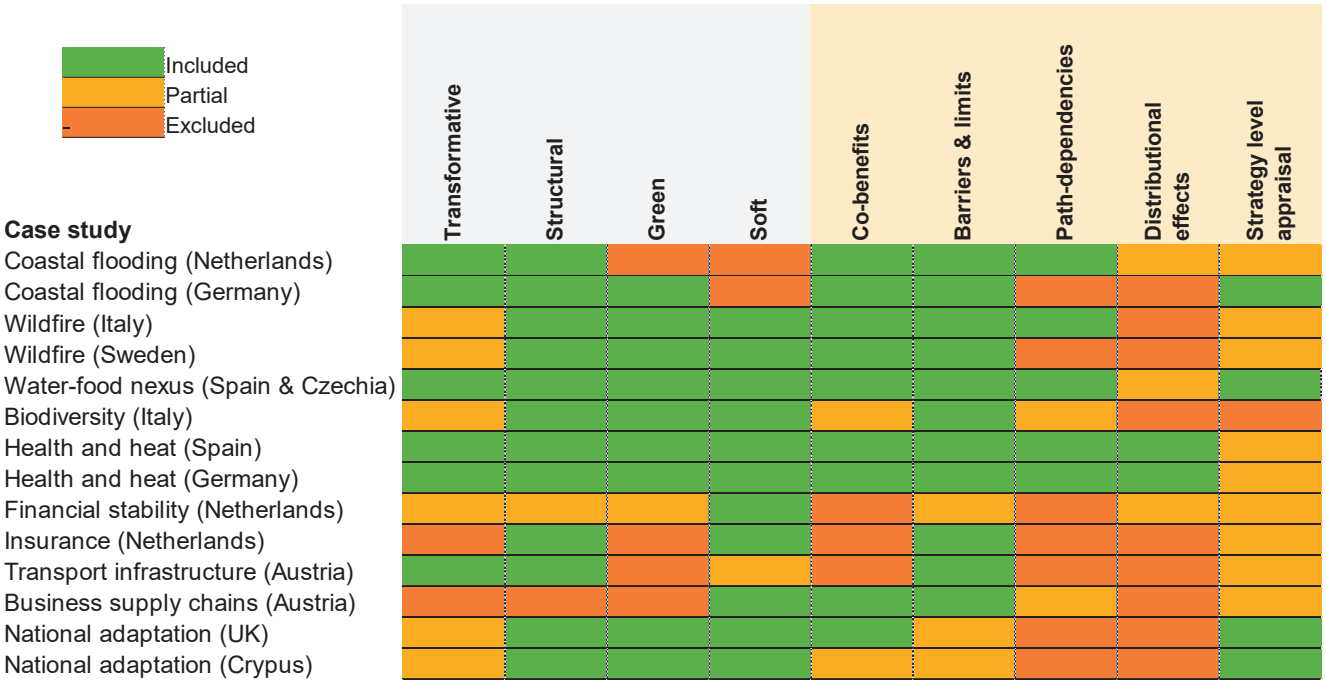


Figure 3. ACCREU adaptation case studies, showing adaptation measures and economic appraisal elements.

Flooding

Two case studies were undertaken on coastal flood protection. The first was focused on local sub-national adaption investments for coastal floods in Den Helder in the Netherlands.

This looked at the economic trade-offs between two options. The continuation of the standard Dutch approach of raising dikes incrementally. An alternative superdike, a transformative structural option designed to integrate safety and urban development in a single intervention, which includes an increase in area for new housing.

The analysis applied extended cost-benefit analysis (CBA) with consideration of uncertainty and intergenerational equity. This found an economic case could be made for the long-term superdike, for most scenarios, but this does depend on housing value assumptions and discount rates (see box)

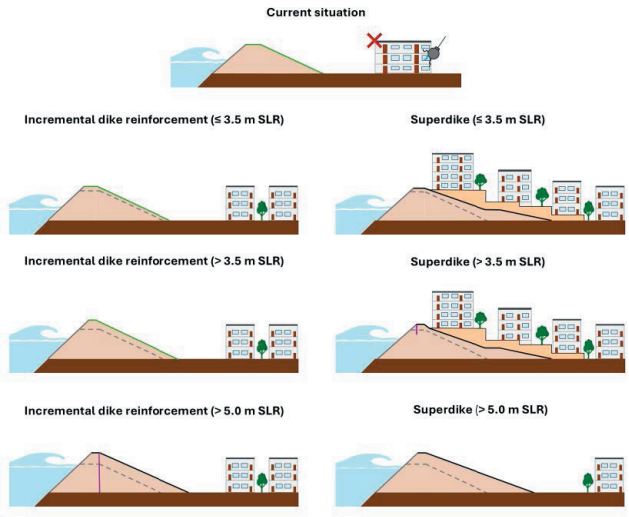


Figure 4. Schematic of the two adaptation measures.

Box 1. The influence of time preference and discount rates.

In economic appraisal, costs and benefits need to be assessed in consistent terms, including when these arise in different time periods. This is based on the concept of time preference, reflecting that people typically prefer to receive goods and services now rather than later. Discounting is used to adjust future costs or benefits to equivalent present values.

For government (societal) appraisal, a 'social time preference rate' (STPR) is used, to reflect the rate society values the present compared to the future. For example, the recommended rate in EU impact appraisal is 4% (and most Member States have broadly similar value).

