



Investment for a well-adapted UK

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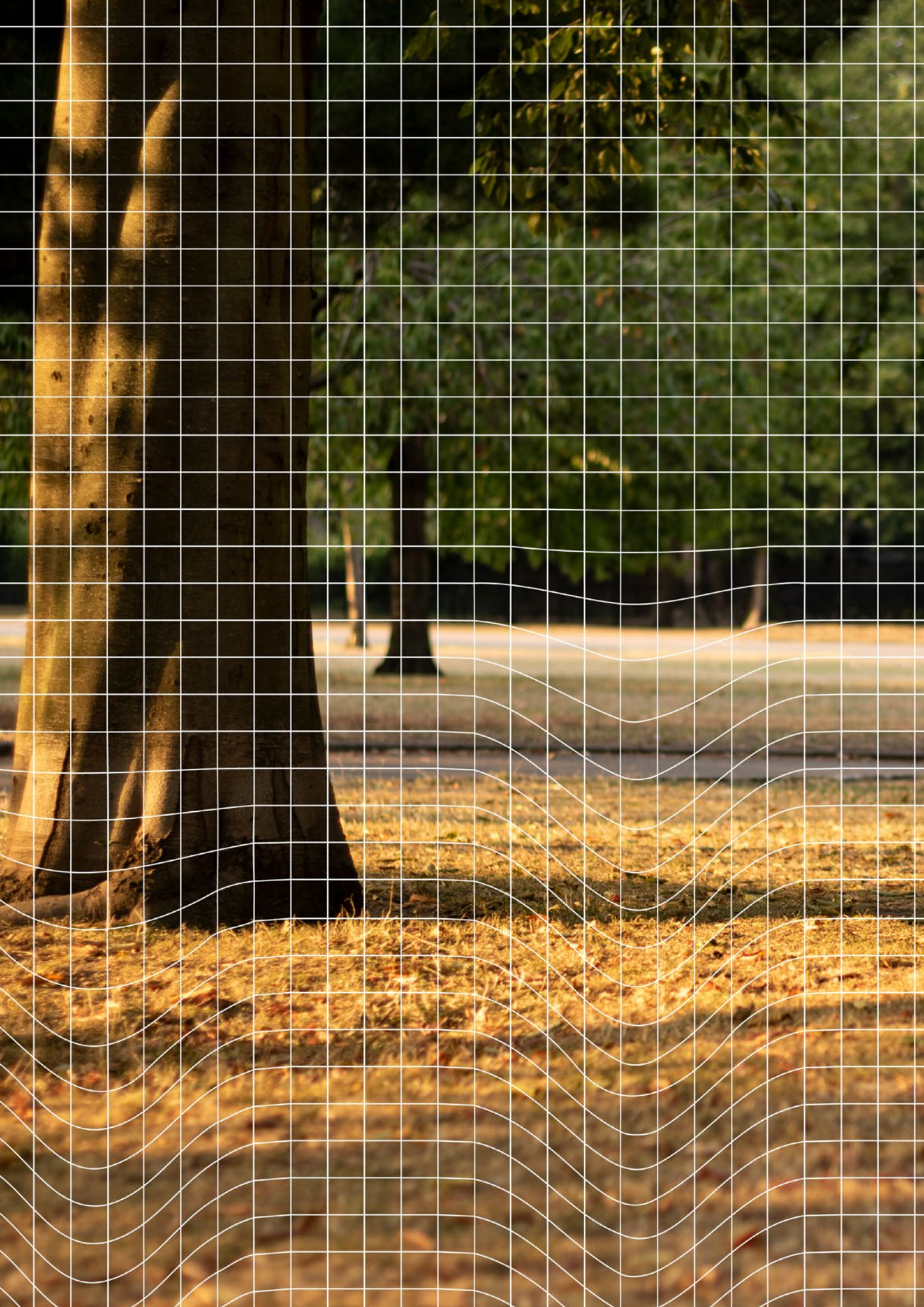
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Executive summary

The UK's climate has already changed due to human emissions of greenhouse gases and will continue to change over the coming decades. Limiting the impacts of these changes on the UK's ecosystems, infrastructure, economy and communities requires targeted actions right across society, but the UK is currently falling short of this challenge with gaps in planning and delivering climate resilience across the board.

Proactively building this resilience to climate change will require significant investment:

- New infrastructure will be needed to protect our towns, cities, communities and coastline from more frequent and intense rainfall and rising seas.
- Current infrastructure systems such as our energy, transport, water and telecoms systems need upgrading to ensure they function well under future weather extremes.
- Many homes, public buildings and workplaces will need to be retrofitted to ensure they remain safe and comfortable during more intense future heatwaves and flooding.
- Ecosystems and biodiversity need to be restored to protect the UK's nature, and the critical contributions to our society and economy that it provides, from the effects of a changing climate.
- Much of current public spending, corporate spending and household spending will need to be aligned to improving climate resilience to ensure that exposure and vulnerability to climate impacts is not increasing.

This report covers what investment is needed for climate resilience and how it can be scaled up.

This report lays out where investment will be needed to build climate resilience, the barriers associated with delivering this, and how key investment streams for adaptation can be scaled up. This summary is structured in two sections:

(a) Investment needs for a well-adapted UK

(b) Unlocking investment in climate change adaptation

(a) Investment needs for a well-adapted UK

Without national adaptation goals it is not possible to estimate the scale of investment in climate resilience needed.

Estimating the scale of investment in adaptation required across the UK is challenging. Currently there is no agreed and well-defined vision for what a well-adapted UK looks like set out by Government, and there are no associated targets or goals for desired resilience standards at a national, local or sectoral level. Without these inherently political judgements on the level of risk tolerance desired in key systems, the full scale of investment needed to deliver increased climate resilience is impossible to assess.

Some estimates exist for improving climate resilience in key areas. These are often on the order of £0.5 - 1 billion per year over the next decade each.

Despite this lack of a full economy-wide picture of investment needs for UK climate resilience, it is known that significant investment will be needed over the next decade in several key systems:

- **Flood protection:** Estimates from the Environment Agency (derived from a cost-benefit assessment) indicate that overall investment flows of around £1 billion per year will be needed to ensure that the UK is prepared for a probable range of flood hazards that can be caused by global climate change. Maintenance spending (required to keep flood defences in good condition) is also likely to be higher under future warmer climates.

- **Public water system:** Estimates from the National Infrastructure Commission suggest that investment on the order of £0.7 bn per year will be needed to build resilience to a 1-in-500 year drought event accounting for both future climate change and population growth. This investment is needed to increase connectivity of the water system, reduce leakage and create additional water supplies in parts of the country that may be particularly prone to drought conditions.
- **Housing retrofit:** Estimates for the investment into housing retrofit to reduce overheating risks vary by the amount of the stock that requires retrofit and the overheating standard used. However, based on available evidence it is plausible that investment needs could be on the order of order of £1 billion per year this decade. Additional investment at a household level will be needed for property level flood resilience in exposed and vulnerable buildings.
- **Nature restoration:** Improving the state of nature by supporting biodiversity and enhancing connectivity will make it more resilient to future climate change impacts. A large programme of investment is needed this decade to protect and restore biodiversity. Available estimates suggest around £3 billion per year of investment might be required this decade.
- **Infrastructure:** The Infrastructure and Projects Authority estimate that £650 billion of public and private investment will be required to 2030-2031. Whilst all of this investment is not directly for the purpose of building climate resilience it is vital that it is delivered with the need to build climate resilience to the UK's current and future climate and weather extremes. Additional investment needs for this 'climate proofing' of wider infrastructure investment flows are not well known.

Total additional investment to fully tackle all the UK's risk from climate change may be on the order of £10 billion per year this decade.

Outside of these areas, there is limited availability of estimates of investment needs for adaptation. Based on the evidence for investment needs in multiple key areas (flooding, public water system, reducing overheating in homes) listed above it is plausible that additional investment flows on the order of £10 billion per year may be needed this decade to help improve the UK's preparedness for climate change. In the event of much higher levels of future global warming, significantly higher investment is likely to be needed and limits to adaptation are likely to be reached despite higher investment.

The public sector, regulated infrastructure sectors, private enterprise and households will all have to invest in climate resilience.

Delivering investment into climate resilience on this scale will require contributions from different sources across society to tackle the full range of climate risks facing the UK:

- **Public sector:** Many adaptation investments bring considerable societal value that is not easily monetised. Often these benefits are best delivered through public spending. Public sector funding is also needed to deal with the social impacts of climate change.
 - In flood prevention, Government has committed overall funding levels for the current period (out to 2025) expected to be consistent with the needs identified by the Environment Agency Long Term Investment Scenarios. Greater certainty of the year-to-year totals, and preparation for potentially higher levels of funding in future, is required to ensure public investment in flood prevention keeps pace with the evolving risks.

- Government has articulated a ‘public money for public goods’ approach to help fund nature restoration, but has not yet translated this through to funding for environmental protection and adaptations at a scale that will help the natural environment in the face of a changing climate. There is continued uncertainty on the implementation and delivery of these schemes. It is also clear that even expanded public funding will not be sufficient to meet the needs for investment in nature recovery and that public funding needs to seek to ‘crowd-in’ private investment to close the overall investment gap.*

Much adaptation at the household level will have to be paid for by owners or occupants directly.

- **Households:** Homeowners need to invest directly in adaptation actions in the home that benefit the householder, including to reduce overheating risk through installing passive cooling measures and property level flood resilience measures in areas of significant flood risk. A lack of incentives to act and low awareness of the benefits of adapting to these climate risks prevent property owners from investing. More action will be needed to support property-level adaptation investments, including to help them be reflected in the property value (e.g. through building level certification and standards for climate resilience) or other financial flows (such as reduced insurance or mortgage premiums). Particularly in areas of high climate risk and low incomes, it may be appropriate for public funding to be used to incentivise or subsidise the changes required to reduce risk.
- **Regulated infrastructure:** Certain critical infrastructure sectors (such as energy, water, road and rail and communications) are subject to an independent regulator. When operating under effective climate resilience mandates, regulators can require investment in long-term climate resilience from the private or public operators of the system. Well designed and implemented climate resilience mandates will be needed across these sectors to support assessment of and investment into adaptation in a joined-up way both within and across sectors.
- **Private enterprise:** Private businesses will be responsible for investing in the resilience of their specific commercial sites and their supply chains, funded through avoided future impacts of climate change on their business operations. Policy action to create new markets and obligations on private enterprise to foster climate resilience, such as the requirement to ensure biodiversity net gain for planning applications, can also help private enterprise to contribute to investment in wider aspects of climate resilience.

Climate resilience mandates for regulated infrastructure can be a key lever to enable investment in adaptation.

Contributions to climate resilience investment must come from beyond the public sector to fully tackle the range of climate risks facing the UK. Whilst public sector funding must remain an important cornerstone of investment in a resilient future it will not be able to meet all the investment needs for climate resilience, nor should it try to. Expanding and combining the range of investment sources able and willing to invest into climate resilience needs to be a key priority. This will require a range of incentives that allow businesses to raise capital to invest in resilience, well-designed regulation to enable investment in all regulated sectors and improved incentives and understanding to enable households to invest in their own climate resilience.

* Estimates from the Green Finance Institute suggest a potential investment gap of around £56 billion over this decade beyond the current commitments from public funding.

(b) Unlocking investment in climate change adaptation

Multiple barriers currently limit investment into building climate resilience from beyond the public sector:

A lack of revenues from undertaking adaptation actions is preventing investable adaptation projects from securing financing.

- **Market and financial barriers.** For many adaptation actions the associated reduction in climate risks does not currently result in investable or bankable cashflows, particularly where risk reductions are widely distributed and hard to quantify. Without these cash flows adaptation projects will not be able to raise capital preventing non-public investment in adaptation. Where cash flows do exist, markets are often underdeveloped.
- **Information barriers.** Insufficient information on climate risks, the benefits (and co-benefits) and effectiveness of adaptation options and low general awareness and understanding of adaptation are common including for financial institutions, limiting market interest in investing in adaptation.
- **Bankability and investability barriers.** Adaptation projects need to deliver appropriate risk-adjusted returns to raise private capital. Some aspects of adaptation projects can negatively impact on perceived bankability and investability. High (or poorly understood) risks, high project complexity, limited ability to aggregate smaller adaptation projects into larger and more attractive investment packages are key barriers.
- **Policy and regulatory barriers.** Regulation (or lack of regulation) that provides insufficient or the wrong incentives can act as a barrier to investing in climate resilience. Unstable or uncertain policy regimes can also reduce willingness to invest.
- **Behavioural barriers.** Low willingness to pay for adaptation or a belief that Government will pay for adaptation or the costs of recovery from climate impacts can reduce the urgency of proactive investment in adaptation to build long-term resilience.

There are demonstrated example of adaptation projects that have overcome these barriers to secure investment from a range of sources.

These barriers can be overcome. There are numerous proven examples of successful private sector investment in adaptation across a range of areas. Public and philanthropic funding have also demonstrated value, undertaking 'proof of concept' adaptation investment mechanisms that serve as templates for a wider set of investors.

Government actions will be required to break down these investment barriers.

Developing robust and predictable regulatory frameworks will help attract public and private funding and finance in adaptation and break down the identified barriers to investment. Government needs to lead with appropriate regulatory and policy frameworks to provide positive incentives. Government must:

- Provide public funding for adaptation, in particular where the benefits of adaptation are widely distributed and difficult to quantify.
- Regulate to correct market failures that result in climate risk being mispriced by the private sector resulting in underinvestment and greater societal fragility.
- Create markets that can remunerate positive adaptation outcomes.
- Build capacity and enable innovation to support investment throughout the economy.

To help Government serve all of these roles, we have identified several areas for targeted action by Government to support investment in adaptation across the economy:

- **Clarifying adaptation goals and roles for investment:** The next National Adaptation Programme (NAP3), due in summer 2023 is a key opportunity to set out the vision for what adaptation in the UK should achieve and a framework of associated goals and metrics. This will help the private sector to choose metrics to assess their own resilience progress, aligned to national policy objectives. NAP3 and the updated Green Finance Strategy should also set out the envisaged adaptation actions to be funded through public sources and where private investment is expected.
- **Creating markets that value adaptation outcomes:** Markets and revenues for adaptation investment often need to be created by effective regulation and standards. Government should prioritise creating markets for adaptation outcomes (and their co-benefits) across relevant legislation and policy programmes, including initiatives on carbon market integrity and the Environmental Land Management schemes. The need for investment in adapting to climate change should be included within mandates/strategic priorities for all relevant regulated industry regulators and implementing agencies through resilience standards aligned to national-level objectives. There should be a duty for sector regulators to identify and create climate adaptation project pipelines, aligned with national adaptation objectives, and to set out how they will enable the realisation of that pipeline.
- **Providing public sector leadership:** Public funding is and will remain a key pillar of investment and funding to support adaptation in the UK, particularly for adaptation actions that provide distributed (public) benefits. NAP3 should contain significant new funding commitments to invest in climate resilience. To help make the case for this, the Office for Budget Responsibility should undertake a full review of how the impacts of climate change in the UK will affect the UK's macroeconomic performance and public finances. Government and its implementing agencies should ensure that a growing fraction of their funding helps to support pioneering projects that seek to provide proof of concept for ways in which adaptation actions can be successfully funded and delivered through public-private partnership funding and financing.
- **Strengthening corporate disclosure regimes:** The update to the Green Finance Strategy in 2023 and NAP3 should set out steps to ensure that the UK Sustainability Disclosure Requirements initiatives (including the Green Taxonomy) are effective in improving our understanding of adaptation investment needs, directing finance towards adaptation and ensuring that regulators and auditors have the necessary expertise to monitor the quality of reporting and provide incentives for organisations to report on their adaptation actions. The UK should build on the work of the Transition Plan Taskforce (on corporate transition plans, including for net zero and wider sustainability objectives) to define common standards for what high-quality adaptation transition plans should look like. This should include how relevant physical climate risks are measured and managed as well as how the plans would contribute to wider societal adaptation to climate change.

- **Empowering financial regulators and public finance institutions to address physical climate risks:** Financial regulators should provide directional guidance for financial institutions to measure physical climate risk and their contribution to climate adaptation (and maladaptation) outcomes across portfolios and loanbooks. This should be integrated into required climate related disclosures as part of the UK's Sustainability Disclosure Requirements, as well as enforced through microprudential supervision. The interdependencies between physical, transition and liability risks must be considered for scenario analysis and stress testing. Stress testing of the financial system to climate change risks should be done regularly as data and methodological approaches improve our understanding of the risks and impacts. The Bank of England should examine how capital requirements for banks should be adjusted based on assessed climate risks and financial regulators in the UK should collaborate with international counterparts to establish a cost of capital observatory for physical risk.
- **Helping to unlock investment through public financial institutions:** UK public financial institutions (such as the UK Infrastructure Bank, British Business Bank, UK Export Finance, and British International Investment) – should create adaptation finance strategies, setting out how they will independently and collectively ensure that no viable UK climate adaptation project fails for lack of finance or insurance. UK public financial institutions should launch new sustainability-linked instruments tied to adaptation outcomes to help prime the market, potentially by offering guarantees to private issuers and lenders for adaptation-linked instruments.

The rest of this report is set out in four chapters:

1. Investment needs for a well-adapted UK
2. Barriers to adaptation investment
3. Instruments for adaptation investment
4. Recommendations



Investment needs for a well-adapted UK

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Summary and key messages

Climate change is bringing multiple risks to the UK's population, ecosystems, infrastructure and economy. Building resilience to these risks will enable the UK's people and economy to continue to flourish despite the challenges of global climate change. To achieve this, significant investment in adaptation to climate change is needed. This chapter sets out estimates of specific investment needs in key areas for building UK climate resilience. It also covers to what extent adaptation and investment for climate resilience are covered within existing financial and corporate climate-related reporting initiatives.

The key messages of this chapter are:

- **Many adaptation actions have greater economic benefits to society than their costs.** A growing evidence base suggests that adaptation interventions today will often have long and short term economic benefits greater than their costs. These include making new infrastructure more resilient, nature restoration, natural (blue-green) and technological (or grey) flood and water management and strengthening early warning systems for heatwaves and other climate change risks.
- **Building climate resilience at scale requires significant investment.** Without clear goals for climate resilience in the UK it is impossible to provide accurate estimates of the full investment need. However, available suggests that multiple key areas (flooding, public water system, reducing overheating in homes) each need investment flows on the order of £0.5 - 1 billion per year over the next decade to build resilience to future climate conditions. A multi-billion pound per year investment to improve the state of UK ecosystems and biodiversity will also be needed to make UK ecosystems, and the services that they provide, resilient to climate change. Investment in other infrastructure system (such as energy and transport networks) will need to be delivered in a way that contributes to improved climate resilience. Across all climate risks facing the UK, the necessary additional investment in climate resilience required this decade could be in excess of £10 billion per year this decade.
- **Current corporate disclosure initiatives are helping to increase attention paid to climate risks, but further changes are urgently needed to understand investment in adaptation and maladaptation.** There has been significant progress in reporting of climate-related risk across the global financial system. The UK Government has taken actions such as making climate-related reporting mandatory for listed companies and is taking steps to establish a green finance taxonomy, including climate change adaptation. However, in part because progress on reporting of physical climate risks and in particular their financial impacts has been slow and is inherently more complex, these initiatives do not provide an accurate understanding of risk, current investment in adaptation and maladaptation or what future investment needs might be.

This chapter is set out in three sections:

1. Actions to build a well-adapted UK
2. The investment needs to build climate resilience
3. Adaptation in financial reporting, regulation and institutions

1. Actions to build a well-adapted UK

This section sets out the risks arising from climate change to the UK, their potential economic impacts, the range of actions that could be used to address these risks, and evidence regarding their costs and benefits. This provides a summary of what investment needs to be targeted towards to build a climate resilient UK.

It is structured in two sub-sections:

- (a) Risks from climate change to the UK
- (b) Actions to increase climate resilience

(a) Risks from climate change to the UK

Climate change creates a large number of risks to the UK.

Current and projected climate change will increase the severity and frequency of UK heatwaves, change UK rainfall patterns, exacerbate wildfire conducive conditions and cause the seas around the UK coast to continue to rise over the next century and beyond. These changes in aspects of UK weather and climate will create risks right across our economy, natural ecosystems, urban areas and agricultural environments, and society. The UK will also experience risks from climate change occurring overseas through its links to an increasingly interconnected world. The latest comprehensive UK Climate Change Risk Assessment (CCRA) identified 61 distinct risks areas (and some areas of opportunities) arising from climate change. These range from impacts of health, threats to the health of our ecosystems and the biodiversity they support, disruptions to key societal infrastructure and implications for our society.

The economic consequences of these risks can be significant.

Together these risks are already having a large economic impact and this will significantly increase without additional action to address them:

- The total cost to society from a sub-set of the CCRA risks for which quantified estimates of monetised damages are available is estimated to be at least £5 billion to £10 billion per year by 2050 under a climate future on course to reach 2°C above preindustrial levels by 2100, with greater damages under more extreme climate change scenarios.¹
- Other studies have estimated that the overall economic cost to the UK economy could range from 1% to 4% of UK GDP by 2050, suggesting higher costs than the subset of CCRA risks for which monetised estimates are available.²
- There is significant uncertainty regarding the economic consequences of climate change-related disruption to key global systems. For example, the passing of climate tipping points or realisation of High++ scenarios could result in significantly different impacts, with much more significant economic impacts. Rising et al 2022 estimate that economic impacts from 'catastrophic damages' could reach around 4% of UK GDP by the end of the century – although with large uncertainty.³

Climate change could also create risks to financial stability.

The UK is currently an important centre in the global financial system. Although not formally assessed as part of the latest UK climate change risks assessment, the risks to financial stability created by climate change (both in the UK and around the world) could create significant additional economic disruption in the UK if it were to occur (Box 1.1).

Box 1.1

Results of the Bank of England's 2022 Climate Biennial Exploratory Scenario

The Bank of England published its first Climate Biennial Exploratory Scenario in 2022. Some of the key messages from the results of the scenario for financial stability were:

- Over time climate risks will become a persistent drag on banks' and insurers' profitability – particularly if they don't manage them effectively. While they vary across firms and scenarios, overall loss rates are equivalent to an average drag on annual profits of around 10-15%.
- Costs to the financial sector will be substantially lower if early, orderly action is taken. For example, projected climate-related bank credit losses were 30% higher in the Late Action (LA) scenario than the Early Action (EA) scenario. Among other factors, this reflects that in the scenario, adjusting late and abruptly to climate risk triggers a messy recession – with rising unemployment as the corporate sector adjusts.
- No Action (NA) on climate delivers the worst outcome from the considered scenarios. The 'no action' scenario results in severe negative outcomes for life and general insurers over the next 30 years. UK and international general insurers, respectively, projected a rise in average annualised losses of around 50% and 70%. These costs would likely be passed on to consumers through higher premiums. Under this scenario, there would be a reduction in access to lending and insurance for sectors and households assessed as being more vulnerable to climate change. Homes at risk of flooding would likely become prohibitively expensive to insure or borrow against. This cost would be borne unequally: 45% of the mortgage impairments in the scenario are accounted for by just 10% of the country.

Source: Bank of England (2022) *Results of the 2021 Climate Biennial Exploratory Scenario (CBES)*.

(b) Actions to increase climate resilience

Adaptation actions come in many forms.

Many types of action can help address the risks arising to the UK from climate change. Table 1.1 summarises a typology of adaptation actions – with the most appropriate action (or range of actions) dependent on the risk considered as well as who might undertake it.

There is an increasing evidence base that adaptation actions are economically sensible.

For any adaptation action, the quantifiable and monetisable benefits arising from avoided climate risks can be compared against the upfront cost associated with undertaking the action. Although there is large variation in the ratio of benefits to costs, there is now significant evidence that for many actions the total economic benefits to society are significantly greater than the costs associated with implementation, with some actions having benefits that could be over ten times greater than their costs (Figure 1.1).*

Adaptation actions however are failing to address the scale of the climate risks.

Despite this increasing understanding that many of adaptation actions can be cost-effective, adaptation implementation across society is lacking. The CCC's most recent Adaptation Progress Report in 2021 found that:

- The gap between future levels of risk and planned adaptation widened between CCRA2 in 2016 and CCRA3 in 2021.

* These estimates only include benefits that are easy to quantify, so the cost-benefit ratios are likely to be even higher.

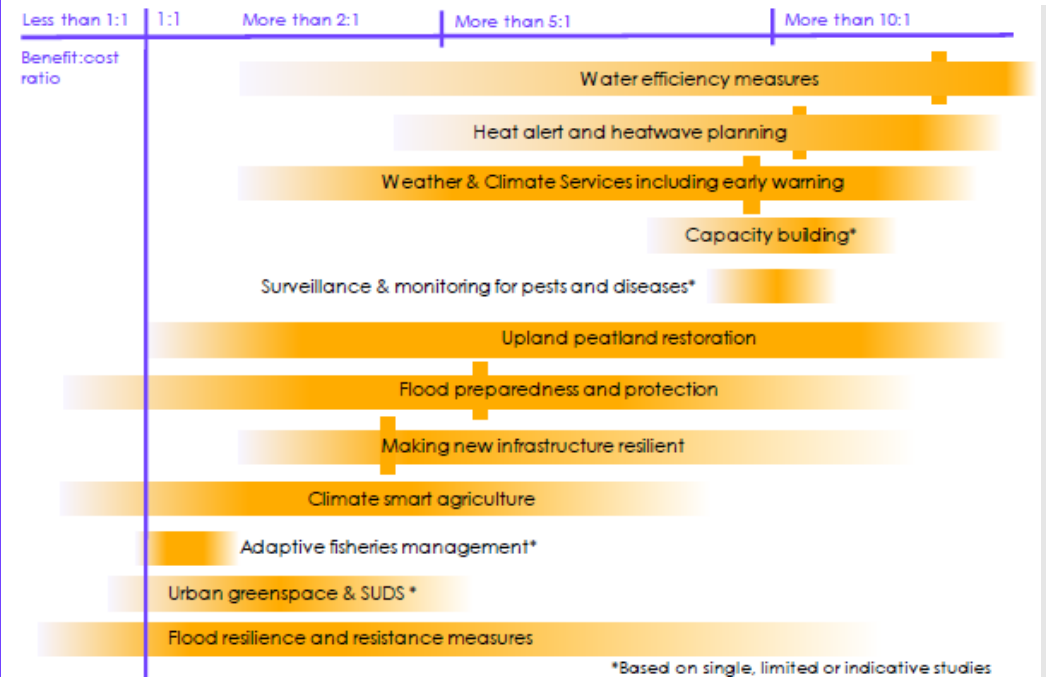
- Planning for 2°C and consideration of 4°C warming is still not happening. This was true for 27 of the 34 adaptation priorities considered.
- Only five of the 34 adaptation priorities assessed showed notable progress in the past two years, and no sector is yet scoring highly in lowering its level of risk.
- Government action has been inadequate to drive progress in most areas. There are various barriers preventing adaptation such as gaps in awareness about the risks, the presence of externalities and missing markets, financial constraints and various behavioural barriers.

This suggests that other barriers (financial and non-financial) to delivering adaptation actions exist at the level of the actors expected to undertake the adaptation actions. In part this is because there is a difference between an economic perspective, which considers all costs and benefits to society, and a financial perspective, which considers private costs and benefits from the perspective of an organisation, group or individual, alongside other barriers. The barriers to investment in adaptation are explored in detail in Chapter 2.

Table 1.1
Typology of beneficial adaptation actions

Type of adaptation action	Examples
Engineered solutions	Improved building design and retrofit, road resurfacing, flood defence investment, drainage.
Nature-based solutions	Protection and restoration of natural and semi-natural ecosystems inland and along our coasts; sustainable management of working lands and seas; and the creation of new ecosystems in our urban area.
Hybrid solutions	Blend engineered and nature-based solutions, such as managed realignment.
New or emerging technologies	Precision farming, using new crop and livestock varieties, remote sensing, new designs for infrastructure assets, use of digitisation and big data for monitoring, evaluation and management.
Behavioural	Changing timing of agricultural practices, information sharing, public engagement, skills development in adaptation.
Institutional	Adaptation standards, supply chain diversification, regulation, advisory services.
Financial	Insurance, risk disclosure, adaptation finance.
Data, R&D	Monitoring and surveillance, inspections, forecasting, research, decision support tools.

Figure 1.1 Benefit-cost ratios of adaptation measures included in CCRA3



Source: Watkiss, P. and Brown, K.A (2021)

Notes: Figure shows the indicative benefit-to-cost ratios and ranges for a number of adaptation measures. It is based on the evidence review undertaken in the CCRA3 Valuation study, which was co-funded by the EU's Horizon 2020 RTD COACCH project (CO-designing the Assessment of Climate Change costs). Vertical bars show where an average BCR is available, either from multiple studies or reviews. The colour intensity demonstrates the concentration of evidence within the range of a BCR for adaptation measures. It is stressed that BCRs of adaptation measures are highly site- and context-specific and there is future uncertainty about the scale of climate change: actual BCRs will depend on these factors.

2. The investment need to build climate resilience

The previous section outlined the range of actions that can help build resilience to climate change in the UK and the evidence regarding their economic costs and benefits. This section explores the role of investment in implementing adaptation and the potential scales of investment needed to build a high level of climate resilience in the UK. It is structured in two sub-sections:

- (a) The role of investment in supporting adaptation
- (b) Estimating the need for additional investment

(a) The role of investment in supporting adaptation

Capital and operational expenditure are both needed for many adaptation actions.

Many adaptation actions will require a one-off up-front expenditure to put them in place. Examples of this include the cost of constructing a seawall (cost of materials, labour etc.) to help prevent coastal flooding or the costs of planting trees to help reduce flood risks. In addition to the upfront expenditure some adaptation actions may also require ongoing expenditure to keep them operating effectively (e.g. regular repairs and maintenance of flood defences). Specific adaptation needs can be broken into three groups regarding the role of investment:

Some adaptation actions to build climate resilience requires large investment above and beyond what would have occurred otherwise.

- **Adaptation requiring significant additional investment:** Adaptation can require investment in new assets/services whose primary purpose is to build resilience to weather and climate conditions.[†] For example, investing in flood defences would have the sole or primary aim of reducing risks of flooding which can be exacerbated by climate change. Creating these assets to build climate resilience at scale can require significant additional investment over and above that which would occur otherwise.
- **Adaptation through changes in other investment flows:** Some adaptation actions may not require significant additional investment flows, but instead require changes in how existing or planned investment flows are delivered, potentially at low or no additional cost. For example, planned investments in additional offshore wind capacity may have greater climate resilience benefits if they are delivered in a range of locations making the overall system less vulnerable to potential future wind droughts. In many cases there may be some additional cost associated with 'climate proofing' these non-adaptation investment flows, and this can vary across asset types and climate hazards.
- **Adaptation that does not require direct upfront investment:** Some adaptation actions do not require a financial expenditure. For example, changes in how occupants manage their houses during heatwaves (appropriate opening and shutting of windows and drawing of blinds etc.) influence overheating risks.[‡]

Some adaptation requires investment flows that would have happened anyway to be delivered differently.

[†] Within this definition we including building resilience to both climate variability within the current climate and to changes in the future mean state and variability of aspects of the UK's climate.

[‡] Although these actions do not require upfront expenditure, there can be indirect needs for expenditure on campaigns and resources to support widespread understanding and implementation of these actions.

Adaptation actions that do not require an up-front investment to deliver them are not considered here or in the rest of the report.

In this report we choose to focus on a small number of adaptation needs spanning a variety of roles for investment.

In this report we choose to focus on a small number of adaptation needs to profile the investment needs, barriers and financial instruments for adaptation in sufficient detail. These areas are chosen to span a range of types of adaptation. This includes both areas that require new investment flows for the primary purpose of building climate resilience and areas that see improved climate resilience delivered by 'climate-proofing' existing investment flows.

Our focus areas are:

- **Nature-based solutions (NbS) to help manage flood risk:** Spending on actions to restore, protect and enhance the ability of natural ecosystems to provide critical services, such as wetlands (saltmarshes along coasts and peatlands in the uplands) for flood mitigation and using stabilising slopes in catchment areas or kelp habitats to reduce the impact of waves, storm surge, and coastal erosion. Scaling up NbS for adaptation will contribute to achieving Net Zero, which cannot be reached without more sustainable management of our working lands, seas and ecosystem stewardship, and also has synergies with biodiversity and co-benefits to human health and wellbeing.
- **Sustainable urban drainage systems:** Urban developments are often at risk from surface water flooding. Sustainable Urban Drainage Systems (SuDS) are water management practices designed to manage rainwater locally, by aligning urban drainage systems with natural processes to promote conveyance, infiltration, storage and attenuation. SuDS are usually implemented within urban areas as a sequence of techniques, such as permeable paving and soakaways, that work together to manage surface water. Investment in SuDS is required for new developments in flood risk areas and is largely funded by developers and local authorities.
- **Retrofitting homes to reduce overheating risk:** Homes across the UK will need to be retrofitted with passive or active cooling measures to reduce internal temperatures during periods of high temperatures.* There is a considerable variation in the residential building stock and the types of cooling measures that may be installed across the country. The majority of the funding to adapt the residential building stock will be private, from homeowners.
- **Climate-proofing infrastructure:** CCRA3 identifies increasing risks to infrastructure from high temperatures, flooding, drought, coastal erosion, and potentially wildfire in the coming decades. Existing energy networks, roads and rail infrastructure require additional spending, to continue to operate effectively under these conditions, and investments to extend these systems and upgrade to new technologies to support Net Zero delivery also need to be climate-proofed (through both engineered or nature-based actions).
- **Increasing drought resilience in the public water system:** Summer 2022 followed a trend towards hotter, drier summers in the UK, highlighting the need to invest to manage increasing risks of future water shortages due to climate change.

* Settlement level interventions, such as increased use of green and blue infrastructure in urban design, can decrease the need for property level interventions against heat and flood risks.

In addition to necessary demand-side measures to reduce water consumption, investment is needed to reduce the water lost through the public supply system and to provide new sources of supply, including increasing reservoir capacity and supporting transfer of water between regions in times of drought.

These areas are used to document the challenges and opportunities for investment in adaptation throughout this report.

(b) Estimating the need for adaptation investment

It is not possible to accurately estimate economy-wide investment needs for adaptation without clear goals for what adaptation is seeking to achieve.

Estimates of the investment need for adaptation in the UK are challenging without a clear vision for what a well-adapted UK would look like. For example, the investment level needed to ensure that the public water system is resilient to a 1-in-200-year drought would be different to the level required if resilience to a 1-in-500-year drought was the aim. This lack of detail on national level objectives for climate resilience means that bottom-up estimates of investment need are highly sensitive to assumptions about a desirable resilience target. Investments are also highly context specific meaning value transfer is difficult among projects. Top-down estimates of adaptation investment need, employed internationally, are also challenging to apply to the UK (Box 1.2).

Box 1.2

International estimates for adaptation investment need

There are some existing estimates of adaptation investment needs for other countries. Estimates of adaptation finance spending by developing countries are generally based on the grants or loans they receive from Development Finance Institutions, and adaptation finance needs by what is set out in their National Adaptation Plans or Nationally Determined Contributions. These approaches are why similar estimates do not exist for the UK. There is large variation in how finance needs are set out, how adaptation is defined and the robustness of the methods, and therefore there is not a clear approach to simply replicate these for making UK estimates.

A recent analysis of some of the costs of adaptation in France estimate short-term annual additional costs of €2.3 billion or around £2 billion per year. This estimate is based on 18 different national budgetary measures which could be taken in the next finance bill and provide benefits regardless of the extent of global temperature rises. The adaptation measures accounting for a high proportion of the total are:

- €500 million per year for spreading effective adaptation measures in cities (for example green spaces, permeable surfaces and shading).
- €500 million per year for reducing overheating risk in the new construction of educational and research buildings.
- €325 million per year for addressing known points of vulnerability in the transport system.
- €300 million per year for managing the water system to reduce the risk of drought and the risk of damage to the natural environment and biodiversity.

Other budgetary measures address managing the coastline, wildfires, and making infrastructure managers and communities aware of the risks they face and having the skills and capability to address them. The study emphasises that it is not possible to estimate total costs for France, primarily because of a lack of consensus on how to respond to climate change. Adaptation costs will not be limited to the costs of these 18 measures and will depend on further political and democratic choices to be made, such as acceptable levels of risk, activities or territories which must be protected and the models for sectors such as agriculture and tourism.

Source: Watkiss, P. (2022). *The Costs of Adaptation, and the Economic Costs and Benefits of Adaptation in the UK*. Policy Paper; Dépoues, V., Dolques, G. and Nicol, M. (2022) *Se donner les moyens de s'adapter aux conséquences du changement climatique en France: De combien parle-t-on?*

In this section, we summarise existing quantitative estimates of investment needs to deliver increased levels of climate resilience within each of the selected focus adaptation areas.

(i) Nature-based solutions to help manage flood risk

Restoring and enhancing biodiversity, which will help make ecosystems more resilient to climate change could require investment of around £2.8 billion per year over the next decade.

The Green Finance Institute estimated an investment need of around £56 million per year for reducing flood risk through natural flood management in England and Wales (over the period 2022 - 2032).^{*} This represents only a small proportion of the overall investment for environmental improvement in the UK needed to deliver the UK's targeted environmental improvement outcomes more broadly (such as the public policies in the 25 Year Environment Plan).^{4†} For example the annualised total investment need (also over 2022 – 2032) to protect and restore biodiversity is around £2.8 billion per year. As improving the state of nature by supporting biodiversity and enhancing connectivity will make it more resilient to future climate change impacts, this wider investment flow needed for nature restoration will also help build resilience to climate change in the natural environment if effectively 'climate proofed'.

(ii) Sustainable urban drainage systems

Investment of around £0.4 billion will be needed to improve resilience to surface water flooding.

A recent report by the National Infrastructure Commission (NIC) estimated annualised investment needs of around £0.4 billion per year between 2025 and 2055 to address surface water risk in England.⁵

- This is based on modelling of interventions judged to have greater economic benefits than costs. Overall, it would see the number of properties at high risk (>60% chance of being affected by surface water flooding in the next 30 years) of surface water flooding reduced by half.
- This investment need is around £120 million per year above current baseline indicative expenditure but would result in over 200,000 properties better protected under a 2°C scenario.
- The report recommends that this investment comes from both public and private sources, with a 40% increase in public expenditure – sustaining past investment increases – adding around £37 million per year in capital investment by 2055, plus additional operational expenditure.
- The NIC estimates water and sewerage company investment could deliver around 60% of the future investment amount.

Not all of this investment will be delivered in the form of sustainable urban drainage systems – other actions (such as conventional piped drainage) are also expected to receive significant investment sums.

^{*} Examples of NFM investments include: In stream structures (e.g. woody debris); Blocking of moorland drainage channels; Woodland planting; Land and soil management practices (e.g. cover crops, hedgerows, suitable crops); River morphology and floodplain restoration (e.g. removal of embankments and re-meandering); Inland storage ponds and wetlands; Protecting riverbanks (e.g. stock fencing); Sustainable urban drainage systems (e.g. swales, wetlands in urban areas, green roofs); Saltmarsh restoration; and Coastal managed realignment and change management.

[†] The outcomes considered include climate-mitigation through bio-carbon, protecting or restoring biodiversity, clean water, improving access and engagement with the Natural Environment, improving bio-resource efficiency, reducing flood risk through natural flood management and enhancing biosecurity.

Overall flood resilience investment could require around £1 billion per year. Even higher levels might be needed under more extreme climate change scenarios.

The investment need in surface water is just one part of a larger investment need for flood resilience – with detailed estimates of the size of this overall need provided by the Environment Agency (Box 1.3).

Box 1.3

Environment Agency Long-Term Investment Scenarios and flood risk management investment in England

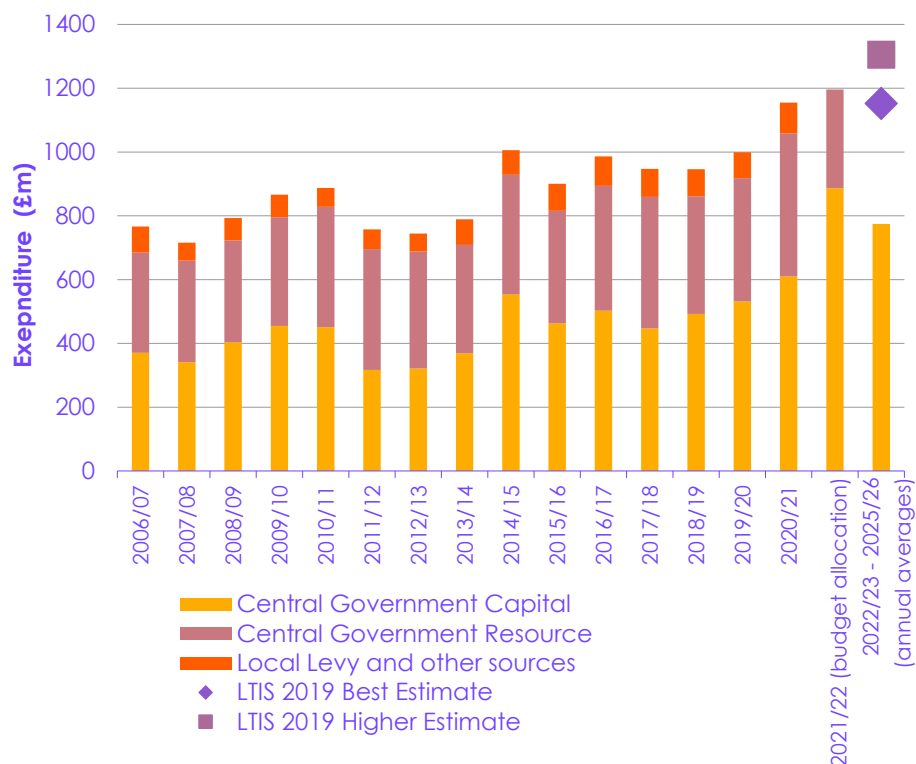
The Environment Agency's Long-Term Investment Scenarios (LTIS) set out the needed level of investment in flood and coastal erosion risk management for England, if we invest in all the places where the benefits are greater than the costs.⁶ This is calculated over the 50-year period 2014 to 2063. Across the whole LTIS 2019 baseline investment profile, the overall benefit to cost ratio is about 9 to 1 – so for every £1 invested, about £9 – from property and infrastructure damages, and other impacts (e.g. agriculture, health, temporary accommodation) – is avoided.

The final LTIS 2019 optimum level of investment depends on policy choices and could range from £1.0 billion to £1.3 billion per year (both in real terms, 2019/20 prices). The majority of this is towards new flood defences. Analysis by Sayers et al. (2021) for CCRA3 found similar total investment needs to LTIS.⁷ The implications of several other scenarios for investment needs have also been explored by LTIS, including a high++ climate change scenario and a scenario which puts higher levels of protection in place. These scenarios can increase the optimum level of investment to around £2 billion per year.

In addition to capital investment for new defences, higher maintenance spending will also be needed. Flood defence assets will be worn down more quickly by the impacts of climate change. Long-term asset maintenance and replacement costs have been found to increase by factors of 3 and 5 once climate change has been factored in. The original plan for the Thames Estuary estimated £87 million per year (£3.3 billion) to maintain the current flood defences until 2050, with a further £120 million to £160 million per year (£6 to £8 billion) to improve and upgrade from 2050-2100.

In March 2020, the Government announced that the capital funding for FCERM would increase from £2.6 billion for the period 2015 to 2021, to £5.2 billion for the period 2021 to 2027. In real terms, the £5.2 billion of capital funding for FCERM is roughly £775m as an annual average for 2021/22 to 2026/27 (Figure B1.4). Based on previous amounts of resource and other funding, which are only determined on an annual basis, this should mean that total funding is in line with the economic optimum estimated by LTIS.

Figure B1.3 Spending on flood risk management in England and the optimum identified by LTIS 2019 (real terms, 2021/22 prices)



Source: Defra (2022) Central Government Funding for Flood and Coastal Erosion Risk Management in England; Environment Agency (2019) Long-Term Investment Scenarios (LTIS) 2019; National Audit Office (2020) Managing flood risk; HMT (2022) GDP deflators at market prices, and money GDP November 2022 (Autumn Statement). Notes: 2021/22 data highlights the budget allocation for resource spending, with local levy unpublished. 2022/23 onwards shows annual averages based on the remaining budget LTIS 2019 estimates adjusted to 2022 market prices.

Source: Environment Agency (2019) Long-Term Investment Scenarios (LTIS) 2019.

(iii) Retrofitting homes to reduce overheating risk

Overheating retrofit investments depend strongly on the definitions and modelling approaches used.

Estimates of the investment need for home retrofits to tackle overheating are highly sensitive to the definition of overheating, number and type of dwellings that measures are applied to and assumptions about the costs of measures. This creates a large range of possible investment needs:

- CCC (2020) estimates that installing moderate cost shading measures, such as high specification blinds or awnings, to the most at-risk property types would add £4-£5 billion of total investment costs to those for achieving Net Zero in the UK to 2050.⁸ Installing ventilation measures such as extractor fans is estimated to cost around £550 per home, while Mechanical Extract Ventilation (MEV) or Mechanical Ventilation and Heat Recovery could add between £1,700-£4,100 per home.
- MHCLG (2019) assessed overheating in different new build dwelling types in the UK and costed packages of adaptation measures to mitigate overheating risk.⁹ The analysis was carried out over the period 2020 to 2029 and calculated the costs of adapting homes that would be built during this period.

The total capital and replacement cost calculated in this study is just under £12bn over the period.

- BEIS (2021) considered increased demands for cooling through an efficient technologies scenario (widespread rollout of air conditioning) and a passive first scenario (passive measures deployed first and then air conditioning in future years once the climate was warmer).¹⁰ The total cumulative capital costs associated with either no intervention or the 'efficient technologies' scenario was £60-70 billion by 2050. This compares to the 'passive first' approach which is around £20-30 billion.
- Arup (2022) found that the estimates for retrofitting the UK building stock with mainly passive cooling measures could be significantly higher if different definitions of overheating and assumptions about the costs of measures are used.¹¹

Addressing overheating may require investment of around £1 billion per year this decade.

Overall these pieces of evidence suggest that plausible estimates for the investment need to reduce risks of overheating in homes could be on the order to £1 billion per year this decade, but with significant variations based on the amount of the stock that requires retrofit and the overheating standard used. Evidence gaps remain regarding the investment needs for adapting other building types across the UK. Overheating occurs across building types such as hospitals, care homes, schools, prisons and some workplaces. Many such buildings will require adaptation to future climate, which may come at a substantial cost. Passive cooling may also be ineffective for some buildings and locations and therefore active cooling measures, and associated running costs, will be required.

(iv) Climate-proofing energy and transport infrastructure

The scale of investment flows in key energy and transport infrastructure systems that need to be climate-proofed is not known, despite their importance for potentially cascading climate impacts:

- Significant investment in the energy system will be required to support the Government's Net Zero ambitions, to scale up and diversify generation sources and introduce new technologies. The CCC's analysis for the Sixth Carbon Budget expected that the additional annual capital investment required (compared to a high carbon system) rises to around £15 billion in 2035 and remains at £5 billion in 2050. Investment in Net Zero energy infrastructure must incorporate adaptation, to ensure a resilient energy system and to avoid lock-in or significantly higher costs of retrofitting for adaptation at a later date. Estimates of the scale of the investment need for adaptation are not known.
- Existing evidence regarding climate proofing the railways has only looked at specific actions or parts of the system.¹² However, Network Rail is now developing estimates of additional investment need for a climate-resilient rail network. Long-term adaptation pathways and investment strategies are expected to be developed for all regions in Great Britain by 2029.
- The Road Investment Strategy 2 (2020 – 2025) includes a vision that the strategic road network is resilient to climate change and incidents, such as flooding, poor weather conditions and blockages on connecting transport networks. It includes performance indicators on structural, drainage and geotechnical conditions.

New estimates for investment needs for a climate resilient rail network are in development.

However, in 2021 DfT reduced the total number of projects to be delivered under the strategy (down from 69 to 58) and reduced National Highways' budget for road enhancements by £3.4 billion (27%). In May 2020, the Government announced a £1.7 billion Transport Infrastructure Investment Fund for local road and motorways (and railway). It is not yet clear what proportion of this additional funding will go towards improving strategic road condition or increasing climate resilience more generally.

- Estimates of adaptation investment needs for ports and airports are not known. Examples of investment needed in these sectors includes raising quay heights at ports exposed to sea level rise and tidal surges, replacing ageing infrastructure at ports and airports, and ensuring tarmacs and electronic equipment can continue to operate in periods of extreme heat.

There is a large pipeline of infrastructure investment that will need to be delivered in a manner consistent with improved climate resilience.

The National Infrastructure Pipeline sets out future planned procurements and levels of investment alongside the workforce requirement to deliver the National Infrastructure Strategy. The Infrastructure and Projects Authority estimate that £650 billion of public and private investment will be required to 2030-2031. Planned investment in the pipeline contains details for 528 individual projects, programmes and other investments. £200 billion of planned investment is projected to occur by 2024/2025. It is critical that with such huge amounts of money being invested, that the infrastructure provided is made resilient to a changing climate.

(v) Increasing drought resilience in the public water system

Climate change is one of several drivers for requiring additional investment for drought resilience in the public water system.

Investment flows on the order of £0.6 – 0.7 billion per year will be needed to build long-term resilience in the public water system.

The National Infrastructure Commission estimated that the costs of maintaining current levels of resilience and relying on emergency measures for more severe droughts are, on average, between £0.8 billion and £1.3 billion per year between 2020 and 2050.¹³ This is what it is worth spending upfront to avoid the risk of drought. There would also be further environmental and public health impacts associated with emergency response. In comparison, the cost of proactive long-term resilience improvements to the same standards ranges from between £0.6 billion and £0.7 billion per year.

Since this estimate, the Environment Agency published the National Framework for Water Resources.¹⁴ This identified that greater reductions in abstraction are likely to be required than those currently considered in water company water resource management plans. This could increase investment needs further.