Discounting leads to challenges for anticipatory adaptation, as upfront costs may be high when compared to benefits that arise in the future (when discounted to present values).This has led to questions on whether different discount schemes should be used for some types of adaptation decisions. The influence of different schemes are shown below for the two dike schemes, in terms of their net present value (the sum of PV benefits and PV costs). A positive value indicates economic benefits outweigh costs.

Minimum and maximum net present value *with* discount rate scheme for incremental dike reinforcement and the superdike.

Discount rate scheme	**Explanation discount rate**	**Incremental**		**Superdike**	
		Min	**Max**	**Min**	**Max**
Discounted utilitarianism	Exponential discounting at 2.25%	–1.9	0.0	–2.5	55.3
Classical utilitarianism	No discounting	–23.9	59.3	–232.7	522.5
Average social discounting	Pure rate of time preference is 0, marginal utility is 1, and average GDP growth rate	–21.6	6.5	–102.4	167.7
Annual social discounting	Pure rate of time preference is 0, marginal utility is 1, and annual GDP growth rate	–23.9	24.5	–172.7	235.8
Hyperbolic discounting	Hyperbolic discounting at 2.25%	–6.1	9.6	–45.6	148.0
Current generation discounting	First 30-years at 2.25%, beyond that at 0%	–23.9	59.3	–248.1	501.5

Note that the average and annual rows use a SRP which is derived from an equation that includes the Pure Rate of Time Preference + wealth effects (expected growth in per capita consumption mutiplied by the marginal utility of consumption).

The second case study focused on large-scale and long-term coastal nature-based solution policies for rural regions in Europe and the German Baltic coast. This looks at the optimal timing and the cost-efficiency of hard protection and beach nourishment versus green coastal adaptation with managed realignment with wetlands (saltmarshes). The analysis takes account of the various costs and benefits, including maintenance costs and compensation for lost land.

In Germany, 63 of 297 floodplains were estimated to deliver BCR ≥ 1 for nature options under sea-level rise (see Figure 5). Economically favourable areas were concentrated along the German Baltic coast. Managed realignment and saltmarsh restoration were particularly cost-efficient in low-populated, rural floodplain areas. This is mirrored at the European level, with highest viability in low-lying coastal plains where land values and exposure levels allow space for inland migration and ecosystem expansion.

Forestry and wildfires

The next set of case studies focus on wildfires. Wildfires are expected to increase with climate change, both for Southern Europe, but also Northern Europe (see Figure 6).

The first case study was in the Campania region of Italy, an area with high value agriculture (e.g., vineyards), tourism, and Protection Areas, with a dense urban–wildland interface. The analysis combined climate-based wildfire risk modelling with economic cost–benefit analysis. This allowed an analysis of how adaptation strategies (grey, green and soft) perform under current and future conditions.

When adaptation benefits (avoided losses) were evaluated under different climate pathways, Unmanned Aerial Vehicle-based monitoring performed positively across all scenarios, but these must be embedded within a broader, coordinated adaptation framework rather than implemented in isolation.

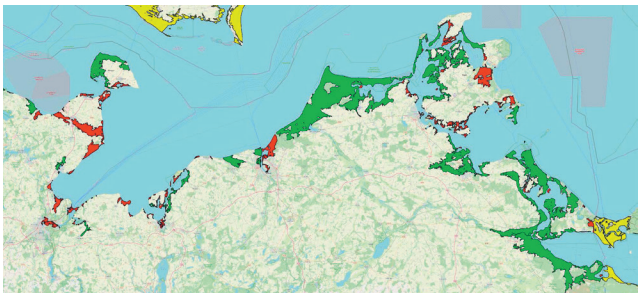


Figure 5. German floodplains. Green BCR ≥ 1 Red BCR < 1.

The second case study was a cost-benefit analysis of forest wildfire prevention measures in Leksand, Sweden, looking at private sector adaptation applicable to forest management. This considered forest management measures (e.g., firebreaks, tree species choice); fire risk prevention measures (e.g., fire index systems to improve awareness and preparedness; and capacity-building measures (e.g., training programs for firefighters).

The CBA found firebreaks had the strongest reduction in wildfire damage and highest economic benefits, followed by planting more fire-resistant tree species. In contrast, reducing tree density was not economically favourable as the costs outweigh the reduction in expected wildfire damage.

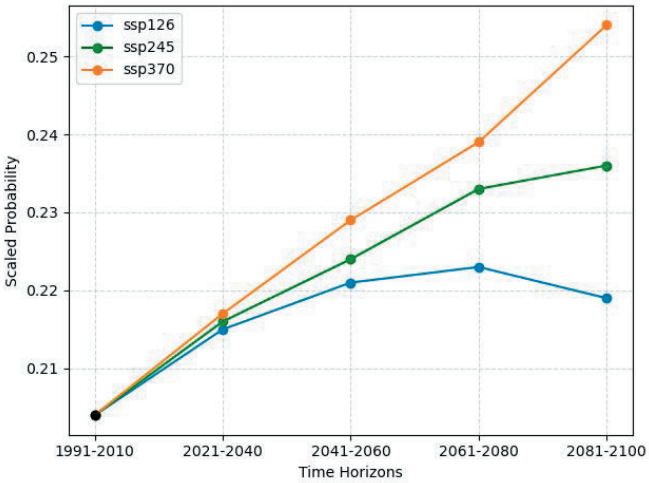


Figure 6. Wildfire risk probability scenarios (Sweden).

Water and food

Two case studies were undertaken on the water and food nexus for the Ebro river (Spain) and Thaya river (Czech Republic), looking at the optimal water allocation between agriculture, drinking water, and ecosystems under climate change.