(vi) Other investment flows

Other large investment programmes – such as for Net Zero and Levelling Up – need to be implemented in ways consistent with increased climate resilience. This may require some additional investment.

There are major investment flows to provide and maintain the infrastructure services we depend on, and to achieve other societal goals, such as Net Zero. If these investment flows do not take the need for adaptation to a changing climate into account, this will result in higher costs, less reliable services and key goals not being met. Some of these investments will require climate-proofing, which can come with additional investment needs. A limited number of other studies have suggested estimates of between 0.5% and 20% of capital costs for climate-proofing infrastructure.¹⁵ This is likely to vary among infrastructure types and relevant climate hazards. Box 1.5 provides some examples of relevant investment flows. Better understanding is needed regarding the scale of additional investment that may be required to ensure these investment flows are contributing to climate resilience across society.

Box 1.5

Investment flows to deliver societal objectives that need to be 'climate proofed'

Net Zero

UK low-carbon investment each year will have to increase from around £10 billion in 2020 to around £50 billion by 2030, continuing at around that level through to 2050. That compares to total investment in the UK of around £390 billion in 2019. One of the largest areas of investment is residential buildings. Measures like reversible heat pumps can provide cooling as well as heating, and energy efficiency measures need to have consideration of ventilation and avoid exacerbating overheating risk. Significant investment will also be required in areas such as surface transport, agriculture and land use, land-use change and forestry, where adaptation will be key to ensuring goals are met.

Levelling Up

The £4.8 billion Levelling Up Fund will invest in infrastructure that improves everyday life across the UK, including regenerating town centres and high streets, upgrading local transport, and investing in cultural and heritage assets. The first round of the Levelling Up Fund supported £1.7 billion of projects in over 100 local areas across the UK, delivering over £170 million of funding in Scotland, £120 million in Wales, and £49 million in Northern Ireland. This presents an opportunity to achieve levelling up at the same time as improving climate resilience in many different parts of the UK.

Agriculture

In 2019 the UK received £4.7 billion of funding under the EU's Common Agricultural Policy (CAP).¹⁶ The Government has guaranteed the same level of overall farm support budget for each year of this Parliament. Central to the new regime is the Environmental Land Management scheme (ELMS). Farmers and other land managers will be paid for the delivery of a range of public good outcomes. ELMS design must recognise that adaptation is a necessary pre-requisite to meeting the scheme's other public good outcomes, because they are at risk from climate change.

Source: CCC (2020) *The Sixth Carbon Budget*.

(vii) Summary

The investment needs into key adaptation outcomes (nature restoration, flood defences, water system resilience, retrofitting homes to reduce overheating risk) described above clearly show that significant additional investment will be needed into climate resilience this decade.* However, these only cover a subset of adaptation outcomes that are needed to tackle the many risks that climate change creates for the UK.

An independently produced study by Watkiss (2022) – published alongside this report – suggests that plausible estimates of total adaptation investment need may be in excess of £10 billion per year this decade when all risks are considered.¹⁷ Over the next UK Climate Change Risk Assessment cycle (through to 2027) developing better constrained economy-wide investment needs should be a priority to both understand in which sectors the largest investment needs lie as well as how much additional investment might be needed beyond current commitments.

It is plausible that investment for adaptation of over £ 10 billion per year could be needed this decade when all climate risks and adaptation outcomes are considered.

* However, the varying geographical extents and means that they cannot however be easily summed together.

3. Adaptation in financial reporting, regulation and institutions

The Government's Green Finance Strategy and its subsequent Roadmap seeks to 'green' the financial system to deliver on the Government's commitments for climate and nature restoration. This means incorporating environmental considerations into all financial decisions of financial institutions, investors, businesses, infrastructure providers and households.*

There are a range of initiatives which aim to help raise awareness of climate risks and adaptation, and drive investment.

In this section we review some of the key public and private initiatives to assess how effective they are in improving understanding of adaptation investment needs and directing finance towards adaptation. We also review the approach of regulators and other institutions in supporting these initiatives and incorporating adaptation to fulfil their statutory duties. This section is structured in five sub-sections:

- (a) Reporting and disclosures
- (b) Financial regulators
- (c) Financial institutions
- (d) Green gilts and bonds
- (e) Conclusions

(a) Reporting and disclosures

Recent years have seen a significant increase in the profile of climate-related disclosures, following the launch of the Taskforce on Climate-related Financial Disclosures (TCFD).

Climate-related reporting and disclosures refer to the information that organisations provide to financial markets, investors and others on the risks they face from climate change and the actions they are taking in response. Recent years have seen a significant increase in the profile of climate-related disclosures, following the launch of the Taskforce on Climate-related Financial Disclosures (TCFD) and its endorsement by national governments and many large businesses.

The following sub-sections detail the latest developments regarding reporting and disclosures within the UK, closely-related requirements and initiatives for the natural environment and the Adaptation Reporting Power (ARP).

(i) Sustainability Disclosure Requirements

In 2021 the Government announced new Sustainability Disclosure Requirements (SDR) and an accompanying Roadmap to Sustainable Investing.¹⁸

- SDR aims to bring together existing sustainability requirements, build on the UK's implementation of the recommendations of the Taskforce on Climate-related Financial Disclosures (TCFD) and make use of international standards.

* Mullan and Ranger (2022) state that 'At the end of 2020, the world's 500 largest global asset managers oversaw USD 110 trillion of assets. To achieve climate-resilient economies and societies, ultimately, there is a need to not just increase the billions of financial flows for adaptation, but fundamentally to align the trillions of public and private financial flows and investment with resilience.'

- It includes disclosure requirements related to corporates, asset managers and asset owners and creators of investment products.

Reporting in line with TCFD should require reporting organisations to carry out scenario analysis including adaptation options, but this does not mean it happens in practice.

SDR is made up of several different parts which cover adaptation (Table 1.3). These are technical requirements set out in guidance but do not necessarily reflect what organisations have reported regarding adaptation to date. TCFD alignment should require reporting organisations to carry out and report the results of scenario analysis, including adaptation options, however most climate scenarios used in TCFD reporting to date have rudimentary assumptions about adaptation and many TCFD reports do not feature adaptation at all.

The Green Finance Roadmap also included a new requirement from 2023 for UK listed companies and financial institutions to publish Net Zero transition plans on the basis that these were essential for investors' ability to monitor progress and hold investee company boards and management to account. The Transition Plan Taskforce published its disclosure framework and implementation guidance for consultation in November 2022, which predominantly covers climate change mitigation but also climate resilience and adaptation.¹⁹

Adaptation plans which link to and build upon net zero transition plans should be introduced.

Adaptation plans (building on net zero transition plans) should be introduced in order to support companies and financial firms to reduce their risks from climate change, and help create demand (and the cash flows) for adaptation investments. These plans should consider how preparers will measure and manage physical risks, as well as how they will contribute to wider societal adaptation outcomes, mirroring the recommendation of the UK Transition Plan Taskforce on net zero transition plans. Companies owned by HMG via UK Government Investments (UKGI) and public financial institutions should be among the first financial firms to develop adaptation plans.

Table 1.3

Key parts of the UK's Sustainable Disclosure Requirements and how they attempt to include adaptation

Initiative	What is it?	How does it include adaptation?
Taskforce on Climate-Related Financial Disclosures (TCFD)	<p>To comply with the recommendations, organisations must disclose specific information in relation to how their governance, strategy, risk management, metrics and targets help them assess and manage their response to climate-related risks and opportunities.</p> <p>The UK Government announced its intention to make TCFD-aligned disclosures mandatory by 2025. This is gradually being introduced for different categories of organisation including listed commercial companies, UK-registered large companies, banks and building companies, insurance companies, asset managers, life insurers and FCA-regulated and occupational pension schemes.</p>	<p>Reporting on physical climate risks and adaptation under governance, strategy, risk management metrics and targets, has been part of the recommendations since their creation.</p> <p>Organisations are asked to consider multiple climate scenarios, though only a 2°C or lower scenario is explicitly requested.</p> <p>Examples are provided for reporting organisations such as required or discretionary increases in capital and operational expenditures to address adaptation.</p>
International Sustainability Standards Board (ISSB) Climate-related Disclosures	<p>The International Financial Reporting Standards Foundation set up a new International Sustainability Standards Board to advise on new global reporting standards for sustainability. These will cover very similar areas to the TCFD recommendations but require more granular financial information.</p>	<p>Reporting should allow understanding of resilience of an organisation's strategy to climate-related changes. This should include scenario analysis and the effect of current or planned</p>

	<p>The ISSB consulted on a Climate-related Disclosures draft in 2022 with plans to finalise it in 2023. The UK Government has announced that it will create a mechanism to adopt and endorse ISSB standards for the UK, effectively replacing the TCFD disclosures.</p>	<p>investments in adaptation or opportunities for climate resilience.</p> <p>How reporting organisations expect their financial performance to change over time, given their strategy to address climate-related risks and opportunities. For example, physical damage to assets from climate events and the cost of climate adaptation.</p>
<p>UK Green Taxonomy</p>	<p>Sets out the criteria which specific economic activities must meet to be considered environmentally sustainable and therefore 'Taxonomy-aligned'.</p> <p>Certain companies will be required to disclose the percentage of their capital expenditure, operational expenditure and turnover that relates to Taxonomy-aligned activities.</p> <p>Providers of investment products will be required to disclose the extent to which those products are Taxonomy-aligned.</p> <p>The UK Government is due to consult on the Technical Screening Criteria and standards for each of the environmental objectives before laying legislation before Parliament.</p>	<p>Adaptation is one of six environmental objectives. Technical Screening Criteria are due to be developed for adaptation which will be based on those used for the EU's Taxonomy for Sustainable Activities.</p> <p>To be considered taxonomy-aligned an economic activity must make a 'substantial contribution to' one of the environmental objectives and 'do no significant' harm to any of the others.</p> <p>In the EU's Taxonomy for Sustainable Activities, significant contributions and avoiding significant harm are based on undertaking robust assessments of physical climate risk and setting out actions in response, including consideration of Nature Based Solutions and Blue-Green Infrastructure.</p>
<p>Source: CCC Analysis; HMG (2021) <i>Greening Finance: A Roadmap to Sustainable Investing</i>; HM Treasury (2020) <i>Interim Report of the UK's Joint Government-Regulator TCFD Taskforce</i>; TCFD (2021) <i>Implementing the Recommendations of the Task Force on Climate-related Financial Disclosures</i>; European Commission (2021) <i>Commission Delegated Regulation (EU) 2021/2139</i>, Official Journal of the European Union.</p>		

Key challenges include scenario analysis, reporting the financial impacts and metrics and targets for physical risk.

If effective the UK SDR could significantly improve our understanding of adaptation investment needs and help direct finance towards adaptation. However, evidence from reviews such as the latest TCFD status report, FCA and FRC's reviews of TCFD reporting, suggest that there are aspects of reporting that organisations are struggling with.^{20,21,22}

- Challenges remain in aspects that are critical for assessing physical risk and adaptation such as scenario analysis, the financial impacts of climate change and metrics and targets beyond those related to reducing emissions.
- Corporates often still see addressing climate change risks as being primarily or even entirely related to climate change mitigation.²³

Unless these challenges are addressed with improvements in understanding and capability, the UK SDR initiatives will not be fully effective in improving our understanding of adaptation investment needs or directing finance towards adaptation. Regulators and auditors also need to have the necessary expertise to monitor the quality of reporting.

Government actions can play a role in overcoming these challenges, for example, through enabling the provision of data as a public good. This could include directly investing in open risk and resilience data and metrics or developing platforms and tools to share relevant datasets, such as those collected by insurance companies.

A taxonomy for adaptation is crucial but attempts so far have failed to provide robust and specific criteria.

The approach in the EU's Sustainable Finance Taxonomy is focused on robust risk assessment and setting out appropriate actions in response. These are necessary components of incorporating adaptation, but lack more specific underlying criteria to ensure that alignment with the taxonomy leads to genuine alignment with and contribution to adaptation and resilience goals.

The Green Technical Advisory Group published advice to Government on the development of the UK's Taxonomy in October 2022.²⁴ It noted that the Technical Screening Criteria currently focus on processes rather than outcomes in terms of delivering resilience investment, and that the EU is now developing an adaptation strategy to work alongside its taxonomy. It made two broad recommendations to Government:

- Develop UK goals, targets and policy frameworks that taxonomy-based investment can 'play into', including setting out the role of public and private investment to deliver the UK's adaptation needs and track progress in capital deployment and ensuring coordination and oversight of public and private adaptation investment to deliver UK resilience.
- Set up an Adaptation Working Group to advise on the design and implementation of an enhanced set of adaptation Technical Screening Criteria.

Mullan and Ranger (2022) propose a set of principles for assessing the climate resilience alignment of finance that could be used by both private financial institutions and the public sector (Table 1.4). It is important to note that these are initial principles focussed on assessing climate risks, which require further underpinning work to provide robust definitions and that risk assessment by itself does not automatically lead to adaptation actions or improvements in adaptation finance.

The study also highlights that metrics for alignment will need to be common and comparable across financial institutions and corporates, though identifying such metrics for alignment is still relatively nascent, even for net zero alignment. Metrics currently under consideration related to physical climate risks, such as proportions of assets exposed, are not comprehensive or forward-looking enough to measure alignment.²⁵

New data and analytics are also required for measuring how portfolios and loan books contribute to fragility and maladaptation, as well as adaptation and resilience.

New data and analytics are also required for measuring how portfolios and loan books contribute to fragility and maladaptation, as well as adaptation and resilience. An effective adaptation taxonomy is an essential part of this, alongside public funding to support innovation in this area to help ensure UK leadership in the areas of advanced data and analytics in the global financial services sector. An important part of this is open data initiatives, as discussed above.

Table 1.4
Potential principles for assessing climate resilience alignment of finance

Initiative	Principle	Examples of how this could be assessed at asset level
Process of risk assessment	Relevant climate-related risks have been identified and managed, in a way that is proportionate to the type of investment and vulnerability to climate risks. This process should aim to achieve robustness against uncertainty.	<ul style="list-style-type: none"> • Existence of process for risk-assessment, including scenario analysis. • Pricing of physical climate risk exposure.
Consistency with adaptation / resilience strategies	The investment should be compatible with relevant strategies for adaptation or resilience (if these strategies exist).	<ul style="list-style-type: none"> • Cross-referencing with relevant strategies (e.g. national adaptation plans).
Consistency with Net Zero	The investment should be compatible with achieving progress towards Net Zero.	<ul style="list-style-type: none"> • Investment also complies with standard for aligning with Net Zero. • Compatibility with national strategies for Decarbonization. • Consistency with NDCs.
Do no significant harm	The investment does not undermine the resilience or adaptive capacity of people or ecosystems, for example by shifting risks to downstream users, or undermining biodiversity and ecosystems.	<ul style="list-style-type: none"> • Compliance with safeguarding standards. • Implementation of countervailing measures to manage identified risks.
Monitoring strategy	Strategies in place to monitor performance over time.	<ul style="list-style-type: none"> • Plan to repeat risk assessment at set intervals and report within risk reporting framework.
Positive contribution to resilience beyond the project / investment	The project or investment actively facilitates societal and ecological / ecosystem resilience line with relevant goals and plans (e.g. national adaptation plan).	<ul style="list-style-type: none"> • Robust analysis of potential benefits beyond the project boundaries and how these might change over time, and how these benefits synergise or trade-off against one another.

Source: Adapted from Mullan, M. and Ranger, N. (2022). *Climate-resilient Finance and Investment: Framing Paper*. OECD Environment Working Papers No.196.

Government amended the 2006 Companies Act under the Companies (Strategic Report) (Climate-related Financial Disclosure) Regulations 2022 to require companies to include sustainability-related information in their strategic report and incorporate TCFD-aligned disclosures. Section 172 of the Companies Act places an obligation on directors to have regard for the impact of the company's operations on the community and the environment. Further clarifications or amendments to the Companies Act could be considered to strengthen contributions from companies to societal resilience, including adaptation.

(ii) Financing adaptation in context of nature-based solutions

Nature-focussed initiatives are furthering progress for the financing needs of the natural environment, though barriers remain.

There are initiatives and institutions focussing on risks to and financing needs of the natural environment which will include adaptation (some key examples in Table 1.5). The Taskforce on Nature-related Financial Disclosures (TNFD) uses a similar framework to TCFD, and helps to ensure that organisations consider a wider range of future nature-related risks and opportunities. Importantly, it requires organisations to consider the alignment between climate and nature-related targets.

These initiatives are furthering progress, though more generally barriers remain. In a report commissioned by the World Wildlife Fund (WWF) and the Royal Society for the Protection of Birds (RSPB), practitioners identified that for NbS at least the following barriers are important; lack of information on costs and effectiveness; lack of accessible finance; governance challenges; inappropriate regulation and legislation; and procurement processes that fail to recognise the multiple benefits that NbS can deliver.²⁶

Biodiversity finance remains predominantly public investments with comparatively little private money.²⁷ Barriers include common standards, data availability and accessibility and that projects are often small in scale and scope. Hoekstra (2022) suggests that the System of Environmental Economic Accounting (SEEA), a global Natural Capital Accounting standard adopted by international organisations and governments in 2021, can help overcome these barriers. An action plan may also be required to enable this, through assessing data needs and enhancing availability, aligning with other common standards and integrating natural capital accounting into the education of finance professionals.

Table 1.5
Examples of reporting and other initiatives for financing adaptation in the natural environment

Initiative	What is it?	How does it include adaptation?
Taskforce on Nature-Related Financial Disclosures (TNFD)	<p>Similar to TCFD, a global initiative to develop and deliver a risk management and disclosure framework for organisations to report and act on evolving nature-related risks, with the aim of supporting a shift in global financial flows away from nature-negative outcomes and toward nature-positive outcomes.</p> <p>In November 2022, TNFD released the third version of its beta framework for market consultation. The next version of the beta framework will be released in March 2023, before the release of the full framework for market adoption in September 2023. TNFD has been endorsed by G7 countries but reporting by organisations is voluntary.</p>	<p>There is a recommended disclosure on the degree of alignment between an organisation's climate and nature-related targets, including how they contribute to each other and any trade-offs.</p> <p>Requires reporting of nature-related financial risks (and opportunities) on companies' financial accounts (income, balance sheet, cashflow). Opportunities focus on reduced costs and new revenues.</p> <p>These include Nature-based Solutions for adaptation.</p>
Green Finance Institute	<p>The Green Finance Institute is a UK-based independent, commercially focused organisation backed by government and led by bankers which was established in 2019. It convenes and leads sectoral coalitions of global experts, that identify and unlock barriers to investment, and aims to design, develop and launch portfolios of scalable financial solutions.</p>	<p>GFI established a collaborative platform 'GFI Hive' which aims to increase private investment in nature restoration, nature-based solutions and nature-positive outcomes in and for the UK.</p> <p>These outcomes contribute to climate change adaptation and there has been consideration of measures such as natural flood management in its work on estimating a finance gap for nature and in the resources on the hive website.</p>

Climate, Community and Biodiversity (CCB) Standards	<p>The Climate Community and Biodiversity (CCB) Alliance is a partnership of international NGOs that was founded in 2003.</p> <p>CCB Standards are international voluntary standards to certify climate, community, and biodiversity benefits from land management projects.</p> <p>An online registry contains details of verified and validated projects. Standards are consistent with Voluntary Carbon Offsets.</p>	<p>Climate change adaptation benefits are an optional criterion. A project must provide significant support to assist communities and/or biodiversity in adapting to the impacts of climate change to be compliant with this criterion.</p> <p>Benefits accredited are consistent with the Lawton Principles (2010) for improving the resilience of the natural environment.</p>
<p>Source: Taskforce on Nature-related Financial Disclosures (2022). <i>The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework Beta v0.3. Climate Community and Biodiversity Standards Version 3.1 2017.</i></p>		

The UK government intends to develop private markets to support investment into natural capital with the aim of leveraging a minimum of £500 million of private investment annually by 2027, and more than £1 billion a year by 2030, to support delivery of nature-based approaches.²⁸

The 2021 Natural Environment Investment Readiness Fund (England) (NEIRF) from Defra and the Environment Agency aims to support the development of projects that can generate revenue from ecosystem services and operate on repayable investment. The fund is also supporting projects that are developing codes or standards, toolkits and methodologies to help measure, quantify, verify and monitor environmental uplift, beyond carbon capture established in the Woodland Carbon Code and Peatland Code, such as hedgerows and saltmarsh.

(iii) Adaptation Reporting Power (ARP)

The Adaptation Reporting Power could provide information on the financial costs and impacts of physical risks and financial barriers, particularly for the infrastructure systems on which we depend.

The ARP was created under the Climate Change Act (2008) to help understand and improve the resilience of key infrastructure systems and other public services to climate change. Reporting organisations are asked to provide reports every five years setting out the risks they face and actions they are taking in response. In the most recent round (ARP3), around 90 organisations submitted reports, many from the transport, energy, water and digital infrastructure sectors. For the first time, financial regulators were invited to report as well.

Reporting organisations could provide information on the magnitude of risks they face, potentially including financial cost and impacts, as well as barriers preventing adaptation such as financial barriers. Since the first round in 2012, reporting through the ARP has not been made mandatory, and financial information is not usually provided. Many organisations who report through the ARP may also produce annual TCFD reports and so could provide financial information through those routes.

(b) Financial regulators

Financial regulators have made positive efforts to consider adaptation though there is more that can be done.

The UK's financial regulators have a range of statutory responsibilities to ensure the resilience and stability of the financial system and protect consumers from adverse outcomes. There have been positive efforts to consider adaptation, such as the PRA's reports on the impacts of climate change on the insurance and banking sectors, the formation of a Climate Financial Risk Forum and three of the financial regulators produced reports as part of the most recent round of the Adaptation Reporting Power.

These reports provided useful initial research on the role of capital requirements in absorbing future losses and the current consideration of climate change in TCFD reporting. They have also highlighted some concerns around the quality of climate-related disclosures and insufficient consideration by some pension schemes (Table 1.5). There were some examples, such as the consideration of mobilising capital for the Net Zero transition by the FCA, which would be useful to develop further in the context of adaptation.

Often regulators' roles cover both mitigation and adaptation. This is good in that there can be synergies and efficiencies from considering them together, however adaptation and physical risk must not fall behind and progress should be closely monitored – particularly given some of the additional challenges from scenario analysis, evidence gaps and forming appropriate metrics and targets.

There is a need to incorporate physical risks into financial regulation and supervision and track the extent to which physical climate risks are mispriced in the market.

Mullan and Ranger (2022) recommend that financial regulation and supervision must ensure physical climate risks are incorporated into risk management practices, to assess macro-level and systemic physical climate risks and resilience, to eliminate greenwashing, to encourage appropriate risk pricing and to set standards for resilience-linked financial instruments such as resilience bonds. There is a need to track the extent to which physical climate risks are mispriced in the market. Understanding where risks are mispriced, will allow us to design interventions to correct this market failure and prioritise based on factors such as the importance of sector.

It is also important to consider the trade-offs from potential adaptation by regulated institutions. For example, banks that divest may be adapting their portfolios and insurers that stop underwriting may be more resilient to future risks, but there are implications for corporates and those trying to access finance and insurance.

Table 1.6
Financial regulators and climate change adaptation

Regulator	Background	Role and previous work related to climate change and adaptation
Financial Conduct Authority (FCA)	<ul style="list-style-type: none"> Regulates the conduct of around 50,000 businesses; Prudentially supervises 48,000 firms; Sets up specific standards for around 18,000 firms. Three operational objectives: <ul style="list-style-type: none"> – Secure an appropriate degree of protection for consumers. – Protect and enhance the integrity of the UK financial system – Promote effective competition in the interests of consumers. 	<p>All three operational objectives are affected by climate change:</p> <ul style="list-style-type: none"> Consumers have access to genuinely green products. Firms integrate climate risks into their investment strategies so investors are protected from losses due to falling asset values. Firms respond to new policies and consumers do not lose money or access to products from failure to do so. Transparency through climate-related disclosures promotes trust in adaptation and mitigation processes among investors and consumers, and reflects the impacts in asset prices. High-quality ESG information enables consumer choice and promotes competition among firms, including through innovation in green finance, and encourages them to be proactive incorporating climate change into their business models. <p>Previous work:</p> <ul style="list-style-type: none"> Published proposals for sustainable investment labels and ensuring trust in the characteristics of ESG-labelled financial instruments to address greenwashing. Extended the application of its TCFD-aligned Listing Rule for premium-listed commercial companies to a wider scope of listed issuers and introduced TCFD-aligned disclosure requirements for asset managers and asset owners (including life insurers and FCA-regulated pension providers). Carried out a review of TCFD reporting and published a report under the most recent round of the Adaptation Reporting Power.
Financial Reporting Council (FRC)	<ul style="list-style-type: none"> Regulates publicly listed companies by providing standards, best practice guidance, corporate reporting, and the UK Corporate Governance Code; Institutional investors through the Stewardship Code; Auditors, actuaries and accountants' compliance with professional standards and UK Generally Accepted Accounting Principles (GAAP); Relevant professional bodies, by supervising, for example, ICAEW, ACCA, IFOA, CGMA, ICAS. 	<ul style="list-style-type: none"> Encourages high-quality governance, reporting and stewardship of ESG and climate-related issues, including physical risks. Supports companies, investors, auditors and actuaries to enhance the effectiveness of their ESG and climate-related activities, including adaptation, by issuing Codes, standards and guidance to promote high-quality governance, reporting, assurance and stewardship. Holds those to account that do not meet statutory or regulatory requirements regarding climate-related reporting. <p>Previous work:</p> <ul style="list-style-type: none"> Published a Statement of Intent on Environmental, Social and Governance challenges in 2021 which commits the FRC to a range of actions. Has provided guidance for and carried out thematic reviews of TCFD reporting, highlighting strengths and weaknesses, including for physical risks.

<p>Prudential Regulation Authority (PRA)</p>	<p>Regulates around 1,500 banks, building societies, credit unions, insurers and major investment firms.</p> <ul style="list-style-type: none"> • Promote the safety and soundness of PRA-authorized firms. • Specifically for insurance firms, to contribute to the securing of an appropriate degree of protection for those who are or may become policyholders; and • A secondary objective to act, so far as is reasonably possible, in a way which facilitates effective competition in the markets for services provided by PRA-firms. <p>As part of the Bank of England, it contributes to the delivery of the Bank's wider financial stability and monetary policy objectives.</p>	<ul style="list-style-type: none"> • The PRA has previously found that firms had insufficient capabilities to effectively manage climate-related financial risks and has published a set of climate-related supervisory expectations for firms. It also proposed a framework to assess the resiliency of the UK's largest banks, building societies and insurance companies, and the wider financial system to different climate scenarios (see Box 1.1 above). Where progress is insufficient and assurance or remediation is needed, the PRA will request clear plans and, where appropriate, consider exercise of its powers and use of its wider supervisory toolkit. • A key part of this toolkit is regulatory capital requirements, which help to ensure that firms have sufficient resources to absorb future financial losses. The traditional approach to sizing these risks for capital-setting purposes has been to assess historical losses associated with exposures. Firms are expected to make their own assessments of capital requirements due to climate change, but under the PRA's existing policies, where firms have significant climate-related financial risk management and governance weaknesses, it could impose an additional capital charge or scalar where appropriate. • Published a report under the most recent round of the Adaptation Reporting Power, and previous reports on the impacts of climate change on the banking and insurance sectors.
<p>The Pensions Regulator (TPR)</p>	<p>TPR is the public body that protects workplace pensions in the UK. Its statutory objectives include:</p> <ul style="list-style-type: none"> • Protect the benefits of members of occupational and personal pension schemes. • Promote and improve understanding of the good administration of work-based pension schemes. • Reduce the risk of situations arising which may lead to compensation being payable from the Pension Protection Fund. 	<ul style="list-style-type: none"> • Climate change sits under its strategic goal of ensuring that decisions made on behalf of savers are in their best interests. Trustees of occupational pensions schemes must prepare a Statement of Investment Principles (SIP) which includes consideration of climate change, such as incorporating members' views and its policy on engaging with asset managers on climate change. • TPR has stated it is concerned that industry surveys indicate that too few Defined Benefit and Defined Contribution schemes are giving enough consideration to climate-related risks and opportunities and that ownership of stewardship policies is too limited. It has said in response it will provide guidance, best practices, supervision and, where necessary, enforcement. • Published a report under the most recent round of the Adaptation Reporting Power.
<p>Source: Financial Conduct Authority (2021) <i>FCA Climate Change Adaptation Report</i>; Financial Reporting Council (2022) <i>Financial Reporting Council Annual Report and Financial Statements for the Year Ended 31 March 2022</i>; Prudential Regulation Authority (2021) <i>Climate-related financial risk management and the role of capital requirements</i>; The Pensions Regulator (2021) <i>Climate adaptation report</i>.</p>		

(c) Financial institutions

(i) Banks

The Bank of England has set a climate objective of ensuring the macroeconomy, the financial system, and the Bank of England itself are resilient to the risks from climate change and playing a leading role in supporting the transition to a net-zero economy.

Banks have made good progress but few have in-house modelling capabilities to quantify climate risk.

As part of its Climate Biennial Exploratory Scenario (CBES) it assessed the climate risk capabilities of Banks. It concluded that Banks have made good progress in integrating climate risk into their governance and reporting frameworks and identifying portfolios most at risk of climate change. However, many face challenges in quantifying this risk, with few having in-house modelling capabilities and most relying on a small number of third parties. Progress has been significantly hampered by a lack of standardised data of sufficient quality to carry out risk assessment, such as the location of corporate assets.

The Bank of England has said it will use the overall and firm-specific results to improve capabilities and identify where more action is needed. The Climate Financial Risk Forum and Network of Central Banks and Supervisors for Greening the Financial System (NGFS) have published guidance on scenario analysis and bridging data gaps, though these still highlight challenges and help rather than solve these issues.

Understanding how capital requirements should be adjusted is important to understand how assets are impacted and how they contribute to risk.

The Bank organised a research conference on climate change and capital in October 2022. Risk based capital adequacy frameworks need to integrate material climate-related risks, including those from physical climate impacts. The Bank of England should examine how capital requirements should be adjusted based on climate risks, both in terms of how assets are impacted by climate risk, but also how some assets create climate risk and contribute to greater societal risk and fragility.

Banks can also offer products like green mortgages which provide incentives for households and businesses to take adaptation action. To date, these have focused more on mitigation and energy efficiency, though BBVA recently created a new loan, the 'first syndicated line of credit linked to the water footprint'.

(ii) Insurers

Insurers have made good progress integrating climate risk but challenges remain in estimating losses and modelling capabilities for physical risks.

Physical risks affect both the assets and liabilities of insurers' balance sheets. As for banks, the Bank of England concluded that the insurers participating in the Climate Biennial Exploratory Scenario had made good progress integrating climate risk into their existing governance frameworks, but still noted numerous data challenges in estimating losses, and modelling capabilities for physical risks varied considerably among firms.

Insurers are well placed to seize the opportunities of adaptation to climate change in a way that benefits insurers themselves, policyholders and wider society. Insurers can improve awareness of climate change risk and provide informed advice on risk and loss mitigation, particularly for direct physical risks to property-related assets. This can both expand the market and increase the proportion of the population that is appropriately protected. Insurers can also feed into public policy and work to educate those who are or may become policyholders by providing guidance on how clients can become more resilient to risk.

This will reduce insurers' payout costs, and the costs to society overall. Premium pricing is also an important lever for institutional change. It may be more straightforward to price risk in some areas, for example, flood risk premiums, than others, such as the impacts of heatwaves on organisational performance.

There is a risk that if previously insured risks become uninsurable due to climate change this could create a protection gap, with customers unable to afford insurance to protect them from economic loss. In such circumstances, government and the insurance industry may conclude that insurance coverage is essentially a public good. Flood Re is an example of a scheme to prevent this from happening. While only for homes and not businesses or non-residential buildings, Flood Re provides good lessons on how the insurance industry can support climate change adaptation (Box 1.2). Consideration should be given to what replacement or similar insurance initiatives can and should look like and the contribution these can make to scaling private and household investment in climate adaptation.

Box 1.2 Flood Re and supporting adaptation

Flood Re is a not-for-profit fund owned and managed by the insurance industry. It caps domestic flood insurance prices to keep insurance premiums affordable in areas of higher flood risk.

When the cost of the flood-risk part of a customer's insurance policy rises above a certain level, the insurer can choose to pass the flood risk element to Flood Re for a fixed price based on the home's council tax band. If the customer makes a valid claim for flooding, the insurer will pay and Flood Re will reimburse from the fund.

Every home insurer in the UK must pay into the Flood Re scheme, providing a levy of around £135 million per year.

It is estimated that about 350,000 properties meet the eligibility criteria and benefit from Flood Re. Properties built after January 2009 are not eligible for Flood Re to avoid incentivizing home-building in flood risk area. Businesses are not covered by Flood Re.

Flood Re is planned to be in place until 2039, after which there will be a free market for flood risk insurance. In order to prepare for the end of the scheme, several transition options are being discussed. From April 2022, the government has allowed Flood Re to pay claims which include an amount for 'Build Back Better' – property flood resilient repairs up to a value of £10,000 above the cost of like-for-like reinstatement.

(iii) Pension schemes

The Pensions Climate Risk Industry Group states that 'All pension schemes are exposed to climate-related risks, whether investment strategies and mandates are active or passive, pooled or segregated, growth or matching, or have long or short time horizons. Many schemes are also supported by employers or sponsors whose financial positions and prospects are dependent on current and future developments in relation to climate change.'²⁹

Occupational pension schemes in the UK hold almost £2 trillion in assets, making them the largest single group of institutional investors in the UK. While their long-term investment horizons mean they are particularly susceptible to the impacts of climate change, the assets they hold mean they are also able to realise the opportunities from climate change and have a large influence over investment in achieving Net Zero and climate resilience.

Pension schemes are exposed to climate risks though a significant number are not yet assessing climate change effectively.

In October 2021, the UK was the first country in the world to require trustees of occupational pension schemes to identify, manage, and report on the climate-related risks and opportunities within their portfolios. Like other reporting initiatives discussed in this section of the report, this is a welcome development, though reviews of consideration of climate change by pensions schemes to date (for example, by The Pensions Regulator in Table 1.6 above) suggest that significant progress needs to be made for this to be effective.

A study by Mercer found that fewer than half (46 per cent) of the pension plans in Europe and the UK are considering the investment risks posed by climate change, according to a study of 850 retirement schemes across 12 European countries.³⁰ The House of Commons Work and Pensions Committee made recommendations to Government on improving pension stewardship of climate change. These included The Pensions Regulator continuously monitoring and updating guidelines for climate-related reporting based on implementation, consulting on whether default options should align to UK Government Climate Goals and for the Department of Work and Pensions to publish information about direct investment by pension schemes in its annual report.

(iv) UK public financial institutions

UK public financial institutions have started to incorporate climate change adaptation into their work but more needs to be done as they can be a key lever for the UK achieving its adaptation goals.

UK public financial institutions have started to incorporate climate change adaptation into their work, but this is still at an early stage, with little detail beyond general ambitions. UK public financial institutions are a key policy lever for the UK achieving its adaptation goals. They should create adaptation finance strategies, setting out how they will independently and collectively ensure that no viable UK climate adaptation project fails for lack of finance or insurance.

The UK should also aim to become a global leader in sustainability-linked instruments for adaptation. UK public financial institutions should support this through new sustainability-linked instruments tied to adaptation outcomes to help prime the market, potentially by offering guarantees to private issuers and lenders for adaptation-linked instruments that meet certain criteria.

UK Infrastructure Bank

The role of the UK Infrastructure Bank in supporting adaptation is discussed in Chapter 3.

British Business Bank

The British Business Bank is a government-owned business development bank which focuses on making finance markets work better for smaller businesses. It does not lend or invest directly but works with over 130 partners such as banks, leasing companies, venture capital funds and web-based platforms. Businesses apply for finance through these partners who, through working with the British Business Bank, can lend and invest more, especially to younger and faster growing companies. The stock of finance supported through the Bank's core finance programmes was £12.2 billion at the end of March 2022, supporting more than 96,000 businesses.³¹

The British Business Bank states it aims to drive sustainable growth and prosperity across the UK, and to enable the transition to a net zero economy. In its most recent annual report it states that it is working on understanding the material physical risks of its own operations and those of its delivery partners, and also identifying opportunities to fund more sustainable small business models and companies developing climate change solutions. For example, a company providing marine habitat restoration received £1 million in equity investment. It has not carried out specific research, as it has for smaller business and Net Zero, or have other programmes for climate change adaptation.

UK Export Finance

UK Export Finance (UKEF) aims to ensure that no viable UK export fails for lack of finance or insurance. It helps UK companies to win contracts by providing attractive financing terms to their buyers, fulfilling contracts by supporting working capital loans and helping UK companies get paid by insuring against buyer default.

UKEF published its first climate change strategy in September 2021, committing it to increasing its support to clean growth and climate adaptation, understanding and mitigating its climate-related financial risks and providing international leadership on climate change among export credit agencies and relevant financial institutions. It has put in place a £2 billion direct lending facility dedicated to financing clean growth projects and has stated a strategy of 'focused alignment' with the Sustainable Development goals to support adaptation and resilience but it is not clear what this means in practice.

British International Investment

British International Investment is the UK's development finance institution. It is an impact investor, and since 2012 has had a particular focus on creating jobs in Africa and South Asia. It decides which businesses to invest in by assessing if they will make a positive economic, environmental or social impact and how commercially sustainable and successful they will be.

In its most recent strategy, it committed that over the next five years, at least 30 per cent of its total new commitments by value will be in climate finance. It stated its investments will support adaptation and resilience, for example by investing in companies that offer data and analytics to enable climate-informed decisions and working with portfolio companies to change processes, practices and structures to avoid damage from physical risks, such as helping investees protect themselves from extreme flooding.

(d) Green gilts and bonds

(i) Green gilts and bonds in Government's Green Financing Framework

In June 2021 the Government published its Green Financing Framework to outline how funds leveraged from Government green bonds and gilts will be spent.³² Adaptation was included as one of the eligible green expenditures. The Government exceeded its target for green gilts, raising £16.1 billion in green gilts in 2021.^{33,34,35} However, it raised only £0.3 billion from sales of green saving bonds for the retail market as of March 2022.³⁶ This may be due to the interest rates offered (0.65% and then 1.30%) being relatively low for retail investors.

The Government published the allocation of proceeds for 2020-21 and 2021-22.³⁷ The only unique expenditure category for climate change adaptation was the EA Floods Programme, approximately £1 billion per year as described above. Government already provided similar funding for flooding before the introduction of the Green Bonds and Gilts. Climate change adaptation was one of multiple expenditure categories for the Global Environment Facility 7th Replacement (£38 million each year) and Green Climate Fund First Replacement (£250 million and £29 million). There are further opportunities to extend the green gilts and bonds offered by government and National Savings and Investment (N&SI) to allow investors and retail savers to contribute to the supply of capital for adaptation, and for government to ensure this is directed to new and a wider range of areas of adaptation in the UK.

Government gilts and bonds can be directed towards adaptation though this has not yet resulted in clear changes in funding.

(ii) Green, climate and resilience bonds

Bonds are IOUs which can be traded in financial markets. Borrowers issue bonds to raise money from investors in return for future payments. Borrowers could be governments, municipalities or businesses (corporate bonds) who want to raise money to help with investment and development.

Green bonds are where the proceeds from bonds will be exclusively applied to finance or re-finance projects with clear environmental benefits. The Climate Bonds Initiative estimated that US\$500 billion of green bonds were issued globally in 2021. Just under two-thirds of the green bond market is issued by corporates.³⁸ In 2021, the UK ranked 5th among countries in green bond issuance with issuance of around \$30 billion.

Climate bonds can be used to address climate change or increase resilience though are a small proportion of the current market.

There are alternate versions of these bonds, where the proceeds will be exclusively used to address climate change or increase resilience. The Climate Bonds Initiative is an international not-for-profit organisation. It developed the Climate Resilience Principles, which set out when activities can be certified under the Climate Bond Standard. Sector-specific climate resilience criteria are the primary reference for issuers of green bonds seeking certification and approach to mainstream adaptation and resilience. As of 2019, 15% of all green bonds issued globally (by value) have been certified under the Climate Bonds Standard & Certification Scheme.³⁹ Issuers must demonstrate that for the assets and activities (re)financed via the bond they understand the risks, have taken actions in response and will deliver resilience benefits over and above addressing the risks.

(e) Conclusions

Despite positive efforts by Government any other organisations, overall progress to incorporate adaptation is slow and needs to increase to be prepared for climate risks.

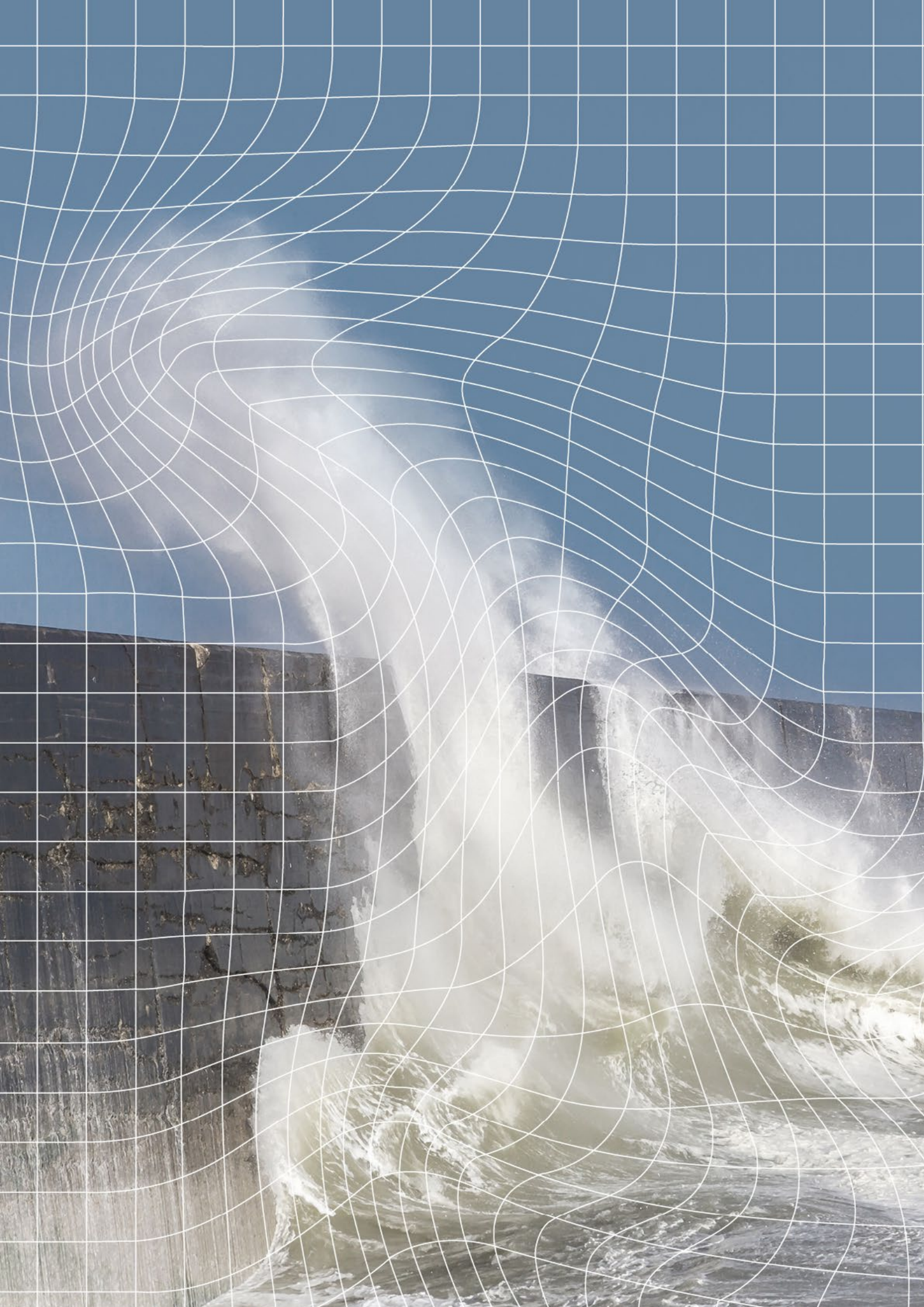
There have been considerable and ongoing efforts by the UK Government and other organisations to improve integration of climate change into financial reporting, regulation, and institutions over recent years. This has generally included requirements to assess and report on adaptation and physical risk. However, this is still seen as secondary to Net Zero. In combination with data and scenario analysis challenges for financial institutions and businesses, this has led to slow progress in incorporating adaptation and physical risk into finance and reporting. The current level of understanding of physical climate risks and investment in adaptation and maladaptation remains very low. Overall, the inclusion of adaptation in financial reporting, regulation and institutions is not yet sufficient to drive investment flows into adaptation.

Financial regulation and supervision must ensure physical climate risks are incorporated into risk management practices, to assess macro-level and systemic physical climate risks and resilience, to eliminate greenwashing, to encourage appropriate risk pricing and to set standards for resilience-linked financial instruments such as resilience bonds.⁴⁰ All financial institutions need to incorporate physical climate risks into their financial decision-making to ensure financial stability, that no viable adaptation project fails due to a lack of finance and insurance and to enable households and corporates to access capital and insurance for adaptation.

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Barriers to adaptation investment

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Introduction and key messages

Despite the economic benefits to society, there is a gap between the level of risk from climate change and the level of adaptation in response. Partly this arises due to differences between societal-level costs and benefits, and private costs and benefits from the perspective of an organisation, group or individual, but even where these are aligned other barriers can stop investment.

This chapter proposes a typology of barriers, based on research by Frontier Economics and Paul Watkiss Associates and the advice from an expert group set up by the CCC for this report. It then assesses these barrier types for five areas of adaptation across buildings, infrastructure and the natural environment. This assessment identifies progress to date in addressing these barriers and highlights the most important residual barriers to overcome for unlocking investment in adaptation.

The key messages of this chapter are:

- **There are a range of different barrier types for investing in adaptation.** Based upon a review of the evidence, five different barrier types have been identified:
 - **Market and financial barriers.** These barriers include; low or no revenues from reducing climate risks; high economic but low financial or internal rates of return; the presence of public goods; underdeveloped markets for buyers and sellers to trade; and discounting which makes benefits further into the future less attractive.
 - **Information barriers.** These barriers include; insufficient information on climate risks or high levels of uncertainty; information gaps on the benefits and effectiveness of different adaptation options and how these vary over space and time; and general awareness and understanding of adaptation, including by investors.
 - **Bankability barriers.** These barriers include; project complexity (time and resources); lack of experience and skills to deliver adaptation projects and financing; projects including a large number of actors (beneficiaries/organisations); low capacity of organisations and lack of interest in investments of low size.
 - **Policy and regulatory barriers.** These barriers include; regulation (or lack of) that provides insufficient or the wrong incentives; lack of coordination and cooperation (including across sectors); conflicting or competing policy objectives; policy uncertainty; and political economy and reluctance to change the status quo.
 - **Behavioural barriers.** These barriers include; low willingness to pay for adaptation or the belief it is government's responsibility; low perceived urgency of adaptation; difficulty to comprehend slow-onset or low probability risks; and social and cultural barriers.
- **The importance of these barrier types, and the solutions to overcome them, vary among different areas of adaptation, but lack of revenue streams is a fundamental barrier across areas.** The detailed examples that we assess in this chapter highlight some areas of positive progress but a range of outstanding barriers for delivering investment in adaptation.

In most areas of adaptation there is often not a clear revenue stream to provide returns to investors, this lack of a financial return in order to repay upfront funding is a fundamental barrier for attracting funding and finance from non-public sources. Information barriers and low levels of existing skills and expertise are also common.

This chapter is set out in two sections:

1. A typology of barriers for investing in adaptation
2. Exploring how barriers vary for different areas of adaptation

1. A typology of barriers for investing in adaptation

This section sets out the reasons why adaptation actions to address risks may not be funded or financed and a typology of barriers. To develop this typology the CCC commissioned an external research project carried out by Frontier Economics and Paul Watkiss Associates and received advice from an expert group set up by the CCC for this report.

Beneficial adaptation investments are not taking place because of the difference between an economic and financial perspective and other barriers.

Chapter 1 identified that many adaptation measures have higher economic benefits than costs. Despite this, there is a lack of investment in adaptation and the gap between actual investment and what is required to manage climate risks is expected to grow over time. This is partly due to the difference between an economic perspective, which considers all costs and benefits to society, and a financial perspective, which considers private costs and benefits from the perspective of an organisation, group or individual. This difference and other barriers mean that beneficial adaptation investments are not taking place.

There are many reasons why adaptation projects or parts of projects may not go ahead. Even the same type of project can face very different barriers due to changes in context, like different geographies. Adaptation is often carried out through incremental changes to a project, such as changes in infrastructure design, rather than a bespoke intervention, such as flood protection. Project barriers may then relate to the whole project, rather than the adaptation component. For example, infrastructure projects and nature-based solutions are difficult to finance whether or not they have adaptation components (Table 2.1).

Projects may not go ahead because of a rational decision based on high costs. In this report barriers are about worthwhile things not happening.

One reason why a project may not happen is because it is too expensive. This may not a barrier, but a rational decision that the benefit-cost ratio is too low. In this report barriers are about worthwhile things not happening. Given that the UK has a well-developed financial system and institutions, the absence of finance is more likely to be a symptom of barriers rather than the barrier itself, though there may be exceptions like finance for SMEs or local authorities.

The Government's Green Book has supplementary guidance for accounting for the effects of climate change,¹ however insufficient inclusion in project appraisals and discounting of benefits far into the future can still act as barriers to investing in adaptation.

To focus on the key barriers for investing in adaptation, this chapter proposes a typology of five broad barrier types. This is based on a literature review and case studies carried out in an external research project for the CCC by Frontier Economics and Paul; Watkiss Associates,² alongside consideration of other evidence (Box 2.1).