For the Thaya river basin, climate change will structurally affect agricultural water use. The default option of irrigation could be a key adaptation mechanism under warming, but it has environmental consequences. The case study investigated these issues. It developed alternative adaptation strategies, considering grey, green, and soft measures, and clustered these into three integrated pathways, shown in the Figure below. These were modelled with a linked modelling system, running crop and hydrological models, the results of which were fed into a partial equilibrium model (GLOBIOM, an agro-economic system model).

The results found that the use of intensive adaptation (HLG) sustains agricultural productivity under climate change, but it also amplifies environmental pressures. Sustainability-oriented pathways (TBC) were found to be the most balanced long-term solution by aligning water conservation, agricultural productivity, and climate mitigation. The findings underscore the importance of integrated, multi-sectoral adaptation planning that bridges water and agricultural policies.

The Ebro River Basin in northeastern Spain is a major agricultural region and irrigation already dominates water use. Seasonal water scarcity already occurs during summer when irrigation demand peaks and climate change is expected to worsen these pressures, increasing irrigation demand by ~65%-80%.

Three adaptation scenarios were developed to address this, considering modernisation to improve irrigation efficiency, local water storage, or crop selection changes toward less water-intensive crops. The modelling analysis found that while adaptation can help to reduce pressure on water resources it can create economic trade-offs, as adaptation reduced crop production and revenues relative to the baseline.

This indicates effective adaptation will require integrated water resources management, combining infrastructure investments with demand-side measures to balance agricultural productivity, water availability, and environmental flows.

A further case study considered biodiversity, using an integrated species distribution model to assess the potential economic effects of conservation. This focused on sea-level risk and nature-based adaptation options for managing a dune and natural reserve protected area in the Venice Lagoon. This includes dune protection, restoration afforestation, as well as enhanced coordination. The costs of these options was compared to qualitative benefits. These show adaptation delivers multiple benefits, including reduced flood risk, biodiversity conservation, carbon sequestration, reduced flood risk for neighbouring settlements, and recreational value.

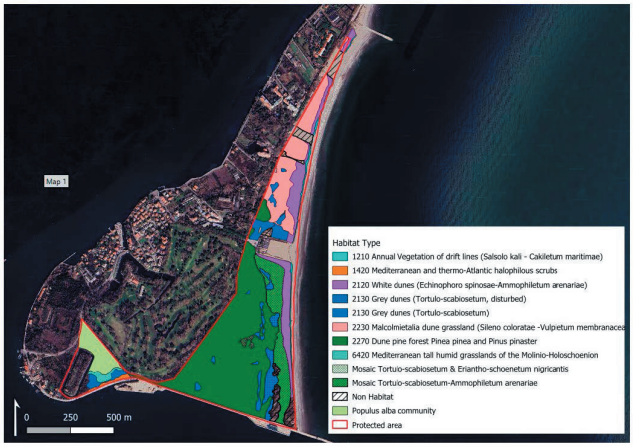


Figure 7. Vegetation habitat map for Oasi Alberoni, Venice

BAU (Business-as-Usual)	HTG (Holding the Ground)	TBC (The best of climate)
Incremental intensification: Unconstrained irrigation expansion Efficiency improvements Trade growth Assumes no binding water restrictions	Moderate adaptation: Planned irrigation expansion Efficiency gains Crop allocation adjustments Maintains production levels Relies on intensified inputs and moderate policy coordination	Transformative sustainability pathway: Constrained irrigation use National adaptation planning Reduced import dependence Balanced provisioning & regulating ecosystem services Represents systemic reorientation toward water-use efficiency and ecosystem balance

Figure 8. Options for the water-food nexus analysis for the Thaya River basin.

Health and justice

The first case study assessed different climate heat-health adaptation policies in the Basque Country. It also include a distributional analysis of how these affected different social groups and vulnerable populations. This can help identify more socially just options.

The options considered were early warning systems, emergency management, urban planning, green infrastructure, public awareness campaigns, and targeted actions for vulnerable populations. These were assessed using a cost-benefit analysis (CBA) on avoided mortality and morbidity, as well as a qualitative social justice assessment: the Adaptation Justice Index (AJI) framework. This considers the four elements of recognition, distributional, procedural and restorative justice and scores different options.

The combined heat-health action plan was found to be highly cost-effective, with economic (health) benefits greatly exceeding costs. However, strengthening equity considerations in adaptation policies could improve both social outcomes and policy effectiveness. Three key areas were identified that would enhance equity and value for money: (i) formalising a dedicated heat budget with equity-focused monitoring; (ii) requiring distributional impact checks and equity criteria and (iii) publishing disaggregated, post-season evaluations for future targeting and spending.

The second case study also looked at health and social justice dimensions of heat action plans for Bremen, Germany. As with the case study above, this looked at how heat risks affect different neighbourhoods and social groups, particularly vulnerable populations. It also looked at how different adaptation policies lead to different benefits for various social groups and vulnerable populations. It then extends this to look at the costs and benefits of socially just adaptation measures, mixing quantitative economic and qualitative scoring for the four justice dimensions. Furthermore, it identifies possible indicators to monitor socially just options.

As with the Basque example, the plan was found to have high economic benefits compared to cost (with a BCR of >70:1). It also was found to explicitly recognise vulnerable populations and includes targeted measures to protect groups most at risk from heat. However, while recognition and participation dimensions are relatively well developed, distributional and restorative justice aspects were less comprehensive, particularly regarding how adaptation resources are allocated and whether policies address structural vulnerabilities.