Box 2.1

A typology of barriers for investing in adaptation

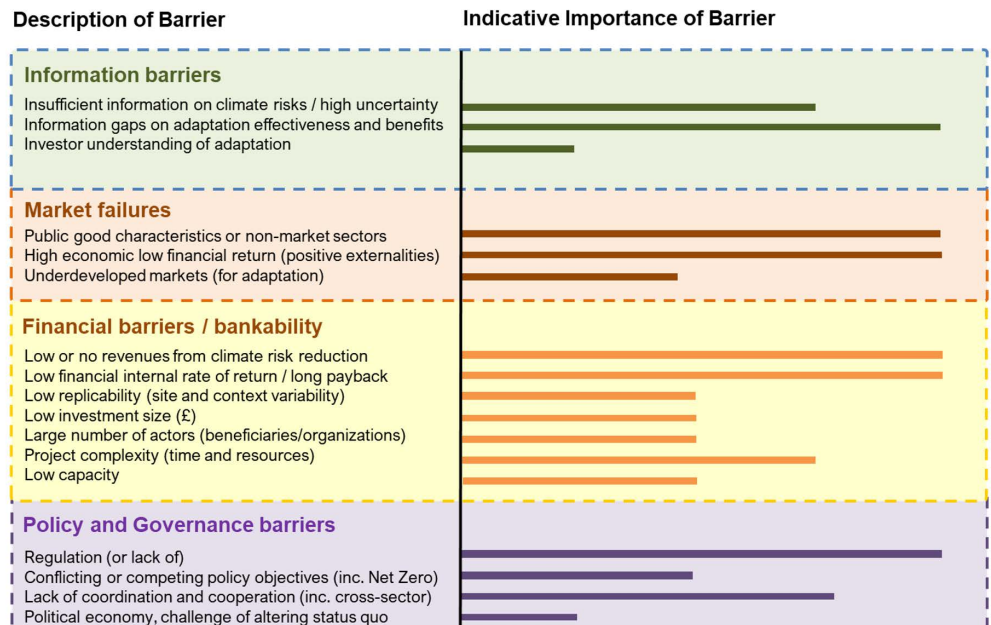
The literature review carried out by Frontier Economics and Paul Watkiss Associates identified different ways of identifying and understanding barriers for adaptation.

- One approach is traditional economic (welfare) theory: barriers are constraints that prevent the appropriate level of adaptation from a societal perspective, and broadly correspond to market failures which typically require government intervention.
- Other approaches focus more on real-world decision-making and experience. This highlights that barriers vary among different economic actors and contexts, and that there can be many practical challenges around the financing and investment of adaptation projects.

Figure B2.1 sets out the barriers as described by external research carried out by Frontier Economics and Paul Watkiss Associates and an assessment of their indicative importance for adaptation. This assessment is based on the literature review findings (the number of studies where the barrier is mentioned, and any evidence on magnitude), as well as the findings about the barriers experienced from the case studies. The overall scoring is presented below. Given the small evidence base, the ranking should only be considered indicative.

The importance of individual barriers will vary with public and private projects, for example, to raise private finance for adaptation, a revenue stream is likely to be a key condition. They will also vary with sector and risk, and for each adaptation project, due to the type of adaptation, finance sources, organisations, etc. The barriers are presented individually, but they will also involve interdependencies.

Figure B2.1 Barriers to adaptation investment and their indicative importance



Source: Frontier Economics and Paul Watkiss Associates (2022) for the CCC. *Barriers to Financing Adaptation Actions in the UK.*

As stated above, this report does not consider high cost in itself as a barrier. Based on the findings from the literature and other evidence, this report uses the following typology of barriers for adaptation investment:

- **Market and Financial Barriers**
 - Low or no revenues from climate risk reduction
 - High economic but low financial/internal rate of return
 - Public good characteristics or non-market sectors
 - Underdeveloped markets
 - Benefits are far into the future and made less attractive by discounting
- **Information barriers**
 - Insufficient information on climate risks/high uncertainty
 - Information gaps on adaptation effectiveness/benefits of different options and how these vary over space and time
 - Investor understanding of adaptation
- **Bankability barriers**
 - Project complexity (time and resources)
 - Lack of experience and skills to deliver adaptation projects and financing
 - Large number of actors (beneficiaries/organisations)
 - Low capacity
 - Low size of investment (£)
- **Policy and Regulatory barriers**
 - Regulation (or lack of) that provides insufficient or the wrong incentives
 - Lack of coordination and cooperation (including across sectors)
 - Conflicting or competing policy objectives
 - Policy uncertainty
 - Political economy and reluctance to change the status quo
- **Behavioural barriers**
 - Low willingness to pay for adaptation/belief it is government's responsibility
 - Perceived urgency of adaptation
 - Difficulty to comprehend slow-onset or low probability risks
 - Social and cultural barriers

Source: CCC Analysis; Frontier Economics and Paul Watkiss Associates (2022) for the CCC. *Barriers to Financing Adaptation Actions in the UK*; Adaptation Scotland (2022) *A Guide to Adaptation Climate Finance*.

Table 2.1
Challenges for different aspects of investing in adaptation projects

Aspect	Challenges
Project inception	<ul style="list-style-type: none"> • Projects are often developed for public funding and not commercial interest, so there is little commercial awareness of or appetite for these projects. • Equally, for projects that want to leverage private sector finance, they're not co-designed with the private sector from the outset which makes them harder to bank. • Projects are developed using different methodologies and approaches, which increases the difficulty of understanding and becoming familiar with adaptation projects.
Developing a pipeline of projects	<ul style="list-style-type: none"> • It can be difficult to build a portfolio of adaptation projects which could generate revenue and attract financing because often there is: <ul style="list-style-type: none"> – Lack of coordination among groups working on different adaptation projects – Different funding streams – Few shared objectives – Requires lots of collaboration
Assurance and standards	<ul style="list-style-type: none"> • It can be difficult to provide assurance that adaptation projects deliver the benefits they claim because: <ul style="list-style-type: none"> – In some areas the evidence of benefits is not monetised, quantified or has some degree of uncertainty. – There are some standards for resilience but these are not applied systematically, and therefore there are a lack of widely trusted and recognizable standards.
Revenue streams	<ul style="list-style-type: none"> • There is a lack of options to capture the benefits of adaptation as revenue. • In the cases of public goods, potential beneficiaries have an incentive to be 'free-riders' and let others pay for their benefits.
Revenue aggregation	<ul style="list-style-type: none"> • There is a lack of existing models for collecting and pooling revenues. • There are few examples of using public funding to blend with private, though this is increasing.
Governance	<ul style="list-style-type: none"> • Models exist for other areas but not adaptation, which include: <ul style="list-style-type: none"> – Clear legal means to collect revenue. – Effective stacking of benefits and revenue streams. – Special Purpose Vehicles backed by credit-worthy bodies.
Investors	<ul style="list-style-type: none"> • Investors may not be providing finance for adaptation because: <ul style="list-style-type: none"> – Adaptation is still relatively new for mainstream investors, who lack a common definition or shared understanding. – They lack decision-relevant data.

The next section of this chapter goes into greater depth to explore how these barriers and challenges may vary among different areas of adaptation.

2. Exploring how barriers vary for different areas of adaptation

The importance of individual barriers will vary by sector and risk, and for each adaptation project, due to contextual factors like the relevant geography, types of organisations involved and sources of funding.

This section explores barriers for five specific areas of adaptation for different sectors. It sets out an approach to assessing which are the most important barriers to meet investment needs for each of these areas of adaptation given their different characteristics and progress in addressing these barriers to date.

The five broad barrier types presented in the previous section (market and financial barriers, information barriers, bankability barriers, policy and regulatory barriers and behavioural barriers) will vary for different adaptation investment needs. The importance of individual barriers will vary by sector and risk, and for each adaptation project, due to contextual factors like the relevant geography, types of organisations involved and sources of funding. To explore how these barriers vary, and in the next Chapter how they might be addressed, we have explored five different areas of adaptation, which were introduced in Chapter 1 and are repeated below.

- Nature-based solutions to help manage flood risk
- Sustainable urban drainage systems (SuDS)
- Retrofitting homes to reduce overheating risk
- Climate-proofing energy and surface transport infrastructure
- Increasing drought resilience in the public water system

It is important to note that there will be further variations in barriers within each of these areas of adaptation. For example, barriers to investing in SuDS will vary for different SuDS projects, based on factors like the location.

To assess the most important barriers for each of these adaptation outcomes and identify more acute issues, we have considered several questions for each barrier type (Table 2.2). These questions help to identify inherent issues for each adaptation area as well as the extent to which these barrier types have been addressed to date.

Table 2.2

Questions used in this report to assess barriers to investing in adaptation and progress in overcoming them for different areas of adaptation

Barrier	
Market and Financial barriers	<ul style="list-style-type: none"> • Do viable business models with revenue streams or cost savings currently exist? • Is there evidence to suggest there has been any progress in developing them? • Do markets for this type of adaptation exist? • Is there a spatial disconnect between those receiving the benefits and where the adaptation outcome takes place? • Are investments mainly anticipatory or reactionary? • Are investments long-term and do the benefits take time to accrue? • Are benefits far into the future and therefore will be significantly affected by discount rates?
Information barriers	<ul style="list-style-type: none"> • Are available adaptation measures well known and understood? • Are the benefits of different adaptation measures well understood including how these vary over space and time? • Are the benefits of adaptation measures able to be measured using evidence and metrics? • Are the costs of adaptation measures known? • Are these costs likely to vary significantly for different contexts including over space and time?
Bankability barriers	<ul style="list-style-type: none"> • Do projects tend to be novel or replicable? • Do projects involve large degrees of complexity, due to site and context specificity or other factors? • Do projects require large numbers of stakeholders to be involved? • Are these stakeholders known or do they need to be identified before engaging? • Is there high or low confidence that expertise and skills exist to progress and deliver projects in this sector? • How difficult or easy is it to create and deliver a pipeline of projects?
Policy and Regulatory barriers	<ul style="list-style-type: none"> • Are there policy or regulatory frameworks in place? • Do existing regulatory frameworks: <ul style="list-style-type: none"> - Include adaptation? - Have incentives for actions which contribute towards adaptation? - Have flexibility to allow for a range of actions which contribute towards adaptation? - Create significant costs through required compliance or permissions?
Behavioural barriers	<ul style="list-style-type: none"> • Do the public and/or businesses expect that the government should pay for these investments? • Is there evidence to suggest willingness to pay through increased taxation? • Is there evidence to suggest willingness to pay through direct investment? • Do interventions/projects create conflicts requiring behavioural change to accommodate them such as changes in land use?

We have used these questions as a starting point for a review of various literature and case studies, including previous CCC Adaptation Progress Reports. For each barrier type within each adaptation area we have assigned a Red Amber Green (RAG) score based on expert judgement to indicate the importance of overcoming this barrier for achieving adaptation investment needs for this adaptation area. The review of evidence and scoring considered several high-level criteria, such as:

- The significance of the barrier type for this particular area of adaptation.
- Progress to date in addressing this barrier.
- How easy or difficult it is to address this barrier.

The results of our assessment and scoring across sectors are shown in Table 2.3 below. It is important to emphasise that barriers are still present even where there are Green ratings, they have just been assessed to be less significant or easier to overcome than other barrier types. The examples we have assessed highlight some areas of positive progress but a range of outstanding barriers for delivering investment in adaptation:

- **Nature-based Solutions to help manage flood risk:** Government has committed to public money for public goods in nature and land management, alongside initial plans to leverage private finance, but this has not yet overcome the barriers that exist to the required investment in adaptation. Key barriers to Nature-based Solutions (NbS) include a lack of information on costs and effectiveness, lack of accessible finance, governance challenges, and inappropriate regulation, legislation and procurement processes that fail to recognise the multiple benefits that NbS can deliver.
- **Sustainable urban drainage systems (SuDS):** Most flood defence systems (green or grey) are public goods requiring public funding. Government has previously committed broadly the right level of funding as suggested by cost-benefit analysis. However, this funding may be directed to the areas with the most beneficiaries, who could otherwise contribute, instead of other vulnerable areas with less capacity. Sufficient investment to address surface water flooding faces significant barriers due to information gaps, coordination among different organisations in a local area and the right regulatory incentives, for example, offered by Ofwat to water and sewerage companies to adopt sustainable drainage solutions.
- **Retrofitting homes to reduce overheating risk:** Home retrofit to address overheating risks typically should be privately financed, but is underfunded due to missing information and other barriers. There is a risk of maladaptation as due to poor information and low awareness, the wrong measures can be seen as substitutes, for example, air conditioning. Misalignment between who is responsible for investment and who receives the benefits means that policy should especially target decisions by homebuilders and landlords given these principal-agent barriers. Public support may be needed for poorer and vulnerable households.
- **Climate-proofing energy and surface transport infrastructure and Increasing drought resilience in the public water system:** The regulators of water, energy and transport systems need to enable the necessary investments to support the resilience of these systems.

There have been positive developments to address barriers in the water sector, due to established planning processes which incorporate climate change and approaches to accelerate infrastructure investment and raise awareness of investments in water efficiency in homes. Barriers remain for water, as well as for climate-proofing energy and surface transport infrastructure, and include providing insufficient or the wrong incentives and a lack of specific longer-term resilience goals and unclear expectations due to a lack of resilience standards.

Table 2.3
Most important barriers for selected adaptation investments needs

Barrier	Nature-based solutions to help manage flood risk	Sustainable urban drainage systems	Retrofitting homes to reduce overheating risk	Climate-proofing of energy and surface transport infrastructure	Increasing drought resilience in the public water system
Market and Financial barriers	R	R	R	R	R
Information barriers	R	R	R	A	A
Bankability barriers	A	R	A	G	G
Policy and Regulatory barriers	A	A	A	R	R
Behavioural barriers	A	G	A	G	A

More detail and the key evidence underpinning the scores in Table 2.3 is reported below in Tables 2.4 to 2.8 which cover each adaptation area in turn. The bullet points in these tables may describe; inherent issues which create barriers for delivering investment for this adaptation area; actions to address these barriers which have taken place and opportunities to overcome these barriers and reasons why realising these may be challenging and has not yet happened.

Table 2.4

What are the most important barriers for investing in Nature-based solutions to help manage flood risk?

Barrier	Notes	Importance
Market and Financial barriers	<ul style="list-style-type: none"> • There are general efforts underway to build the markets for Nature-based solutions (NBS) across the UK (market making activity), with efforts to create revenue streams but the regulation and policy around them is relatively immature. • There are multiple benefits of Natural Flood Management (NFM), including: improving habitats, biodiversity and capturing carbon. There is the potential to generate revenue particularly through capturing carbon, though there is limited evidence of this to date. This would be helped if investor rules allowed the aggregation of different environmental services and benefits in a single product, which is also known as stacking. • External factors in a catchment can affect performance-based payments. • There can be misalignment of business and project cycles. Business cycles tend to be three-year, while NFM projects tend to be longer term. This can result in a misalignment between revenues, and capital and interest payments to investors. 	Higher
Information barriers	<ul style="list-style-type: none"> • Projects are context specific which can make effectiveness uncertain. • Benefits can be non-monetary and hard to measure. • There are challenges for markets and trading platforms to include long-term monitoring of outcomes and the costs of verification. The difficulty of monitoring outcomes is linked to uncertainty around the exact outcomes of catchment market projects. 	Higher
Bankability barriers	<ul style="list-style-type: none"> • Projects can be highly context-specific, which increases transaction costs, as there are no economies of scale and each project must be studied in full to understand the uncertainties around their effectiveness in different locations and for differing climate hazard severity. • Multiple NFM schemes are often needed across a large catchment area to have a meaningful impact on flood risk. • Schemes can be complex to set up. Schemes often require convincing a range of authorities responsible for the different elements of the landscape to bring together their different requirements. • The overall pipeline is low in volume and deals are often small. 	Medium
Policy and Regulatory barriers	<ul style="list-style-type: none"> • A lack of an institutional framework • Co-ordination failure. • Prescriptive rather than outcome-based regulation can limit the ability of projects to deliver a wide range of environmental benefits. 	Medium
Behavioural barriers	<ul style="list-style-type: none"> • There is evidence of willingness to pay by private investors, but it is often linked to government help or to wider benefits such as carbon rather than adaptation benefits. • Multiple beneficiaries and a range of actors can undermine willingness to pay, particularly if benefits are uncertain. 	Medium

Source: CCC (2021) *Progress in adapting to climate change: 2021 Progress Report to Parliament*; CCC Analysis of; Frontier Economics and Paul Watkiss Associates (2022); Price, R. (2021) *Nature-based Solutions (NbS) – what are they and what are the barriers and enablers to their use?*; Environment Agency (2021) *Using the power of nature to increase flood resilience*; Broadway Initiative (2020) *Accelerating private investment in nature-based solutions*; Terranomics for WWF (2002) *Nature Based Solutions – a review of current financing barriers and how to overcome these*; Financing Nature Recovery UK (2022) *Scaling Up High-Integrity Environmental Markets Across The UK*.

Table 2.5

What are the most important barriers for investing in Sustainable urban drainage systems?

Barrier	Notes	Importance
Market and Financial barriers	<ul style="list-style-type: none"> • There are some potential revenue streams identified for SuDS including: a reduction in site owner drainage bills where adaptation allows disconnection from the public sewer, outcome payments from water utilities and nutrient trading. Evidence from the IGNITION project, Manchester UK, shows limited success to date, primarily due to drainage bill savings being low compared to project delivery costs. • Uncertainty in future water charging regimes mean that it is difficult to guarantee or predict future revenue streams. • Some SuDS may provide multiple benefits, including improving habitats, biodiversity, recreation space and capturing carbon. There is the potential to generate revenue from these benefits, though there is limited evidence to date. • Investments are often anticipatory, with benefits extending far into the future, meaning discounting can reduce their attractiveness. Benefits may also be misaligned to those who accrue the costs. 	Higher
Information barriers	<ul style="list-style-type: none"> • B&ST (Benefits Estimation Tool – valuing the benefits of blue-green infrastructure, CIRIA) is a tool which includes 15 monetised and 3 non-monetised benefit categories to help overcome information gaps. It is not clear how widely the tool is used and it does not consider performance under multiple climate futures. • There is high uncertainty around the amount of benefit (returns) that an intervention will deliver for a specific location – or to other locations downstream. This uncertainty is associated with the effectiveness of the intervention and the future revenue stream. There are few existing baselines for projects to be measured against. • Evidence suggests a low-risk appetite within the public governance environment. • While the unit costs for SuDS components can be identified (e.g. permeable paving per m²), this varies due to site specific factors, such as the size of the catchment area. Each site requires specific technical analysis and design. 	Higher
Bankability barriers	<ul style="list-style-type: none"> • Projects are usually highly site and context specific and will include many stakeholders. • Multiple SuDS interventions (a pipeline of schemes) – are usually needed within a residential area to have a meaningful impact on flood risk. • The IGNITION case study demonstrates a pipeline of SuDS projects can be created, but can also collapse due to construction delays. • Capacity and skills shortages are an issue for multiple aspects of flood management, such as installation, engineering, programme management and spatial planning. These are key for delivering NBS, SuDS and aligning with Net Zero aims. • There are difficulties associated with multiple layers of flood risk responsibility, particularly for securing future maintenance of adaptation schemes. • The National Infrastructure Commission has recommended that government should require upper tier local authorities, water and sewerage companies and where relevant, internal drainage boards to produce joint investment plans for managing surface water. 	Higher

Policy and Regulatory barriers	<ul style="list-style-type: none"> • The Partnership Funding formula determines how much grant-in-aid schemes get and how much they have to make up in other contributions. Updated payment rates for surface water flood risk, benefits to the environment, and wellbeing, may improve the likelihood of SuDS projects getting funded. • The planning system does not provide sufficient incentives for high-quality SuDS with multiple benefits. As yet, there have been no updates to the Planning Practice Guidance, where issues of 'grey' vs 'green' SuDS, their adoption and wider benefits of green infrastructure could be covered. • The IGNITION project found that only 4 of 9 water utilities in England currently offer the required charging bands mechanism for non-domestic buildings in order to use the reduction in drainage bills as a revenue stream. • A lack of technical standards makes it difficult to prove the practical case for SuDS – which are not yet mandatory or regulated via standards. Furthermore, there is a lack of longer-term resource funding and clarity of responsibility for their maintenance. 	Medium
Behavioural barriers	<ul style="list-style-type: none"> • There is some national and international evidence of 'willingness to pay' and valuing of the multiple benefits (e.g., aesthetic, biodiversity) provided by SuDS. For example, there is international evidence from the USA of successful community contributions for flooding, with local populations voting to accept additional payments. • However, a lack of public awareness about SuDS means it is challenging to get contributions from beneficiaries, and many schemes remain funded by local government and agencies. • There are some established routes for non-government contributions, like Partnership Funding. Some local authorities and groups are familiar with how to successfully apply for grants. 	Lower
<p>Source: CCC (2021) <i>Progress in adapting to climate change: 2021 Progress Report to Parliament</i>; CCC Analysis of; Frontier Economics and Paul Watkiss Associates (2022); Johnson & Geisendorf (2022); <i>Valuing ecosystem services of sustainable urban drainage systems: A discrete choice experiment to elicit preferences and willingness to pay - PubMed (nih.gov)</i>; IGNITION (2022)</p>		

Table 2.6

What are the most important barriers for investing in retrofitting homes to reduce overheating risk?

Barrier	Notes	Importance
Market and Financial barriers	<ul style="list-style-type: none"> • There is an incentive for homeowners to pay for increased comfort, and/or the potential avoided counterfactual of air conditioning (cost of electricity), but there is a lack of revenue stream to attract finance. • Incentives for developers are low, as they bear the cost/risk but households enjoy the benefits. • There is a lack of a 'payback period' which exists for decarbonisation retrofit through lower bills and improved EPC rating, which helps homeowners justify investments. The overheating retrofit 'payback' for residents is improved comfort and health, which is a general welfare benefit (and can lead to a productivity benefit) but isn't monetised. • There is no equivalent of EPC for overheating, though a few tools have been produced such as the Good Homes Alliance's overheating assessment tool. • Investments are often anticipatory with benefits extending far into the future so discounting can reduce their attractiveness. • Green mortgages are a potential solution, through offering an incentive of reduced mortgage rates, based on whether the house is resilient to future climate. To date green mortgages have focussed more on Net Zero and energy efficiency than resilience to the future climate. New metrics such as those published by XDI on climate risks to the address based could help, though did not include heatwaves. 	Higher
Information barriers	<ul style="list-style-type: none"> • There is low information on over-heating risks (current and future) and how these vary for different contexts such as building types, locations and occupancy. • There is low awareness of the negative health and wellbeing impacts of overheating at home and potential knock-on impacts on productivity/ educational attainment. This lack of awareness may lead to underinvestment in cooling measures. • There is low awareness of how to reduce overheating in homes. This is due to a very heterogenous building stock and range of available passive cooling options. The costs and effectiveness of options can vary significantly across the building stock. • There is a risk of maladaptation as the wrong measures can be seen as substitutes, for example, air conditioning. For households able to afford air conditioning, there is a negative externality present. Air conditioning expels hot air into the urban environment, thus increasing outdoor temperatures and the urban heat island effect. There is an information gap about this, and the impact on the surrounding environment may not impact an individual's use of air conditioning. 	Higher
Bankability barriers	<ul style="list-style-type: none"> • There is a very large number of individual actors; thousands of developers / households, with high heterogeneity. People may perceive overheating differently and have varying desires to cool down their homes during hot weather. • There is likely a skills shortage as there is currently low demand for installing cooling measures. In addition, the way measures are installed impacts their performance. 	Medium
Policy and Regulatory barriers	<ul style="list-style-type: none"> • There is a lack of requirement for overheating measures in building codes. Building regulations for new homes which require an assessment should help address this. 	Medium
Behavioural barriers	<ul style="list-style-type: none"> • The adaptive capacity of renters is limited and they may have less knowledge of the options available to them. Tenants benefit from adaptation but have less agency to adapt buildings. • Retrofitting certain building types such as blocks of flats requires coordination between residents. This may be difficult in certain circumstances, for example in a block of flat with different tenancy types (leasehold, freehold, tenant, social housing) 	Medium

residents) who have different characteristics and perhaps willingness to pay for building works.

- Coordination may also create a cost issue. Doing some building works could be cheaper if different houses coordinated to share certain costs (e.g. scaffolding), but may make it more challenging to initiate action.

Source: CCC (2021) *Progress in adapting to climate change: 2021 Progress Report to Parliament*; CCC Analysis of; Frontier Economics and Paul Watkiss Associates (2022); Good Homes Alliance (2019) *Overheating in new homes; Tool and guidance for identifying and mitigation early stage overheating risks in new homes*; XDI (2021) *UK National Physical Climate Risk Report for Mortgage Lenders*.

Table 2.7

What are the most important barriers for investing in climate-proofing of energy and surface transport infrastructure?

Barrier	Notes	Importance
Market and Financial barriers	<ul style="list-style-type: none"> Infrastructure potentially provides stable revenue streams. Climate-proofing helps reduce long-term losses through reduced risks though is not necessarily linked to new revenues. Climate-proofing is largely anticipatory, though repairing and improving the condition of assets provides the opportunity for reactionary investment. 	Higher
Information barriers	<ul style="list-style-type: none"> There is a new Physical Climate Risk Assessment Methodology (PCRAM) produced by the Climate Coalition for Resilient Investment. There is a lack of data sharing due to confidentiality concerns. Limited levels of understanding of interdependencies can undermine the overall understanding of risk and the benefits of investments. The scale of investment and the true costs and benefits are difficult to estimate if it is not clear what standard of protection is required. There is a lack of data on current disruptions to services and the impacts of weather which can undermine the case for investment. 	Medium
Bankability barriers	<ul style="list-style-type: none"> Climate-proofing requirements differ a lot based on relevant climate risks for a particular asset and geography. The delivery of major projects and long-term decisions can create uncertainty and risks for investors. The National Infrastructure and Construction Pipeline exists but does not give a clear idea of where or how private finance can deliver projects. The UK Infrastructure bank has been established to stimulate investment in infrastructure though it is focussed more on Net Zero and less on climate resilience. 	Lower
Policy and Regulatory barriers	<ul style="list-style-type: none"> There is a lack of specific longer-term resilience goals and unclear expectations due to a lack of resilience standards. Regulators seek a balance between rewarding investors with a reasonable return and ensuring consumers do not pay too much. 	Higher
Behavioural barriers	<ul style="list-style-type: none"> There can be affordability and distributional concerns if climate-proofing requires, or is perceived to require, higher charges or bills for customers. Businesses may perceive the National Infrastructure and Construction Pipeline as uncertain and be reluctant to provide private finance. 	Lower

Source: CCC (2021) *Progress in adapting to climate change: 2021 Progress Report to Parliament*; CCC Analysis of; Frontier Economics and Paul Watkiss Associates (2022); CBI (2020) *Investing in Infrastructure*; National Infrastructure Commission (2021) *The Second National Infrastructure Assessment: Baseline Report*.

Table 2.8

What are the most important barriers for investing in Increasing drought resilience in the public water system?

Barrier	Notes	Importance
Market and Financial barriers	<ul style="list-style-type: none"> Water companies issue debt or raise equity to finance projects so they can make investments that are paid off by future years' revenue. Investors require a return on finance, which customers pay over a long period. This is the case for England, where water is in private ownership but may differ for public ownership, such as for Scotland. There are examples of green bonds being used to finance parts of environmental investments, which can include adaptation alongside other benefits like reduction of greenhouse gas emissions (for example Anglian Water's issue of green bonds). There tends to be more anticipatory investment in this sector due to more long-term planning. There can also be reactionary investment for things like burst pipes or water mains. 	Higher
Information barriers	<ul style="list-style-type: none"> Water Resource Management and Asset Management Plans are established processes which involve modelling of climate impacts on water availability. There are some clear metrics of benefits such as changes in the supply-demand balance, though understanding of impacts and investment to achieve resilience to more extreme droughts is less developed. There are low levels of awareness of current water usage and water-efficiency improvements in homes, though increased metering and water-labelling, which is due to be introduced, should improve this. 	Medium
Bankability barriers	<ul style="list-style-type: none"> Direct procurement for customers (DPC) aims to result in water companies competitively procuring more aspects of an infrastructure project, including financing for the project. System-level investments and transfers are likely to vary and be more complex due to different geographies, creating an absence of scale economies. Property-level investment is likely to be less variable. When repairing or replacing assets, this work may focus on a least-cost approach and miss opportunities to improve resilience due to a lack of existing skills, expertise or incentives. 	Lower
Policy and Regulatory barriers	<ul style="list-style-type: none"> Targets set in the Price Review determine planning. Ofwat's determinations set funding levels, and consider trade-offs with higher bills for consumers. It has been historically difficult to build major new infrastructure, both directly related to adaptation and which needs to be climate-proofed. The Regulators' Alliance for Progressing Infrastructure Development (RAPID) in England has been established to accelerate the development of new water infrastructure. The Environment Agency's National Framework proposes for regional groups to work with local business sectors that use non-mains supplies, especially key abstractors, to seek cross-sector solutions including funding arrangements. The Water Industry Natural Environment Programme (WINEP) provides information to water companies on the actions they need to take to meet environmental legislative requirements. This provides guidance but can also limit the flexibility of actions that can be taken, as opposed to outcome-based regulation. 	Higher

<p>Behavioural barriers</p>	<ul style="list-style-type: none"> • Previous water company customer engagement has demonstrated a willingness to avoid the most serious drought restrictions, though not necessarily less serious restrictions. • People may believe it is unfair to have to pay higher bills if they perceive that issues such as leakage are not being effectively managed. 	<p>Medium</p>
<p>Sources: CCC (2021) <i>Progress in adapting to climate change: 2021 Progress Report to Parliament</i>; CCC Analysis of; Frontier Economics and Paul Watkiss Associates (2022); National Infrastructure Commission (2021) <i>The Second National Infrastructure Assessment: Baseline Report</i>.</p>		

Conclusions

This chapter has identified a range of different barrier types for investing in adaptation. Based upon a review of the evidence, five different barrier types have been identified:

- Market and financial barriers
- Information barriers
- Bankability barriers
- Policy and regulatory barriers
- Behavioural barriers

The chapter then explored how these barriers varied among five different areas of adaptation. This highlighted that a lack of revenue streams and business models, in addition to and influenced by various information gaps, are important barriers to delivering adaptation investment across sectors. Skills and capacity, the role of regulation and behavioural barriers exacerbate these and create additional challenges.

There are examples of tools and guidance for information barriers, or schemes to try and capture revenue streams from co-benefits or other cost-savings. But progress remains limited given the investment needs and further options are considered in the next chapter.

There are various examples within these adaptation areas of attempts and opportunities to overcome the different barriers, such as new tools and guidance to address information barriers, or schemes to try and capture revenue streams from co-benefits or other cost-savings. These provide some indication of the types of actions which will be required to deliver the necessary level of investment for adaptation. There are also linkages and interdependencies among the barrier types, and therefore coordinated action will be required if significant progress is to be made.

Endnotes

¹ Defra (2020). *Accounting for the Effects of Climate Change: Supplementary Green Book Guidance*.

² Frontier Economics and Paul Watkiss Associates (2022) for the CCC. *Barriers to Financing Adaptation Actions in the UK*.



Instruments for adaptation investment

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Introduction and key messages

The previous chapter identified numerous barriers to broadening the range of investment sources to build resilience to climate change impacts in the UK. The primary identified barrier for many areas of adaptation was the lack of clear monetised revenues arising from improved resilience that enable upfront capital borrowed from the private sector to be paid back. This chapter focuses on the range of revenue streams that could enable adaptation projects to secure investment.

The key messages of this chapter are:

- **Public investment will be critical for building climate resilience.** Public funding represents the most significant investment source for many key areas of adaptation today. Continued and expanded public funding for adaptation will be a cornerstone of building a well-adapted UK. This is particularly the case for adaptation that results in widely distributed (public) climate risks reduction benefits for many beneficiaries (such as flood defences, nature restoration and transport infrastructure). However, public funding alone will not be sufficient to fully adapt to a changing climate and a broader set of investment sources outside the public sector will be required.
- **Broadening the sources of adaptation investment depends on building revenue streams to pay back upfront investments.** The most important factor increasing investment in adaptation beyond the public sector is the availability of revenues. This will often require innovative methods to measure the value of climate risk reduction and associated co-benefits. Appropriate revenue streams to broaden the range of investors into adaptation vary across adaptation areas. Often a combination of revenue streams is needed to make adaptation projects investable.
- **There are proven examples of successful private sector investment in adaptation across a range areas.** A key reason many private actors have been hesitant to invest in adaptation to date is uncertainty that business models have been proven. However, the number of successful case studies is growing. This demonstrates that with effective implementation and management barriers can indeed be overcome. These examples can serve as a template for wider adoption.
- **Developing robust and predictable regulatory frameworks will help attract investment into adaptation.** All sectors and levels of society have a role to play in adapting to climate change, especially the private and financial sectors. To realise the full potential of these sectors, Government must lead with appropriate regulatory and policy frameworks to provide positive incentives.

This chapter is set out in three sections:

1. Revenues and financing for adaptation investment
2. Identifying appropriate revenues for adaptation
3. Cross-cutting conclusions

1. Revenues and financing for adaptation investment

Access to capital and revenues are both essential parts of securing investment.

Investment into adaptation depends on both access to finance and the availability of revenues to repay the finance over time.

- **Financing** is the source of the upfront capital needed to create the adaptation good or service. When this is provided by the private sector (e.g. debt) this will need to be paid back over time together with interest.
- **Revenues** are the cashflows (additional income or avoided cost) that ultimately pay for the provision of the adaptation goods and/or service. Revenues are needed in order to repay borrowed capital and to pay for the operational expenditures needed to maintain functioning of the adaptation good and/or service.

Revenues that can help fund adaptation investment can come from public funding, user fees, other private revenue streams or households.

Revenue streams to support adaptation investment can be categorised into four types each with their own characteristics:

- **Public and philanthropic funding:** Funding provided directly from the national or local government or its agencies. This could be in the form of funding for ongoing operational expenditures or capital funding (e.g. grants) for upfront investment. Philanthropy provides non-refundable funding from sources including high net worth individuals, family offices and foundations.
- **User fees:** Where users must pay to use an asset or service (e.g. electricity or water systems) – there is potential for adaptation to be funded through increases in the bills of the users. This revenue stream is used in the regulated infrastructure sectors to support investment in general resilience – for example payments for water system infrastructure resilience from water bills governed through the sector regulator (Ofwat).
- **Other private revenues:** Monetary transfers for benefits arising from adaptation (e.g. maintaining the resilience of ecosystem services). Where adaptation provides measurable financial benefits or co-benefits to others and can be operationalised through markets this can be a possible revenue stream to support adaptation investment. Alternatively, where adaptation actions undertaken by business are expected to lead to cost savings (such as avoided climate impacts on the business in the future) this can be used to justify the necessary inward investment for adaptation to occur.
- **Household expenditure:** Some adaptation actions do not lead to revenue streams despite their benefits. For example, retrofitting homes to reduce overheating risks makes houses more pleasant to live in and improves the welfare of its occupants but these benefits are not monetised. In these instances, the adaptation investment is funded directly from household expenditure.

The next section will explore the candidate revenue streams suitable to support investment in several different areas of adaptation. Table 3.1 shows the range of adaptation areas covered in this chapter and the potential revenue streams considered for each.

The specific revenue streams considered here are not exhaustive, but instead aim to document key opportunities and challenges associated with each. Case studies illustrating how these revenue streams have been used within specific projects are included throughout. These are drawn from the commissioned report by Frontier Economics and Paul Watkiss Associates published alongside this report.¹ Additional case studies can be found in a report by the Chair our Independent Advisory Group published alongside this report.²

Table 3.1

Revenues sources to support adaptation investment

Sector	Adaptation action	Public funding	User fees	Other private revenues	Household expenditure
Natural Environment	Nature-based solutions (NbS) to manage flood risk	Environmental Land Management schemes funding		Impact investments Ecosystem credits Payments for ecosystem services	
Built Environment	Increased use of sustainable drainage systems (SuDS)	Flood and Coastal Erosion Risk Management funding		Drainage band model	
Buildings	Homes retrofitted to reduce overheating risks	Energy efficiency funding			Homeowners/ occupant expenditure
Energy, transport & water	Climate-proofing energy transport and water infrastructure	Taxpayer expenditure on road and rail network	Energy and water bills		

2. Identifying appropriate revenues for adaptation

This section assesses potential revenue streams to support adaptation investment.

This section assesses potential revenue streams to support investment in a range of areas of adaptation. For each area the characteristics, strengths and limitations of specific potential revenue streams are discussed, and case studies are presented to show how projects have successfully used the revenue stream to secure investment.

(a) Nature-based solutions to reduce vulnerability to flood risks

Nature-based solutions (NbS) can help build the resilience of the natural environment to climate change impacts through actions to protect, sustainably manage and restore natural or modified ecosystems* in both urban and rural areas. This in turn helps bolster the ability of humans to withstand the impacts of climate change, through strengthening both ecosystem and social resilience, and building adaptive capacity.

Nature-based solutions typically create widespread public benefits.

NbS for adaptation typically support the flow of, or sustain, a wide range of public goods such as disaster risk reduction, carbon sequestration and agricultural productivity. These public goods have many beneficiaries. For example, NbS on rural land in the upper reaches of river catchments can protect downstream towns and cities from flood damages. These beneficiaries generally cannot be excluded from increased resilience despite not contributing to up-front investment costs.

(i) Public funding - Environment Land Management schemes funding

The Environmental Land Management schemes (ELMs) could be a source of public funding into nature-based solutions to help manage flood risks.

The Environment Act 2021 will establish incentives for landowners to implement NbS through the Environmental Land Management schemes (ELMs). The implementation plan for ELMs at the time of writing includes a commitment to reduce the risk of harm to people, the environment and the economy from natural hazards including flooding. Protection from, and mitigation of, environmental hazards is included in the list of public good outcomes that could be eligible for payments under the ELM scheme.

If designed and implemented well, payments from ELMs could be a valuable revenue stream to support investment in NbS to reduce vulnerability to flood risks due to the following characteristics:

- **Blending with other financial instruments:** Results from ELM tests and trials suggest there is strong potential for co-investment with private sector mechanisms. Blending public with private funding sources could allow projects to be deployed at greater scale and ambition and demonstrate further proof of concept for private green finance initiatives to fund projects without available public revenues.
- **Benefit certainty:** ELM payments will be based on delivery of specific adaptation outcomes, such as natural flood management (NFM). This will help ensure that revenues are directly driving measurable adaptation benefits.

* Both land based and marine based.

- **Scalability:** The 'Local Nature Recovery' and 'Landscape Recovery' schemes under ELM provide an opportunity to deliver adaptation outcomes at scale to help make this funding stream support effective catchment-wide adaptation. However, their effectiveness will depend on take up and require successful collaboration amongst landowners.
- **Replicability:** ELM funding could be allocated to project locations right across England, meaning that the scheme can support a wide variety of projects and locations under a single structure. Financial support under the scheme should be prioritised for areas where the investment need/climate risk is most urgent.
- **Impact on public finances:** ELM funding will be sourced from budgets reallocated from contributions to the EU Common Agricultural Policy. However, the Government funding commitment under the scheme is unclear in the long-term (beyond 2027). A sufficiently large budget to ensure that worthy projects can be supported to improve climate resilience around the country is necessary to ensure the schemes have impacts commensurate to the size of the climate risks.
- **Stimulus for new private markets:** Projects which successfully demonstrate proof of concept through delivering adaptation benefits under ELMs outcomes-based schemes will help stimulate and de-risk private sector investment through the development of novel and robust frameworks to quantify the climate resilience benefits. These methods can provide templates for other revenue streams.
- **Quality for adaptation:** Identified outcomes (including, for example, those that build resilience to flood risk) under ELMs must be met to receive payment. This will require the effective monitoring to be in place. However, it is not clear as of yet which environmental standards and codes projects will be required to adhere to.

ELM payments are a potentially highly significant revenue stream for NbS, but details of how the schemes will support resilience remains unclear alongside long-term budget certainty.

There is significant potential for public funding sources to support NbS for flood risks, via ELM payments. Streams such as ELM could additionally leverage private investment alongside public money in encouraging delivery of climate adaptation outcomes, including flood management. They can also help establish robust methodologies to quantify adaptation benefits, which are needed to enable private revenue streams to also support NbS, particularly around deliverability and value for money. Establishing clarity around how the ELM schemes will operate, ensuring they have long-term budget certainty, and that they are accessible to a range of potential projects at many scales is a priority to ensure that this important revenue stream is effective for supporting investment in adaptation.

(ii) Other private revenues

Investment in NbS has traditionally been sourced from public sector funders.³ However, there is evidence of growing interest and opportunities for institutional investors to engage in the NbS market, and regulations under the Environment Act should help enable greater participation by private finance (Box 3.1).

There are a number of candidate private investment sources that could help support investment in NbS to reduce flood risk (Table 3.2). These generally depend on markets for ecosystem services created by regulation (e.g. biodiversity net gain) or corporate Environmental, Social and Governance (ESG) commitments. Climate resilience benefits may often be realised as a co-benefit to a wider environmental benefit (such as carbon storage) that is monetised within these markets.

Private revenues to support investment in NbS depend on markets for ecosystem services, often driven by regulation.

Box 3.1

Regulations under the Environment Act 2021 to support increased participation by private finance

The Environment Act 2021 makes Biodiversity Net Gain (BNG) a condition of planning permission, requiring all developers to demonstrate how they will deliver a 10% improvement to the biodiversity value of any application site. The new requirement is thought to come into law by late 2023. To achieve BNG, proposals must follow a four stage 'mitigation hierarchy' which compels planning applicants to avoid harm in the first instance, then mitigate, and finally compensate for losses on-site, off-site, or through a combination of the two solutions.

Potential for new markets facilitated by the private sector

A key feature of the Environment Act is the intention to establish a new "compliance market" that will ensure the supply of off-site biodiversity units to developers. The UK Government has not proposed to establish a centralised trading platform for biodiversity units, but instead will rely on the private sector to facilitate the market and fulfil the required roles. This will involve the support of various private sector suppliers and intermediaries, with brokers, habitat banks, large land agencies and start-up platforms likely to all play roles in facilitating such transactions.

The market for biodiversity units will be required to function alongside other environmental markets, such as nutrient trading and the Woodland Carbon Code, as well as UK Government funded programmes. Landowners and managers will be permitted to combine payments for biodiversity units with other payments for environmental services, provided they are paying for distinct and additional outcomes (e.g. carbon sequestration and biodiversity benefits).

Habitat created or enhanced will be eligible for registration and sale of the associated biodiversity units.

The ability to fulfil biodiversity gains off-site will enable landowners and managers to create or enhance habitats anywhere in England for the purposes of selling biodiversity units to developers requiring them. Planning authorities will also be able to sell biodiversity units from their own land. Developers that exceed the statutory requirements for BNG on a given development site, may also be allowed to sell the excess biodiversity units generated.

Habitat banking* will also be considered to smooth the supply of biodiversity units and promote market liquidity by carrying out the work to establish the habitat in advance and "banking" the resulting units until they are required by developers. Habitat banking facilitates multiple smaller parcels of land to be incorporated, enabling the delivery of larger and more strategic sites.

Markets for NbS benefits need to be designed well to avoid risks of unintended consequences.

Consistent regulation and enforcement of private NbS markets is important for ensuring standards of quality without limiting NbS implementation. Emerging markets such as those for voluntary carbon offsets and biodiversity credits will require appropriate and well-considered regulation and enforcement to ensure that financial incentives do not incentivise poor quality or negatively impactful projects and deliver across many environmental benefits (including improved climate resilience).[†]

* Habitat banking describes the leasing of parcels on which conservation activities are conducted to generate habitat or biodiversity 'credits for trade on markets', i.e. areas of land where environmental restoration has taken place that can be bought to compensate for unavoidable habitat destruction through development.

† The CCC's 2022 report on 'Voluntary Carbon Markets and Offsetting' investigates measures to ensure the integrity of carbon offset projects, in particular, avoiding potential damage to other priorities such as climate adaptation and biodiversity, through considered design.

Table 3.2

Examples of private investment mechanisms relevant to support NbS for NFM

Mechanism	Notes
Impact investments	Private debt and equity investments in profitable activities that also support conservation and sustainability objectives. Such measures can help build resilience of the natural environment to climate impacts (e.g. through flood mitigation interventions). These can be sourced through a variety of instruments including thematic investment funds, incubators, venture capital firms and exchange-traded funds (ETFs).
Ecosystem credits	Verified ecosystem credits are generated through the delivery of interventions that protect and enhance ecosystem health and general biodiversity, and therefore build the resilience to climate impacts. Traded platforms facilitate the buying and selling of credits via an intermediary. Companies or organisations can purchase credits to comply with or achieve environmental regulations or outcomes; farmers or landowners supply by carrying out activities to achieve these outcomes.
Payments for ecosystem services	Unlike trading platforms, land managers and landowners (suppliers) can directly sell ecosystems credits that are generated through actions that support climate adaptation (among other benefits) to buyers from the public and private sectors. Where the benefits to specific third-parties from an NbS project can be quantified and monetised arrangements can be put in place to enable the third-party to fund the project to go ahead.

Currently several potential limitations present risks to the effectiveness of these private revenues for supporting adaptation:

- Adaptation benefits from NbS projects are generally not currently monetised. Whilst these mechanisms have the potential to support activities and projects that will help build the resilience to climate impacts, including flooding, unintended maladaptation from projects is possible if climate risk reduction benefits remain an unmonetised co-benefit. NbS project viability will generally depend on revenues from multiple environmental benefits, meaning that the lack of monetisation for adaptation benefits could be preventing otherwise viable projects from going ahead.
- Uncertainty around the level and consistency of revenues for certain ecosystem services, can undermine investor confidence.
- Voluntary carbon offsets sales through voluntary carbon markets provide a rapidly growing revenue stream for NbS projects across a range of different ecosystems. However, carbon offset projects that do not sufficiently consider the need to mitigate climate risks to the wider environment (e.g. biodiversity and social equity) can undermine the longer-term resilience of the supporting ecosystems to climate change. Traded schemes with a higher weighting in non-carbon benefits (e.g. ecosystem services) tend to be more expensive and therefore less attractive to buyers. Ecosystem credit markets are less mature than those for carbon, but cost should fall as the market develops.

There are proven examples of successful blending of public with private sources to support investment in NbS to reduce flood risk. One such case is the Wyre River Project in Lancashire (Box 3.2), which aims to use NbS to reduce flood risk in the Wyre River catchment, using a mix of public funding and other private revenue streams.

The project demonstrates how the demand side (buyers of environmental credits) and the supply side (landowners) can efficiently be brought together to support the successful delivery of a set of adaptation actions.

Box 3.2

Case study: River Wyre Catchment, Lancashire – Natural Flood Management

Summary

- **Climate risk:** The communities local to the River Wyre catchment have experienced a 1 in 50-year flood event four times between 2000 and 2020. The economic cost to insurers of a 1 in 50-year flood is £1.96 million.⁴
- **Investment need:** The Wyre River Project aims to use NbS to reduce flood risk in the Wyre River catchment, using a blend of public and private finance. The estimated costs of the project comprise £1.5 million of capital expenditure, and £50,000 a year in running costs. This supports the delivery of more than 1,000 targeted measures (e.g. installation of ponds, hedges, leaky dams) to store, slow and intercept flood water and prevent peak flows.
- **Adaptation benefits targeted:** In addition to approved flood mitigation, co-benefits from the project include the creation of new wildlife habitat, improvements in water quality, and climate change mitigation through carbon sequestered and stored in the newly created peatland and wetland landscapes.

Investment support mechanisms

- **Public/philanthropic investment:** Upfront costs of the project were met through non-refundable grants of £627,500 were provided by issued from the Woodland Trust. Grants were issued over years one to three. via the Northern Forests Grow Back Greener programme.
- **Impact investment:** Private investment for £850,000 was agreed in the form of a nine-year loan. c.£870k debt - capital and interest repaid from revenues (see below). Social Investment Tax Relief (SITR) was also key enabler of the project.

Revenues generated

- **Performance payments:** Five buyers from the public and private sector, including United Utilities, Wyre Council, FloodRE, and the Environment Agency, collectively make NFM performance payments of £220,000 per annum over the nine-year project.
- **Impact investors** also agreed to a 1% 'incentive reduction' in the loan interest rate if the interventions achieve stipulated biodiversity targets.
- **Ecosystem credits:** The resulting improvement in habitats and increased biodiversity from the project also enabled further revenue lines through the generation of biodiversity and carbon credits

Barriers encountered

Financial:

- Differences between the funding cycles of investors (typically three-year) and the project term (nine-years) meant there was a potential risk of misalignment between revenues, and repayments of capital and interest.
- A further challenge was external factors (e.g. climate variability) in the catchment affecting the project's ability to meet the flood risk reduction targets that are required to qualify for the payments.

Informational:

- Uncertainty around how the agricultural transition in England will impact functioning of existing schemes.

Bureaucratic:

- Unlocking the SITR took considerable time and effort; this was the first time the tax relief had been used for environmental purposes.

(b) Sustainable Urban Drainage Systems (SuDS) to reduce flood risk in urban areas

Sustainable Urban Drainage Systems (SuDS) help manage surface water flooding risk.

Sustainable Urban Drainage Systems (SuDS) are designed to manage surface water flood risk via the transport of surface water, slowing runoff, storing water and allowing water to soak into or evaporate from the ground. SuDS are commonly used in new-build development, re-development, and retrofitting, and are generally adopted by local authorities. The National Planning Policy Framework sets out that major developments should incorporate sustainable drainage systems; if local authorities consider development and planning applications in flood risk area, sustainable drainage systems must be incorporated.⁵

The use of SuDS can generate both public benefits – through the mitigation of flood risk, improved amenity, and biodiversity in urban areas – and private benefits (for example, reducing runoff decreases the volume of surface water that water companies are required to treat in combined sewer systems).