Strengthening monitoring systems, improving data on vulnerable populations and ensuring long-term funding will be key to delivering equitable and effective climate adaptation. There is also a need to address the root causes of vulnerability, including housing conditions and socio-economic inequalities.

Recognition
1.1 There is a process for identifying vulnerable groups
1.2 Consideration of climate impacts on marginalised and/or vulnerable groups
1.3 Consideration of differential adaptation needs of marginalised and/or vulnerable groups
1.4 Consideration of impacts of adaptation interventions on marginalised and/or vulnerable groups
1.5 Consideration of impacts of societal structures and existing injustices on marginalised and/or vulnerable groups
Distribution
2.1 There is a process to map and assess the distribution of risks from climate impacts
2.2 There is a process that assesses the distribution of benefits from adaptation across the population
2.3 There is a process that assesses how positive or negative effects of the strategy are spatially distributed
2.4 There is a process that assesses of how positive or negative effects of the strategy are temporally distributed
Participation
3.1 The creation of the strategy involved participation of relevant stakeholders during different phases of the process
3.2 The creation of the strategy involved participation of the general public during different phases of the process
3.3 The strategy has a structured plan for participation in the implementation
3.4 The strategy has a structured plan for participation of vulnerable and marginalised groups in the implementation
3.5 The adaptation strategy has a participatory process for monitoring, evaluation and learning (MEL)
Restorative justice
4.1 The strategy acknowledges and addresses the roots of marginalisation and vulnerability
4.2 The strategy acknowledges the need to compensate for the diverging impacts of climate change

Figure 9. Justice assessment framework.

Finance and the private sector

This case study started with an analysis of the potential flood risks of climate change for mortgage lending by Dutch lenders, and the impacts of reducing property values, increasing mortgage default risks, and weakened bank balance sheets.

It assessed whether climate hazards pose systemic risks to the Dutch financial system and which adaptation options could help to reduce these vulnerabilities. This aligns to the broader efforts by central banks and regulators to assess climate-related financial risks, including recent climate stress tests.

While current flood adaptation policy is projected to manage risks, from a financial stability perspective, the concern is on low-probability, high-impact flood events, as it is these that could trigger large losses and propagate through the financial system. These were assessed with individual dike failures, and 'Worst Credible Flood' scenarios which involved multiple simultaneous breaches. This assessed how flood damage would affect lenders through credit-risk channels in terms of their capital ratios (a key indicator of bank resilience).

The analysis found that flood-related losses appear manageable from today's perspective, though this likely underestimates the broader macro-financial impacts of potentially more severe future floods. The case study also explored macroprudential adaptation policy options. This found that reducing lending for flood-exposed properties to 90% of the property value (LTV cap) would significantly reduce mortgage credit risk for lenders. However, it would also strongly reduce the accessibility of the housing market.

The second case study also examined flood risks in the Netherlands, focusing on the role of insurance in spreading and managing business-level flood risk while also stimulating building-level adaptation investments.

The study analysed the effect of insurance premium discounts to incentivise the adoption of risk-reduction at the building level, such as wet-proofing and dry-proofing.

The analysis was conducted using a flood insurance model that disaggregated insurance demand across several economic sectors in the Netherlands, revealing the effectiveness of an insurance incentive on a sector-by-sector basis.

Different insurance supply systems were evaluated, allowing for a better understanding of the effect of the insurance system on uptake and adaptation across sectors.

The results showed that insurance premium discounts can increase both insurance uptake and the investment in building-level adaptation measures among businesses. Moreover, the involvement of the government in the insurance system leads to an increase in insurance uptake, exposing more businesses to the potential insurance incentive. Finally, the study found that not all sectors respond equally to insurance incentives, providing insight into which sectors can be targeted most effectively. The increase in building-level adaptation driven by insurance incentives also leads to measurable reductions in flood damage, which rise over time as climate risk intensifies.

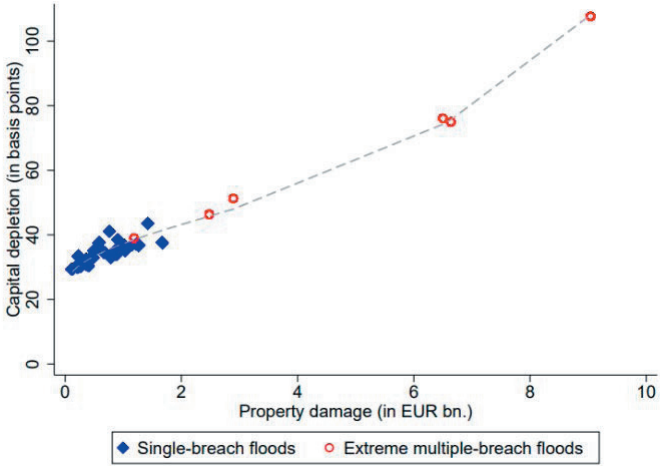


Figure 10. Property damage and capital depletion.

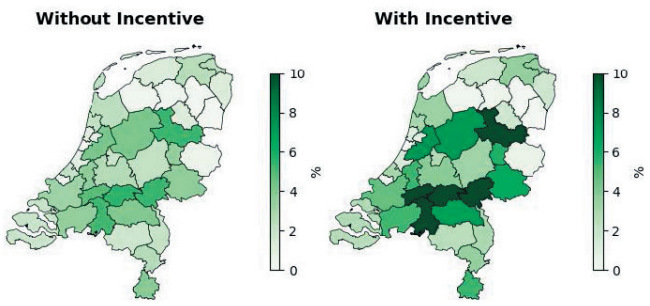


Figure 11. Percentage of flood-prone businesses with insurance coverage and adaptation investments, comparing scenarios before and after the implementation of an insurance incentive.

Transport and supply chains

This case study examined how flood risks may disrupt key transport corridors in Austria, focusing on both rail and road infrastructure. This assessed the direct effects and wider economic consequences. This took a system-level approach, working at the network (national) level for both impacts and adaptation.

It then looked at adaptation approaches, considering different scales, including hazard-level adaptation and protective measures such as flood barriers or dikes, asset-level adaptation. For example by raising roads or rail lines above expected flood levels, network-level adaptation, increasing redundancy in transport networks to allow rerouting when corridors are disrupted, and finally, system-level adaptation, which involves broader structural changes to supply chains or transport systems. These were assessed with an economic CBA.

This found that for road infrastructure, adapting all assets would be costly and benefit-cost ratios would be below one in many regions. This suggests that adaptation may not be economically justified everywhere. For rail infrastructure, adaptation measures appear more economically attractive, with BCRs above one in most regions (though in only a few regions was the BCR above 2:1). While stakeholders currently favour incremental adaptation measures – such as improving the resilience of specific road and rail assets – the analysis suggests that future increases in flood risk may eventually require more transformative adaptation strategies.

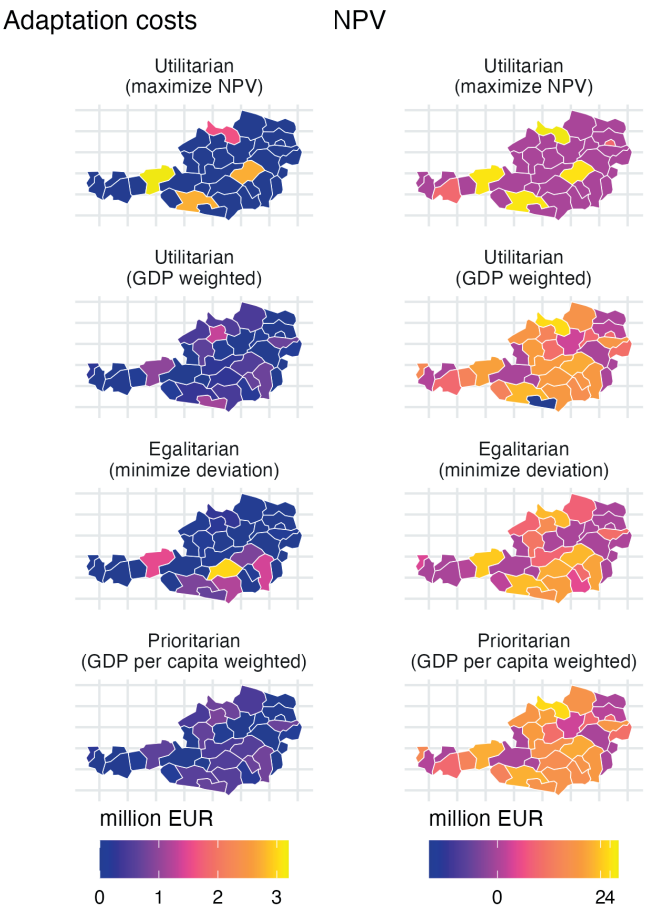


Figure 12. Rail Adaptation costs (left) and NPV (right) under different allocation scenarios

Because public adaptation budgets are limited, the analysis also examined how funds might be distributed across regions using different fairness principles. These included utilitarian (maximising total benefits), egalitarian (equalising benefits across regions) and prioritarian (prioritising more vulnerable regions). A utilitarian allocation strategy concentrated investments in regions where adaptation generates the highest economic benefits, whereas egalitarian and prioritarian approaches distribute investments more evenly.

A further case study in Austria was undertaken to assess the propagation of climate risks through global supply chains and how businesses can integrate climate adaptation into supply chain management. This was developed with two Austrian companies. One company operates downstream, producing photovoltaic technologies with production facilities in Europe but relying on suppliers that source components from Asia. The second company operates upstream, producing printed circuit boards with facilities in both Europe and Asia and sourcing around 90% of inputs from Asia.

The adaptation options considered including increasing inventory levels to maintain safety stock buffers, improving operational flexibility in production planning, localising suppliers within Europe, and implementing climate risk monitoring systems for suppliers.

The analysis of costs and benefits was qualitative. This found that supplier diversification was an important strategy for improving supply chain resilience, but it is not sufficient on its own. Even when alternative suppliers exist, switching suppliers typically takes time, meaning disruptions can still affect operations. Effective adaptation, therefore, requires a combination of measures, which also includes safety stock inventories and operational flexibility.

Integrating these approaches into a comprehensive supply chain resilience strategy can help businesses better manage climate-related disruptions while supporting more proactive decision-making in the face of increasing climate risks.

National (cross-cutting)

The last set of case studies are national, and assess multiple options as part of national adaptation plans for England and Cyprus.

For England, the case study costed the main priority actions in the National Adaptation Programme 3 (NAP3). This developed a costing method that differentiated types of adaptation investments (with associated cost attribution) between targeted adaptation investments, where adaptation is the primary objective, and climate-proofing investments, where adaptation is a secondary objective (as well as measures that fall between).