(i) Public funding – FCERM funding

Public funding for SuDS is delivered through local authorities.

Around one-third of current Flood and Coastal Erosion Risk Management (FCERM) public spending is earmarked to target surface water flood risk. This funding supports SuDS projects delivered by local authorities, rather than being part of the Environment Agency's remit. This means that public funding for SuDS is often used for smaller-scale projects. These projects tend to require site-specific technical knowledge. Components may be replicable, but each project will be different, and impacts will differ with location. Furthermore, this public funding is largely only available for capital spending, not ongoing maintenance which is an important part of ensuring that SuDS remain effective.

This public funding is allocated based on where flood mitigation benefits are greater than costs. However, the benefit certainty of surface water interventions is harder to quantify than fluvial or coastal defences. New tools, such as the Benefits Estimation Tool (B&ST) by the Construction Industry Research and Information Association (CIRIA) can help improve this by site-specific assessment of the economic value of environmental and social benefits of SuDS.

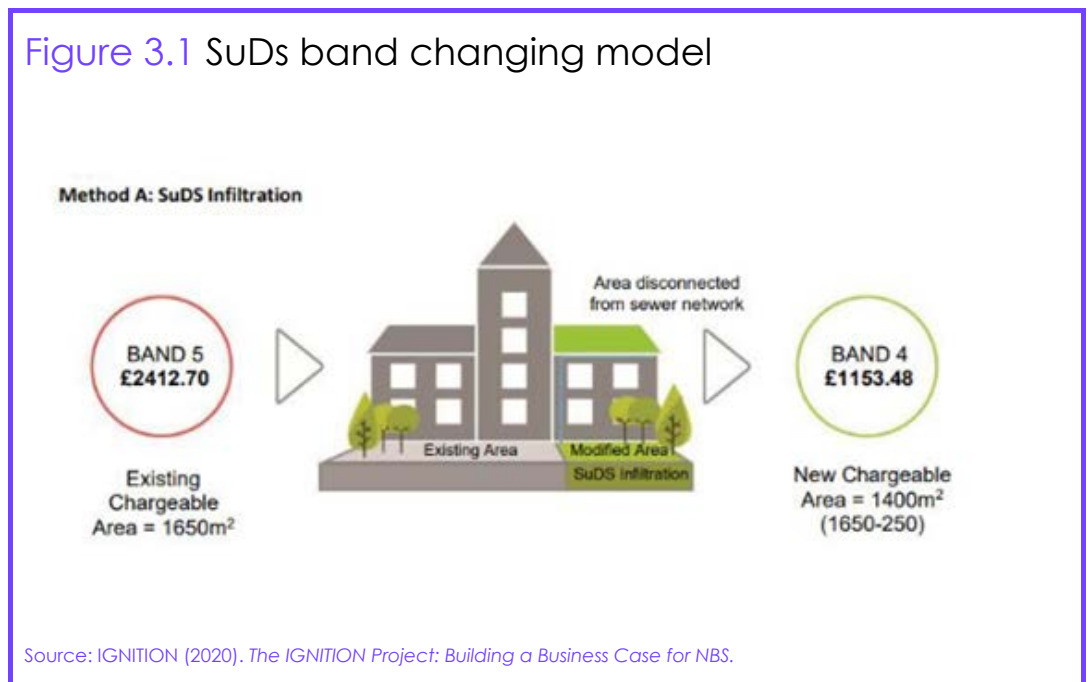
The wide range of benefits that SuDS can support means that public funding will remain a key route for investment in SuDS provision in the future. Most funding is currently for small-scale schemes, with funds allocated to local authorities for individual or grouped project locations. Current funding allocation is not suited to counting the benefits of multiple SuDS working together.⁶ A more joined-up approach to wider schemes may facilitate upscaling and consistent delivery of SuDS from public funding.

(ii) Other private revenues – Band charging model

Reductions in surface areas connected to the public sewer network can lead to lower charges for non-domestic customer surface water bill.

A potential revenue stream that could broaden the range of investors in SuDS is the band charging model. Four water companies in England use charging bands to set non-domestic customer surface water bills. Bills are based on the area of a site which drains into the public sewer network. SuDS can reduce the drainage area (Figure 3.1) - this reduction is commonly assessed using two components: reduction in volume of surface water discharged; the attenuation of flow the SuDS feature offers. If the reduction is sufficient to move the site to a lower drainage band, bill savings can result. The cost savings can be used to repay and service the upfront capital investment needed to create the SuDS.

Figure 3.1 SuDS band changing model



This revenue stream has the advantage of being able to work across multiple smaller projects that can be combined into a single investment package. Delivering multiple, smaller, spatially distributed SuDS schemes means that the capital investment and the associated risk has the potential to be shared amongst stakeholders.

However, there are range of challenges associated with the band charging model that may limit its effectiveness as a financial mechanism to fund the delivery of SuDS projects.

Charging band revenues may have to be combined with other revenue streams to make SuDS projects viable.

- Charging band revenue streams alone may not be sufficient to cover full SuDS finance costs by themselves. This means that band charging revenues may have to be combined with public grant funding (usually from Central or Local Government) to cover the shortfall, or other benefits from SuDS be monetised.
- Currently there is a lack of standardised approaches for valuing the full range of adaptation benefits generated by SuDS, such as improvements to water quality. Charging bands can also change over time, with future payment rates not guaranteed. Effective integration of all of these revenue streams is needed to make a wider range of SuDS projects viable.
- Private investment funded through band charging models requires cooperation from site owners. For instance, site owners need to agree to transfer the drainage bill savings to the SuDS project developer to repay the finance over an agreed period.

There are several case studies of SuDS funded through private or blended revenues.

There are several examples of small-scale SuDS interventions with private or blended financing in England. The IGNITION Project, a £4.6 million EU-funded research and development project, looked to gather evidence, develop business cases, and pilot urban green infrastructure in Greater Manchester (Box 3.3). Part of the project included developing a business case for co-investment in multiple SuDS schemes across ten councils within the Greater Manchester area.

Box 3.3

Case study: Greater Manchester SuDS IGNITION project

Summary

- *Risk:* Surface water flooding has increasingly impacted residential properties within the Greater Manchester area. To help mitigate future flood risk, SuDS were proposed as part of improving green urban design in the area.
- The IGNITION Project aimed to develop a financial model for retrofitting SuDS via a reduction in costs from water utilities, using 16 pilot sites across the region.* The key project partners included ten councils within greater Manchester area, the Water Resilient Cities Project as the project manager, and United Utilities.
- *Investment need:* Funding supports the construction and development of a range of SuDS projects, which aim to improve management of water flows. Expected SuDS delivery costs at each of the individual sites were between £20,000 and £250,000, representing total cost of between £1.38 million - £2.09 million.⁷
- The initial business model centred around attracting external investment to pay for SuDS design and construction, which would then be repaid through the revenue stream created via the reduction in site owners' drainage charges

Investment support mechanisms

- The model would utilise a policy offered by the water company for Greater Manchester, United Utilities, which incentivised SuDS, to attract private finance. However, analysis indicated that at most of the sites, annual potential drainage change savings would only amount to around £300 to £2,500 per year – not sufficient to repay installation investment within suitable timescales.
- The pilot scheme has therefore moved towards a blended finance approach which combines upfront capital finance with non-repayable funding.
 - This would require around £1.5 million upfront investment – two thirds of which was sourced from a 'SuDS for Schools' £1 million grant from the Department of Education.
 - The repayable finance segment was estimated at around £200,000 over 10 years. This would still leave a portion of the initial capital investment yet to be sourced.
 - The pilot would facilitate a pipeline of SuDS to be implemented through a Special Purpose Vehicle (SPV) which would also manage the finance flows, procurement, and regulatory permissions.

Revenues generated

- Analysis suggests annual potential drainage charge savings at the SuDS sites would range from £300 to £2500 per year.⁸ On this basis, it would typically take between 50 to 100 years for drainage bill savings to cover the cost of delivering the SuDS. In April 2022, the delivery cost estimate of the IGNITION SuDS project ranged from between £1.38 to £2.09 million. Repayable finance from drainage bill savings would be unlikely to cover more than around 10-15% of these delivery costs.
- A further possibility to generate additional revenues was identified from the sale biodiversity credits and carbon offsets in the future.

Barriers encountered

Financial:

- Difficulties associated with monetising the broader benefits of SuDS interventions (which would include societal benefits such as air quality enhancement, health improvements) meaning financial revenues generated can be low.

* A £4.6 million European Regional Development Fund (ERDF) grant through EU Urban Innovation Actions initiative (until April 2022) covered the cost of developing the project (setting up the research groups, business case exploration and co-development with stakeholders), but was not used to the pilot SuDS schemes. The scheme is currently at proof-of-concept stage – but it aims to scale up to a larger pilot across Greater Manchester.

- No effective revenue model to cover the longer-term costs of implementation. Poor confidence in in SuDS revenue streams over time can mean the return-on-investment timeframe is longer than most investor preferences.
- Project implementation costs were variable, with costs per m² ranging widely between sites (from £40 per m² to £240 per m²).

Information barriers:

- There was low existing capacity within the public sector or water companies to create a business plan for SuDS and no baseline on which to measure against.
- Each site required specific analysis and design, and the financial benefit of disconnecting a particular site from the sewerage network was hard to quantify.
- Lack of evidence for the efficacy of SuDS for providing benefits, including reduced flooding and reduced sewer overloading benefits, as well as co-benefits. This requires improved quantification of these benefits.
- Communication of the finance revenue streams to stakeholders was challenging, especially with many stakeholders involved across multiple projects.

Bankability barriers:

- Timelines can be challenging – SuDS on school land had to be constructed during school holidays. Disruption to the timeline disrupted delivery across the pipeline.
- Each of the 16 sites in the current pipeline required a legally binding site reduction agreement for 10 years, but specialised agreements were considered risky by the water companies.*
- There was some reluctance from stakeholders to participate in the programme. The need to identify sites via technical screening processes prior to stakeholder engagement meant that some site owners were contacted at a late stage in the project planning.

Regulatory barriers:

- Regulatory shifts can happen in the short-term. This generates uncertainty and can have a negative impact on the financial viability of the project.

* The period over which the Water Services industry can set price increases for privately owned water companies is shorter (Asset Management Plans, AMPs, are renewed every 5 years).

(c) Retrofitting homes to reduce overheating

A range of adaptation measures can be used to combat overheating within existing buildings. These can include low-cost actions such as fitting internal blinds and more expensive measures such as external shading. Energy efficiency measures such as loft or wall insulation, if properly installed, can keep buildings cool during hot spells, as well as keeping buildings warm in winter.

Preparing homes to better withstand current and future heatwaves can be capital intensive.

All these measures require upfront capital expenditure of varying scales. The benefits from this expenditure (reduced internal temperatures during heatwaves) are largely to the occupant (increased comfort) although there may be wider spill-over public benefits (such as reduced pressure on public health resources) when deployed on buildings, particularly heat-vulnerable occupants (e.g. care homes).^{*} They are also generally not associated with revenues, with the exception of measures such as insulation that impact household energy usage.

(i) Public funding - Energy efficiency funding

Public funding to retrofit buildings to improve energy efficiency could help support overheating as a co-benefit.

Within the privately owned housing sector, the biggest role for public funding is expected to be supporting reduced overheating risk as a co-benefit of investment in greenhouse gas emissions reductions through energy efficiency improvements to buildings.

There are various schemes through which the Government will provide public funding to support energy efficiency upgrades. Most of these schemes are targeted to fuel poor homes; these include the Energy Company Obligation (ECO 4), Home Upgrade Grant (HUG), Social Housing Decarbonisation Fund and Local Authority Delivery (LAD) scheme. The Government have recently launched a consultation on an energy efficiency scheme, ECO+, which is targeted at 'able to pay' households. The primary objective of these schemes is to reduce emissions and energy bills; however, the energy efficiency installations should have an adaptation co-benefit if they are installed correctly.

However, these policies alone are far from sufficient to ensure the building stock is resilient to future climate.

- The public funding available for energy efficiency is far from sufficient to retrofit the necessary number of homes across the UK at pace to achieve the balanced pathway of emissions reductions. The current funding schemes will have some impact on overheating risk across a small subset of the building stock alone.
- Research has shown that in certain circumstances, energy efficiency measures such as loft or wall insulation may exacerbate overheating risk.⁹ This tends to be the case in properties with high levels of energy efficiency, that aren't well ventilated.

Overheating risks can be made worse by improved building insulation if effective ventilation and shading is not also considered.

Public funding mechanisms will there likely only play a limited role in building large-scale resilience to overheating risk across the entirety of the building stock. However, there are examples of residential retrofitting projects (that aim to tackle both emissions reduction and adaptation) that use a blend of private and public funding. One notable example is an innovative renovation project of eight flats within a single tenement building in Glasgow (Box 3.4).

^{*} There are wider benefits to both the occupants employer through reduced productivity losses (including through better sleep) and public benefits via reduced burden on the health system due to heat-related illness.

The two aims of the project were to improve the energy efficiency of the whole building, whilst also making it more resilient to extreme weather events. The project demonstrated the important role public funding can play in unlocking higher levels of additional funding, which can in turn expand the scope of the entire retrofit project.

Box 3.4

Case study: Glasgow Tenement Retrofit

Summary

- **Risk:** A single tenement building consisting of eight housing association flats in Glasgow was renovated between February 2020 and November 2021. The renovation project targeted the delivery of measures to improve the carbon and energy efficiency of tenements. All eight flats are owned by a housing association, Southern Housing Association.
- **Investment need:** The total final cost of the project was £1.3 million. It aimed to decarbonise the flats through energy efficiency measures, which would in turn lower energy bills. While adaptation was not the primary focus of the project, it was one of many factors considered as part of the renovation of the flats. In addition to overheating risks, measures implemented also looked to adapt the building to future extreme climate (e.g. intense rainfall).*

Investment support mechanisms

- **Grant funding:** Glasgow City Council provided £448,000; Scottish Government's Social Housing Net Zero Fund provided £129k (for air source heat pumps).
- **Private finance:** A further £718,000 of funding was provided by the Southside Housing Association.

Revenues generated

- An identifiable revenue stream resulting from the measures is future rental payments from social housing tenants, although this revenue stream is not directly linked to the works.

Barriers encountered

Informational:

- A lack of awareness as the potential suite of mitigation and adaptation benefits delivered led to reluctance by stakeholders to support the measures, who saw them as costly and superfluous.

Financial:

- The lack of well-established blended financing routes for this type of project, undermined investor confidence in the scheme.

Regulatory:

- Delays in receiving approval for certain parts of the project slowed down the work. This was largely due to a lack of precedence.

(ii) Household expenditure

Homeowners and residents will have to invest in overheating retrofit measures for their own properties.

Actions to retrofit homes to reduce overheating risk do not create revenue streams but do provide benefits to the residents of more comfortable homes during heatwaves. Owners and occupants will therefore be expected to provide the necessary capital to retrofit private sector homes to reduce overheating risk.

* Permeable wall insulation was used and timber joists were re-designed to limit the chance of them rotting during periods of heavy rain.

A key barrier identified in Chapter 2 was that many people in the UK are not aware of the impact of overheating in homes, nor what options are available to limit it. This is exacerbated by the heterogeneity of the UK building stock and variability in suitable measures for homes. Helping homeowners to better understand whether their home is likely to be at overheating risk, and the available adaptation options could make increased investment in overheating mitigation more likely.

Initiatives such as heat risk certification and point of sale obligation may help provide reassurance that investments into overheating adaption would be maintained in the home's value.

Beyond awareness raising, heat risk certificates and point-of-sale obligations could encourage homeowners to make the significant investments into overheating retrofit measures:

- **Heat risk certificates:** Disclosure of overheating risk against an established standard, such as the TM59 standard currently applied to new built homes under Part O of the Building Regulations, could enable well adapted homes to potentially command a premium when transacted. This certification could play a similar role to the Energy Performance Certificate (EPCs) currently in place, by providing a form of verifying the impact of retrofit actions to tackle overheating risk. This may ultimately flow through into the value of a property, although there is limited evidence that high EPCs rating currently impact a property's value.
- **Point-of-sale obligations:** Beyond certification, Government could place an obligation on homeowners to prove that their home is resilient to future climate, in order to sell it. Similarly, the private rented sector could be regulated such that landlords must prove whether a home is resilient to overheating (and/or flooding) impacts in order to rent it out.

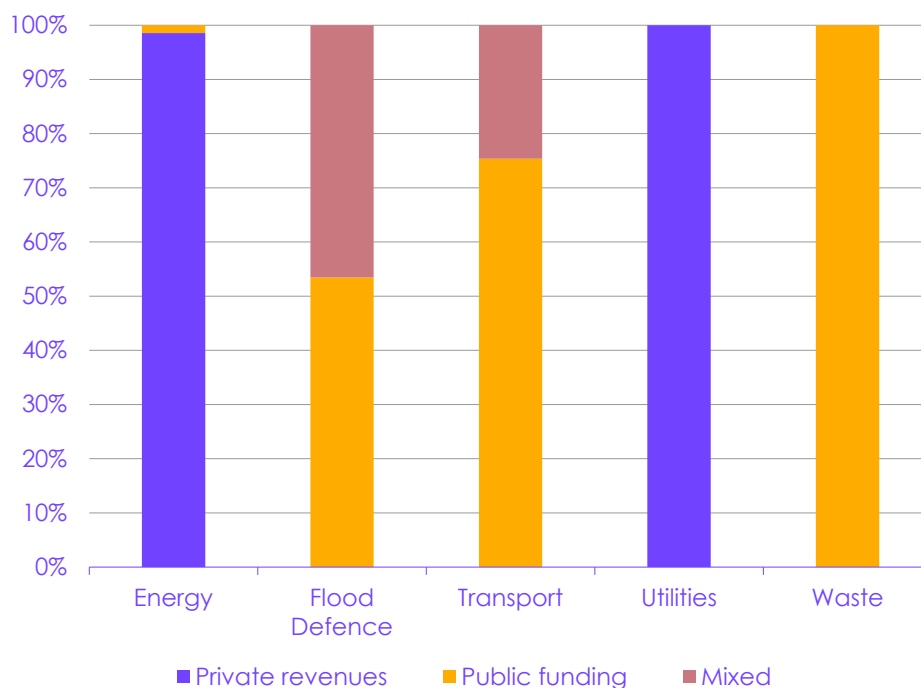
If successful, these initiatives may help encourage expenditure by homeowner or residents on actions to retrofit homes to reduce overheating risk by increasing confidence that this investment in their homes may be reflected in its market price.

(d) Climate-proofing infrastructure

Most infrastructure sectors are regulated in the UK. A mixture of public and private funding models are used across the sectors.

Both public and private funding streams are used to enable investment in UK infrastructure (Figure 3.2). In some sectors the majority of this comes from private sources (e.g. energy and water – through customer bills) whilst in others the majority is provided by the taxpayer (e.g. investment in roads). Most key infrastructure sectors are also regulated in the UK, meaning they are subject to constraints on how investment can be funded from consumer bills.

Figure 3.2 Share of funding for UK infrastructure capital investment for pipeline projects 2021-25



Source: Infrastructure and Project Authority (2021) *National Infrastructure and Construction Pipeline 2021*.

(i) Public funding – transport infrastructure

Transport infrastructure investment is mostly supported through public funding.

Investment in the physical infrastructure of transport networks is mainly funded via taxation due to the public benefit nature of this infrastructure. Roads are primarily funded publicly by revenues from taxation levied by central Government.

- National Highways is funded by Government to operate the national strategic road network. The Road Investment Strategy 2 (2020 – 2025) – the main investment programme in the UK's strategic road network – has several design standards that aim to account for climate change in upgrades to the road network and new roads.
- Local authorities fund local roads and public transport through Government grants, council tax, user charges (such as parking revenue, toll roads and congestion charges) and planning system charges such as levies on new developments.

Network Rail, which operates the rail network, receives grants from central Government for enhancement of the existing network. Government also subsidises the operation of the rail industry through tax revenues, with passenger fares covering some of the day-to-day operational costs of the railways.

Higher levels of public funding, invested in the right places, is likely to be necessary to climate-proof transport networks.

Based on the current public-led investment model, investment in climate-proofing of transport systems will likely require increased levels of public funding over time due to increasing pressures of climate change hazards, including the need for more regular maintenance and repair. Public investment to deliver weather and climate resilience will also need to recognise the increasing interconnectedness of infrastructure systems. It may sometimes be the case that the most cost-effective way to protect against future climate hazards may be through investment in other adjacent infrastructure networks. There are significant challenges in doing this, including regulatory, financial and data sharing barriers, but there are early signs of progress in developing this way of thinking (Box 3.5).

Box 3.5

Case study: Climate Resilience Demonstrator (CReDo)

Summary

- *Risk:* Flooding risk to infrastructure (energy, water, telecoms) is projected to increase significantly under future climate change projections. Failure of one asset, in the event of a flood, can cascade and cause assets of other operators to fail. CCRA3 identified more action is needed to manage cascade risks across the UK infrastructure network.
- *Investment need:* CReDO was created to show, at a pilot scale, how a full system digital twin could help infrastructure operators avoid cascading failure caused by extreme flooding events. Funding awarded for a digital twin pilot project to simulate the impact of flooding events and identify the best adaptation measures across energy (UK Power Networks), water (Anglian Water) and telecoms (BT) infrastructure in East Anglia.

Investment support mechanisms

- *Grant funding:* CReDO was grant funded, after gaining a year of funding from the UK Research Innovation (UKRI). The project is being taken forward by Connected Places Catapult, expected cost is £5 million over four years. The funding provided by the grant was not to fund the asset owners to run the project, but instead to fund a collaboration of third parties to produce the pilot such as innovators, academics and researchers.

Revenues generated

- No direct revenues generated from the pilot project.
- Analysis suggested an annual potential benefit from CReDO of between £6 million and £13 million for East Anglia, and between £81 million and £186 million for the UK, depending on the scale of flooding.
- These results are based on a simulation, but give an indication of how large an impact a project like this could create, and incentivise investment into future work on the model if operators take it forward using private finance.

Barriers encountered

Behavioural barriers:

- Significant difficulty in signing up asset owners to provide their data, due to confidentiality concerns. This barrier was significant, but a solution was found using information sharing.

Information barriers:

- Lack of understanding by asset owners and investors as to the true extent of the risk their assets face.

- Generally, interdependent risks are not well understood, and true risk level is often underestimated. (Dawson, 2015) state that looking at the risk of flooding from a linear regression (or solo operator) perspective captures only 17% of the variance in risk, whilst analysis of the first order sensitivity indices provides only 29% of the variance — highlighting the importance of variable interactions (as would occur between operators) in determining risk.
- The value of the Digital Twin and the subsequent reduced risk are not fully understood by the private asset operators.

Financial barriers:

- Large investment in time (and therefore cost) required by the asset owners to be involved in a project like CReDo, particularly at larger scale.
- CReDo has not yet stimulated private finance to take the work forward at operator level.

Public provision of finance could also support adaptation, but currently public finance institutions have focused more on climate change mitigation.

Public provision of financing (the upfront capital) can also be a lever to help increase investment in climate resilience in parts of the infrastructure sectors. Public financing can have lower financing costs than from private sources and can also help finance investment opportunities that would not otherwise be delivered by the private sector alone. An example of this is the UK Infrastructure Bank (UKIB), which was launched in 2021 to accelerate investment in infrastructure projects that will support the Government's Net Zero and levelling up ambitions. It aims to de-risk infrastructure investments through aiming to 'crowd-in' private capital in addition to its public financing. However, to date the UKIB has focussed on emissions reduction in financing projects and is yet to demonstrate a firm commitment to addressing Net Zero and adaptation together. (Box 3.6).

Box 3.6

Role of the UK Infrastructure bank in stimulating investment in climate resilience

The UK Infrastructure Bank (UKIB) was launched in 2021, tasked with accelerating investment into ambitious infrastructure projects, cutting emissions and levelling up every part of the UK. With its initial £22 billion of financial capacity, the bank aims to deploy up to £3 billion of debt and equity and £2.5 billion of guarantees a year, committing over £22 billion over the next five to eight years, subject to the pipeline of investable projects in each year.

The private sector function will invest up to £8 billion and issue up to £10 billion of government guarantees. The local authority function will lend up to £4 billion to local authorities at a preferential rate for high value and strategic projects of at least £5 million.

In its first year, the bank closed seven deals worth £610 million.

The UKIB's first strategic plan sets out its two strategic objectives:

- to help tackle climate change, particularly meeting the government's net zero emissions target by 2050,
- to support regional and local economic growth through better connectedness, opportunities for new jobs and higher levels of productivity.

The bank has five priority sectors set by HM Treasury, and has identified the following investment opportunities (though other projects are encouraged to apply):

- Clean energy – power, heat and buildings, hydrogen, fuel supply and industry
- Transport – electric vehicle (EV) charging infrastructure, zero emissions public transport, port infrastructure, mass transit systems and infrastructure upgrades
- Digital – rollout of gigabit capable broadband, 5G rollout

- Water – finance projects under the direct procurement for customers (DPC) mode, consider role in nature-based solutions
- Waste – new and retrofitted energy from waste plants, recycling infrastructure.