The analysis estimated that fully implementing NAP3 would cost approximately £9 billion per year between 2025 and 2028 in England (just over €10Bn). This is approximately 1% of current Government spending or around 0.4% of GDP. The largest proportion of these were for targeted adaptation, but a significant proportion were for climate proofing.

Approximately 55% of these adaptation costs will fall to the public budget. The remaining costs are passed through to households and businesses, either through utility bills (e.g., in water or energy bills) or from the introduction of higher standards leading to increased costs (e.g., in new houses).

This analysis also extended to look at the economic benefits of this adaptation, using a review process to identify the potential economic returns. This found that most adaptation actions should deliver positive economic returns, with benefit-cost ratios greater than 1.

A similar analysis was undertaken to cost the National Strategy for National Adaptation Strategy (NAS) in Cyprus. This estimated that total adaptation investment needs to 2050 would cost approximately 4 billion Euros (in current prices), equivalent to about 0.5% of national GDP. However, less than 30% of these investments were currently planned or budgeted, meaning there was a large adaptation funding gap of ~ 3 Bn.

Interestingly these had a different profile to English adaptation costs, with much higher costs for heat related interventions. The analysis also found that public funding will need to play a dominant role, with around 70% of total adaptation investment likely to come from public sources (national and EU).

A final case study was undertaken in the UK to assess the macroeconomic effects of adaptation, and the implications for the economy and the public finances.

This focused on flood protection investments, and looked at current and future adaptation costs and benefits in 2030 and 2050. The results from flood modelling assessment were then input into a macroeconomic model (a CGE model).

This found that adaptation actually reduces future government spending on disaster recovery and avoids economic losses that would otherwise reduce tax revenues. It therefore reduces the impacts of climate change on the economy (GDP) but also has net positive effects for the public finances.

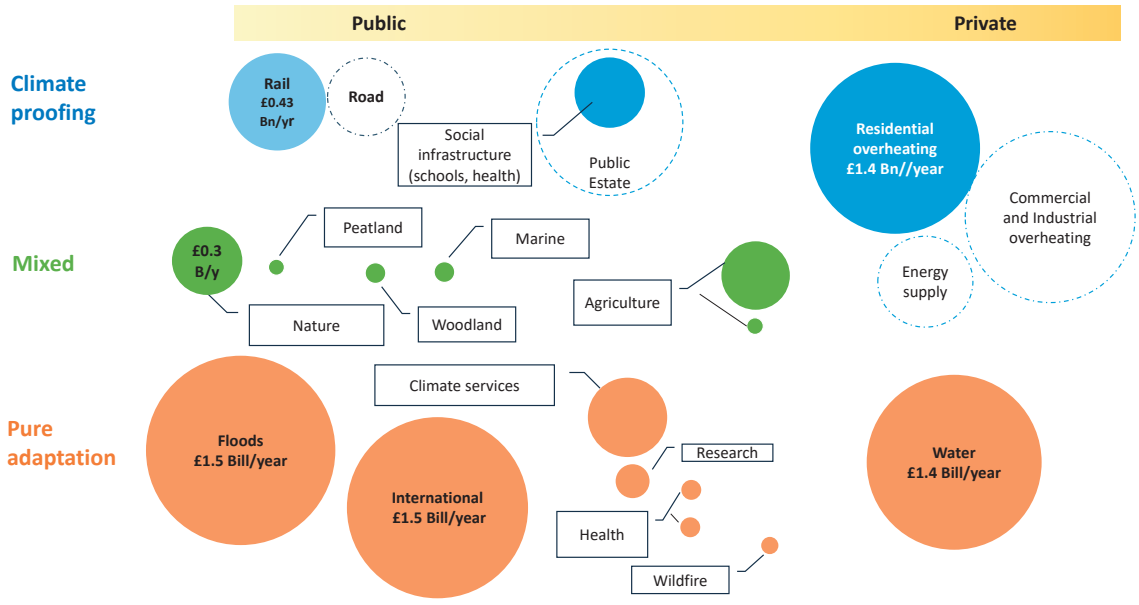


Figure 13. Major adaptation costs for England. (Size represents £M/year)

Policy Insights

The case studies provide valuable insights on the economic appraisal of adaptation. These have been analysed to produce policy insights.

Adaptation options

The adaptation options considered included a mix of **incremental** and **transformational** adaptation.

The incremental options were more focused on specific sites, and involved discrete options such as flood protection or wildfire management, but included both soft and hard interventions. There were also a set of case studies that involved more integrated analysis, such as the assessments of water-food nexus. Finally, there were a set of more transformational options that were more systemic and at greater scale (e.g., large-scale managed coastal realignment, national road network analysis). This also included case studies that included climate justice (the heat-health analysis), which is often included as a requirement of more transformational action.

It was possible to undertake an economic analysis of both incremental and transformational options, but the latter required greater scale of analysis, and there was a trade-off with the level of detail.

A range of methods is needed

A range of modelling approaches was used in the case studies. These included local scale analysis, with impact models linked to adaptation, e.g., using flood, crop or water models, as well as ecological species distribution models. It also included partial and general equilibrium models, which allow economy wide analysis, as well as financial risk models.

A range of methods were also adopted in the case studies. These included standard cost-benefit analysis, but also extended CBA analysis with decision making under uncertainty, long-term and intergenerational considerations.

There was also the use of complementary social justice frameworks to bring in equity dimensions examining recognition, participation, distribution and restorative justice in heat adaptation policies.

There were also other qualitative approaches used, such as semi-structured interviews to understand private sector adaptation.

A key conclusion is that the economic appraisal of adaptation is more diverse and comprehensive than standard CBA. As well as different types of models – often used in combination – it requires extended frameworks especially for transformational adaptation, and qualitative components for distributional analysis and equity.

Methods can influence results

A further finding of the case studies is that adaptation often involves co-benefits, in addition to reduced climate change damages. When comprehensive economic appraisal was undertaken, including these co-benefits, the economic case for adaptation was generally positive. Many of these were environmental or social benefits (non-market). While the case studies endeavoured to quantify and value these, this was often challenging.

However, when these non-market benefits were included, the relative attractiveness of various options shifted, leading to different priorities. This highlights that capturing these benefits is critical for the economic appraisal of adaptation. This is important to ensure the total economic benefits of adaptation are captured (and reported in benefit to cost ratios), but also that options are compared fairly. The methods used in economic appraisal, and the level of comprehensiveness, influence appraisal results.

Similarly the assumptions can have a strong influence on results and relative attractiveness of options. An example of this was the choice of discount rate scheme. This highlights the need for sensitivity analysis and transparent methodological choices rather than treating results as fixed answers.

A further issue relates to the distributional aspect of adaptation. The case study on transport networks highlighted that different adaptation objectives (decision paradigms) influences who benefits from adaptation equity.

This case study found that if economic efficiency and total benefits are maximised, this shifts adaptation towards specific regions. In contrast, if different decision criteria are used, then adaptation will shift towards the most vulnerable and have more equitable outcomes (even though total benefits may be lower).

Interestingly, stakeholder discussions consistently identify that even qualitative recognition of co-benefits is crucial for building political support, overcoming skepticism, and justifying investment. This suggests that the value of comprehensive appraisal is not only technical but also procedural, and can help influence decision-makers.

Barriers to adaptation

There is an emerging literature on the barriers and constraints to adaptation. These can be due to market failures (such as information failures or positive externalities) but also policy and coordination failures. There are also a set of wider challenges, including more practical issues around site specificity, acceptability, etc.

An analysis was undertaken of the main barriers facing the ACCREU adaptation case studies. The key implementation barriers are shown in the figure on the right. Institutional and financial barriers were the two most prevalent constraints identified and were present in all case studies. These barriers also led to incremental measures being favoured. More integrated and transformational options generally faced more barriers due to governance challenges, short-planning horizons, and existing financing structures.

Enabling factors for adaptation

A further set of insights emerged from an analysis of the main enabling conditions for adaptation, i.e., the actions that can help overcome the barriers above. Mirroring the barriers, the most important were governance and institutional (for example, with inter-agency and multi-level cooperation) and financial (for example, with long-term financial resources). However, more interestingly, social and cultural enablers were also important.

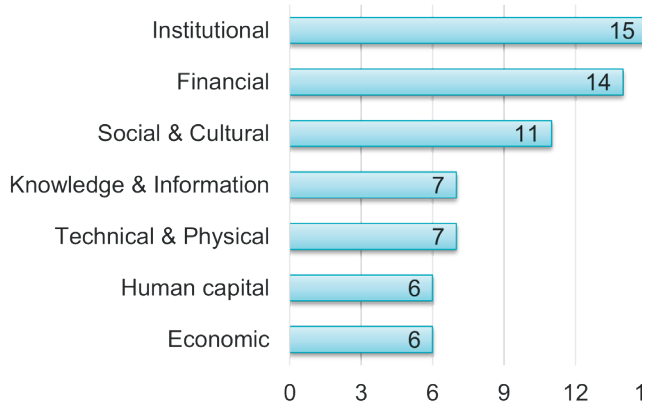


Figure 14. Key barriers identified in the 15 case studies.

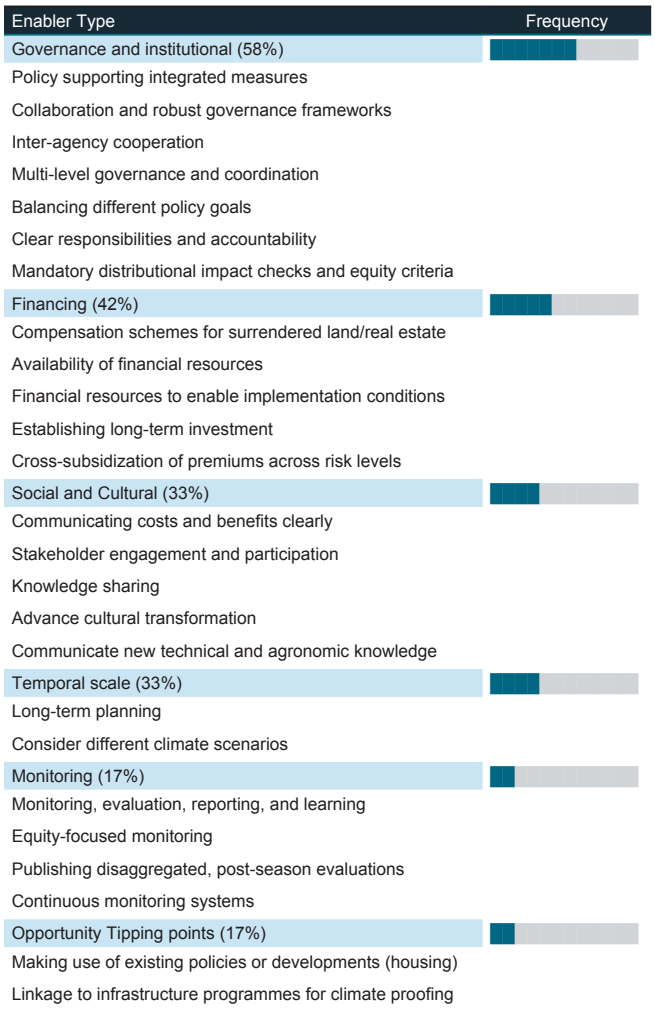


Figure 15. Key enablers in the case studies.

Synthesis of Adaptation Returns

A further stream of the ACCREU adaptation work was to compile the evidence from the literature on adaptation costs and benefits. A synthesis of this work and key insights is summarised below.

This review established a growing evidence base on the economic returns of adaptation, often reported as the economic benefit to cost ratio, the BCR. A selection of some of the findings are shown in the figure below. This leads to a number of important insights.

Adaptation can lead to positive economic returns, but these are site and context specific. Adaptation can lead to net economic benefits, as represented by a BCR above 1. The figure below shows that economic returns are mostly, but not always, greater than 1. However, it also shows that returns vary significantly, with a large range around each option. This reflects the fact that benefits are site and context specific, reflecting local hazard, exposure and vulnerability.

There are important differences between science-first and policy-first studies, and ex ante and ex post studies, which influence economic return. It is stressed that the studies in these reviews includes a mix of science first and policy first methods (see the earlier Figure 2) and that this means they are often not directly comparable. Science first studies are able to optimise to a defined scenario and so tend to lead to higher economic returns than more applied policy studies.

In addition, a large proportion of the estimates reported in the literature (and in the figure below) are based on ex ante appraisal, undertaken in analysis before implementation, rather than ex post data on the actual benefits delivered. This indicates there may be a degree of optimism bias.

Economic returns are higher than financial returns. As highlighted earlier, economic returns are focused on societal (welfare) benefits, and include non-market benefits. This is different to the financial returns that would accrue to private actors and the return on investment. The review finds financial returns of adaptation are typically lower than economic returns. This is because many adaptation investments are either in public goods, involve non-market sector or have non-market benefits, or that it is difficult to realise commercial returns from the benefits. This means even though adaptation makes sense from a societal perspective, it will still be challenging for investment.

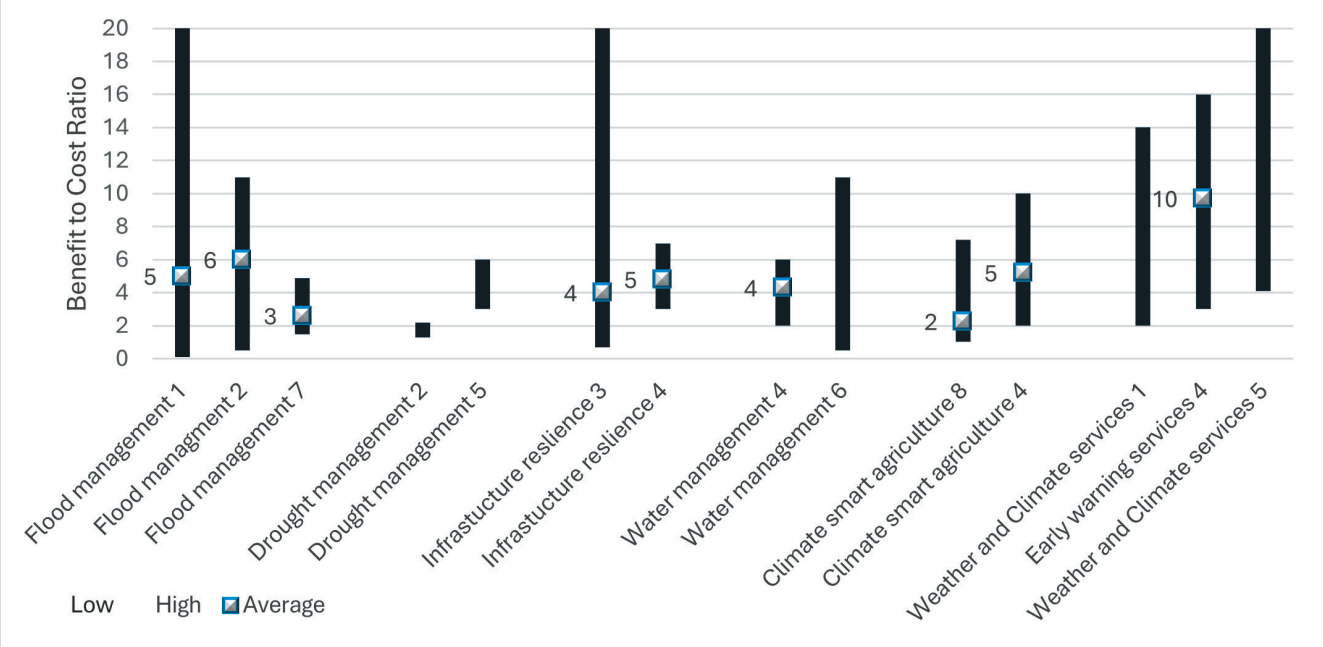
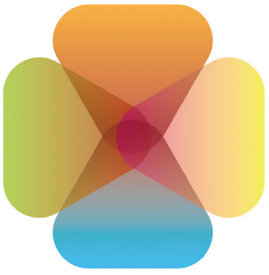


Figure 16. Examples of the Benefit to Cost Ratios for Adaptation from the Literature.



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