Investment is likely to be heavily weighted towards energy projects, reflecting their importance to the UK's net zero and energy security ambitions. The large investments required in the electricity system present an opportunity to ensure that the Net Zero electricity system, and other UKIB investments, are resilient to the future climate conditions which will pose increasing risks to energy supply. If climate resilience is neglected in this investment there is significant risk of locking in future climate impacts or additional costs later.

The strategic plan states that the bank's Environmental and Social Governance policy and framework will be developed to incorporate resilience to climate change as an additional pillar.

[Source: UK Infrastructure Bank \(2023\)](#)

(ii) User charges – water and electricity

Regulation in infrastructure sectors means that investment aligned with resilience can be mandated.

Infrastructure sectors in the UK are regulated. This means that regulators have the power (to varying extents) to mandate investment aligned with long-term resilience needs. Infrastructure regulators currently consider building climate resilience within their price determinations to varying extents.

- **Ofgem.** For the regulated energy networks the cost of financing investment is assessed by Ofgem and a return is provided to cover financing costs through price control mechanisms.
- **Ofwat.** Mechanisms for private investment in the water system exist through the operation of a regulated water market in England and Wales. Investment needs for resilience are relatively well understood, however, investment is often thwarted by a regulatory cycle that prioritises capital investment, and longer-term adaptation projects that will benefit future water users are not incentivised by current regulation. The Government's strategic priorities for Ofwat include the need to be resilient to a one in 500-year drought, with the aim to meet this by 2040.
- **Ofcom.** There is currently no statutory obligation to consider climate resilience in the regulation of telecommunications and ICT.

In infrastructure systems where the costs of investment can be supported through user bills (electricity and water) regulator resilience mandates can allow (some of) the costs of this investment to be passed through to the consumer, balanced against the regulator's obligations to keep bills at manageable levels.

Resilience mandates and regulation need to be well designed to ensure that these revenues are available at the correct scale and are used to support long-term climate resilience. Outcome-based regulation (which enables flexibility in which actions are undertaken to achieve the desired outcomes) can be useful here as it will likely help foster cross-company and cross-sector collaboration on resilience investment that is needed to ensure the whole infrastructure system is resilience. Shorter-term planning horizons within infrastructure regulation (typically five-year regulatory cycles) can disincentivise investment in projects with longer-term adaptation benefits, so novel approaches to infrastructure regulation are needed to ensure the correct incentives to support long-term resilience are in place.

Learning from the successes and challenges of past regulatory cycles will be critical to ensuring that infrastructure regulation is effective and that well-designed climate resilience mandates can be implemented in other regulated sectors (Box 3.7).

Box 3.7

Case study: Water sector resilience to droughts and flooding (England and Wales)

Summary

- Risk: Climate change is expected to have a major impact on the UK water sector, including: hotter, drier summers leading to increased occurrence and severity of droughts; damage to water infrastructure such as reservoirs, dams, and water and sewage treatment plants, as a result of increased flooding; damage to buried infrastructure, such as water pipelines, from flooding and subsidence; reduced water quality if more frequent flooding affects water treatment facilities; and more intense rainfall contributing to the overloading of sewers, leading to environmental damage and flooding of property.
- Investment need: Private investment to increase the resilience of the water system.

Investment support mechanisms

- Private investment: Capex and opex investment by private water companies, regulated by Ofwat. A £51 billion price and service package was set for the 5 years from 2020-24, including £13 billion allocated for new infrastructure to increase resilience. £643 million was allocated to increase the resilience of water and wastewater infrastructure against potential failures. £469 million was allocated for drought resilience – developing new water resources and enabling transfer of water across the country. Water companies plan to invest £650m to install at least 2 million new water meters over the 2020-25 period, to provide more insight into consumer demands and help identify leaks.

Revenues generated

- Revenue allowances are set by Ofwat in each price review. Adjustments are made to allowed revenue to reflect service performance. Investment in resilience reduces the revenue at risk from failure to meet service performance requirements.

Barriers encountered

Financial barriers:

- Water companies are more likely to invest in capex rather than opex intensive projects due to the five-year regulatory cycle. Projects that have a long-term horizon for benefits, also have a long-term horizon for costs and are not incentivised by the current regulation that only has a five-year horizon. As adaptation projects have inherently long-term horizons - the higher benefit will be gained by future customers than current – these projects are not incentivised by the current regulation.
- Raising funds for projects with future benefits can be hampered in some cases by too much focus on outcomes for current consumers. Water companies' adaptation investment projects are ultimately financed by higher customer bills. Customers may be unwilling to pay for adaptation that they may not benefit from, or benefit less from than future customers.

Behavioural barriers:

- Limited scope for the water sector to form cross-sector partnerships to tackle climate change adaptation challenges. Requirement to deliver against Water Industry National Environment Programme (WINEP) reduces the opportunities for innovation and working across sectors to deliver the best value solutions.

3. Cross-cutting conclusions

(a) Investing into a climate resilient UK

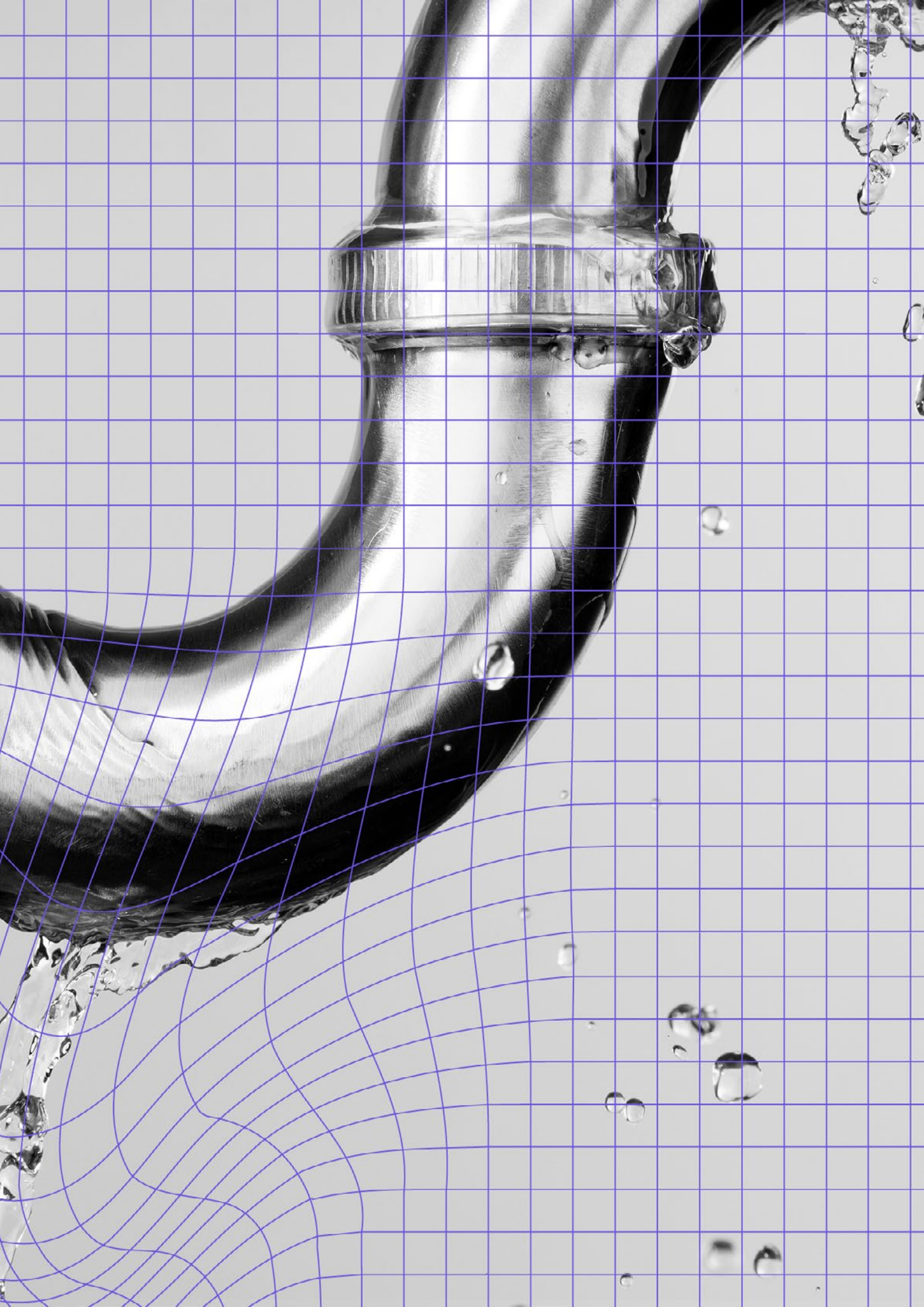
The previous section has profiled a variety of potential revenue streams that could support investment into adaptation actions. Cross-cutting conclusions emerging from this include:

- **There is a key role for public funding to invest in adaptation:** Public funding represents the most significant investment source for many key areas of adaptation today. Continued and expanded public funding for adaptation will be a cornerstone of building a well-adapted UK. This is particularly the case for adaptation that results in widely distributed (public) climate risks reductions for a large number of beneficiaries. Seeking to expand the set of investment sources available for adaptation investment should not remove focus on the need for appropriately sized and effectively delivered public investment programme to support adaptation actions with strong public benefits (such as flood risk management and nature restoration).
- **Non-public revenue streams are critical to broaden the investment sources for adaptation, but often do not yet exist at scale:** Clearly identified and predictable revenue streams are important to enable private investment in adaptation as these are essential to enable borrowed capital to be paid back. Some adaptation actions can be supported entirely from revenues not directly linked climate risk reduction (e.g. carbon and biodiversity benefits for NbS projects), however a wider range of projects could likely be viable if the climate risk reduction benefits are also monetised through market creation by effective public policy. In regulated infrastructure sectors, resilience mandates are a critical level to require investment from the private infrastructure operators for long-term climate resilience if well-designed and appropriately implemented.
- **Public and philanthropic funding can have an important role in building the models for broader investment:** Many of the case studies considered here show the value of targeted public or philanthropic funding schemes to build effective partnership investment models bringing in other private revenue streams. These 'proof of concepts' can have large subsequent spill-over benefits through driving and de-risking private sector investment, which in turn will help foster the development of innovative methods to accurately monetise the value of adaptation actions to others.
- **Increasing the scale adaptation action supportable by revenue streams is a key challenge:** The adaptation case studies explored in this chapter are characterised as small-scale projects, situated in a tightly defined geography, and with a tendency to focus on a specific climate risk. In many cases, however, efforts to support resilience to climate change will require large-scale, catchment level interventions through which multiple outcomes (e.g. policy, economic, social) and climate risks must be considered. This will require adaptation finance to flow into projects (or a combination of projects) that seek to tackle multiple climate hazards, across different geographies, and that aim to support a range of policy objectives. In many cases, however, (e.g. sustainable drainage schemes) current funding allocation is not suited to counting the benefits of multiple schemes and projects working together.

Government should help facilitate conditions that stimulate adaptation investment. Enabling environments that promote policy stability and good governance will help attract private investment. This is particularly important in areas where weak domestic market regulation can increase risk of maladaptation (e.g. poorly designed carbon offset projects). However, government interventions should be measured and must ensure that policy and regulatory frameworks do not impede adaptation investment. Governance structures also need to be improved and defined with greater precision to increase confidence from investors.

Endnotes

- ¹ Frontier Economics and Paul Watkiss Associates (2022). *Barriers to financing adaptation actions in the UK*.
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- ⁶ Arcadis (2020) *London Strategic SuDS Pilot Study*.
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Recommendations

The previous chapters have summarised the investment needs for adaptation, the barriers preventing these needs from being met and different revenue streams that could potentially broaden the base of investment in climate change adaptation. This chapter sets out our recommendations for improving the UK's approach to funding and financing adaptation in order to support a resilient financial system and a well-adapted UK.

(ii) Investing into a climate resilient UK

Improved climate resilience requires investment, both upfront capital expenditure and ongoing operational expenditure. Some areas will require dedicated investment to improve climate resilience, such as investment in blue-green infrastructure in cities to reduce risks of surface water flooding and overheating, and in other areas existing or planned investment flows (such as investment into the UK's planned zero carbon electricity grid) need to be 'climate proofed' to be resilient to future climate conditions.

The public sector, private sector and households all have to invest in adaptation.

The wide range of areas where investment in adaptation to climate change is required means that this investment will need to come from public sources, private enterprise, and households:

- **Public investment:** Many adaptation actions provide widely distributed and often difficult to quantify benefits – for example investment in flood defences to protect key towns and cities, and investment in the provision of ecosystem services. Higher levels of public investment will be needed to support these areas of climate resilience even where this is combined with other private sources. Whilst private investment in these public goods can and should be supported, there will always be an important role for public investment.
- **Private enterprise:** Private enterprise will need to invest in aspects of resilience where they are key beneficiaries, financed through either financial markets or internal investment. Depending on the sector, the business may be able to pass on some of the costs of the adaptation investment through to their customers. Private enterprises are increasingly measuring climate risk and developing plans to manage such risks. This is the result of a combination of factors, including the increased impacts of climate change on businesses, as well as voluntary and mandatory climate-related disclosures, spurred by global initiatives such as the Taskforce on Climate-related Financial Disclosures (TCFD) and the International Sustainability Standards Board (ISSB). There is, however, little to no evidence that this is yet driving any significant increase in levels of private investment in climate adaptation.
- **Households:** Some adaptation investment will come directly from household expenditure. For example, investment to retrofit homes to reduce overheating risk will predominantly need to be undertaken by homeowners/occupants directly as these adaptation actions largely have private benefits (more comfortable homes) and no associated revenues.

Revenues are needed for private investment into adaptation.

For private sector investment to support climate change adaptation alongside public funding streams, revenues (cashflows) that are bankable and investable are required. This is essential to allow providers of capital to recover the upfront capital they have deployed with an appropriate risk-adjusted return. There are a variety of potential revenues for private investment in adaptation and climate resilience.

Appropriate revenues will vary by sector and the nature of the adaptation benefit, however creating and scaling up revenues will require several cross-cutting innovations:

Predictable revenues for adaptation will often require innovation in measurement and monetisation of the benefits of adaptation actions.

- **Measurement and monetisation:** Accurate and agreed methods for monetising the benefits of adaptation actions are key to create investable revenues. Often the benefits from adaptation actions are complex and will require new and innovative methodologies that are simple to use but remain scientifically robust. Consensus building through the establishment of standards for measuring and monetising adaptation benefits is needed, with Government playing an important role to ensure that these are aligned to national frameworks and targets for adaptation and climate resilience.
- **Demonstrator projects:** Adaptation projects using innovative funding and financing approaches can serve as templates for others to copy and help provide confidence that successful and profitable projects can be delivered in reality. A key role for the Government and its agencies is to support innovative adaptation funding demonstrators and document and publicise the learnings from these across the sector.

'Greening' of the finance sector to better support adaptation is also needed.

The finance sector will also need to better incorporate adaptation into their operations to ensure that viable adaptation projects don't fail due to a lack of finance. Strong and widely used corporate disclosure standards and datasets provided as public goods will help ensure that a lack of data does not prevent projects from securing financing easily and cheaply, as will increased levels of understanding and awareness of what actions and activities are supportive of improved climate resilience (included at investment portfolio level) throughout the financial sector. Risk-adjusted returns associated with adaptation projects must also be appropriate to attract private sector investment, with public financial institutions playing an important role to ensure this is the case.

(b) Actions to enable investments in resilience

There are multiple roles of Government in adaptation investment.

Government has critical roles in supporting adaptation investment.

- It can provide public funding for adaptation, particularly where the benefits of adaptation are widely distributed and difficult to quantify.
- It can regulate to correct market failures that result in climate risk being mispriced by the private sector resulting in underinvestment and greater societal fragility.
- It can create markets that value positive adaptation outcomes.
- It can build capacity and enable innovation to support investment throughout the economy.

This section contains recommendations on how Government can serve these various roles. These are summarised under six areas:

Clearer adaptation goals are necessary to help guide investment.

(i) Clarifying adaptation goals and roles for investment

A vision of what a well-adapted UK looks like, backed up with measurable and specific goals can help enable investment in adaptation. Such goals would help provide a focal point for investment in adaptation from both public and private sources, similar to the role that the UK's Net Zero target has taken on for reducing greenhouse gas emissions. Although targets by themselves (without appropriate and well-designed associated policy actions to create funding streams) will not increase investment in adaptation, without targets the lack of clarity regarding desired resilience standards in key systems means that the scale of investment required cannot be reliably estimated and acted upon. Setting targets would also help the private sector to choose metrics for measuring their own resilience progress that are aligned to national policy objectives.

The forthcoming Third National Adaptation Plan (NAP3) is critical to setting out this vision for what a well-adapted UK looks. NAP3 should set out the vision of what a resilient UK would be like, and back this up with clearly laid out specific and measurable resilience standards and targets.

Putting in place these goals for adaptation will make estimates of the adaptation investment need more robust. This should be a priority for the Fourth Climate Change Risk Assessment so that future NAPs are better informed on investment needs.

In addition to this lack of targets to guide investment, national policy frameworks do not provide a clear indication of the balance of public and private investment needed in different areas of adaptation. This is currently holding back private sector investment as businesses may expect adaptation actions to be paid for by Government or to be compensated for the damage from extreme weather and climate events.

The refresh of the Green Finance Strategy in 2023, together with NAP3, should clarify where the Government expects adaptation actions to be funded through public sources and where private investment is expected. NAP3 should contain clear new funding commitments for investment in adaptation over the coming five-year period and the breakdown across department budgets.

(ii) Creating markets that value adaptation outcomes

Policy action can help create new revenue streams that value adaptation outcomes.

Access to revenue streams is critical to enable private investment, but revenues are currently lacking for many adaptation actions. Creating these revenues will often require targeted regulation and standard setting by Government. Nature-based solutions that can support adaptation outcomes will have a wide variety of other environmental benefits (e.g improved water quality or carbon storage). Revenues for all of these benefits will be needed to enable a wide variety of projects to be investable. Regulations that require improvements in ecosystem services (such as the requirement for Net Biodiversity Gain under the Environment Act) can create markets for these ecosystem services. The creation of effective standards for environmental integrity in emerging voluntary carbon markets is also needed, so that these don't risk detrimental impacts on climate adaptation or other environmental objectives. Requirements for overheating risk certification in buildings could provide a mechanism through which household investments in overheating retrofits could be reflected in the property value.

Government should prioritise creating markets for adaptation outcomes across relevant legislation and policy programmes, including initiatives on carbon market integrity and the Environmental Land Management Schemes.

The structure of the UK's regulated infrastructure sectors can allow for investment in resilience by infrastructure operators, and in some sectors (electricity and water) for this to be paid for through customer bills (balanced against other considerations such as affordability). However, this will only prove an effective funding route for investment in adaptation to climate change if driven by a clear and explicit climate resilience mandate for regulators. It is Government's role to put this in place. This requires a well-defined and operable expected resilience standard aligned to national level goals and a clear mandate to regulators to require investment aligned to the long-term resilience needs of the relevant sector. If this is put in place, infrastructure owners and operators will be required to invest the appropriate amounts towards improved resilience to climate change. Effective scrutiny will also be needed to ensure that climate resilience mandates deliver on their intended purposes and are functioning well. In particular, that these mandates are being delivered in an integrated way aligned to wider regulatory objectives.

The need for investment in adapting to climate change should be included within mandates/strategic priorities for all relevant regulated industry regulators and implementing agencies through resilience standards aligned to national-level objectives. There should be a duty for regulators to identify and create climate adaptation project pipelines, aligned with national adaptation objectives, and to set out how they will enable the realisation of that pipeline.

Beyond including resilience in regulator mandates, Government can help take a coordinating approach to embedding risks associated with infrastructure interconnectedness within investment decisions. For example, the water sector can be impacted through weather-related failures in the power system. Mandating regulators to work together (including through information sharing), and facilitating this, as well as defining common standards where necessary, can help ensure that investment in resilience across infrastructure systems is most effective in reducing overall levels of climate risks.

(iii) Public sector leadership

The public sector must both directly fund adaptation and also seek to 'crowd-in' private investment.

Public funding is and will remain a key pillar of investment and funding to support adaptation in the UK, particularly for adaptation actions that provide distributed (public) benefits. Making the case for continued and increased funding for adapting to climate change requires a good understanding of how and where the damages avoided from public spending on climate change adaptation outweigh the upfront investment requirements. Specific borrowing mechanisms linked to adaptation spending (such as Green Gilts and NS&I Green Bonds) should be explored to help expand the range of capital sources contributing to spending on climate adaptation.

The Office for Budget Responsibility should undertake a full review of how the impacts of climate change in the UK will affect the UK's macroeconomic performance and public finances, building on the analysis in their 2021 Fiscal Risks Report, to enable a full-cost benefit analysis for public investment in adaptation.

Public funding should also seek to be a catalyst for private sector involvement. Part of this involves supporting novel and innovative public-private partnership funding models for adaptation investment to build up a library of successful projects – providing a template for wider adoption.

Case studies considered in this report show that examples of these successful business models exist, but further development of business models in new areas of the adaptation challenge and a greater awareness of these business models is required.

Government and its implementing agencies should ensure that a growing fraction of their funding helps to support pioneering projects that seek to provide proof of concept for successful funding and delivery of adaptation actions through public-private partnership funding and financing.

Public sector leadership should also extend to Government owned companies. Public sector companies and companies owned through UK Government Investments (UKGI) should be early adopters of adaptation-related corporate disclosures and plans.

(iv) Strengthen corporate disclosure regimes

There has been increased uptake of initiatives for climate-related financial disclosures, which have raised the profile of the economic consequences of climate change impacts and the need for adaptation. However, in their current form these do not enable a clear picture of how much investment there is in climate change adaptation in various parts of the private sector or serve as a sufficient incentive to drive effective adaptation action.

As these market-led initiatives continue to evolve and have greater statutory underpinning (such as through the UK Sustainability Disclosure Requirements), a priority should be extending their focus to capture adaptation actions and to track investment more effectively. This will require mandating disclosures against metrics and a taxonomy or equivalent which provide clear and specific criteria for adaptation beyond a requirement to carry out risk assessments.

The update to the Green Finance Strategy in 2023 and NAP3 should set out steps to ensure that the UK SDR initiatives (including the Green Taxonomy) are effective in improving our understanding of adaptation investment needs, directing finance towards adaptation and ensuring that regulators and auditors have the necessary expertise to monitor the quality of reporting and provide incentives for organisations to report on their adaptation actions.

The UK should build on the work of the Transition Plan Taskforce (on corporate transition plans, including for net zero and wider sustainability objectives) to define common standards for what high-quality adaptation plans should look like. This should include how relevant physical climate risks are measured and managed as well as how the plans would contribute to wider societal adaptation to climate change.

Within the financial sector new datasets and standards are needed to measure portfolio level contributions to fragility and maladaptation, as well as adaptation and resilience. These datasets are public goods and should be freely available to provide greatest benefit. There is therefore a strong case for public sector leadership to co-create these with relevant private sector expertise, in which the UK is a global leader.

Better information on adaptation and climate risk from corporate reporting is vital.

(v) Empowering financial regulators to address physical climate risks

Financial regulators need to put climate resilience at the centre of their operations.

Effective financial regulation must incorporate physical climate risks into risk management practices. All financial institutions need to incorporate physical climate risks into their financial decision-making to ensure financial stability and to enable households and corporates to access capital and insurance for adaptation.

Financial regulators should provide directional guidance for financial institutions to measure physical climate risk and their contribution to climate adaptation (and maladaptation) outcomes across portfolios and loan books. This should be integrated into required climate related disclosures as part of SDR, as well as enforced through microprudential supervision. The interdependencies between physical, transition and liability risks must be considered for scenario analysis and stress testing. Stress testing of the financial system to climate change risks should be done regularly as data and methodological approaches improve our understanding of the risks and impacts.

Supporting this:

- The Bank of England should examine how capital requirements for banks should be adjusted based on assessed climate risks in terms of how assets are impacted by climate risk, how existing and planned adaptation will influence this, and how some assets create climate risk and contribute to greater societal risk and fragility.
- Financial regulators in the UK should collaborate with international counterparts to establish a cost of capital observatory for physical risk, similar to efforts to track this for transition risk (for example by the International Energy Agency). Such an initiative would help identify instances where investment risk on adaptation projects is mispriced (reflected in overly high cost of capital) and where policy interventions could help address this.

(vi) Helping to unlock investment through public financial institutions

Public financial institutions can help to ensure that viable adaptation projects find finance.

Public financial institutions are key to ensuring that adaptation projects with good business cases can access financing. They can help unlock private investment in projects that would be unattractive to private markets alone. This may be achieved through Government guarantees or aggregation of similar projects at scale to reduce risk, or by helping to build and maintain a pipeline of bankable projects.

UK public financial institutions (such as the UK Infrastructure Bank, British Business Bank, UK Export Finance, and British International Investment) – should create adaptation finance strategies, setting out they will independently and collectively ensure that no viable UK climate adaptation project fails for lack of finance.

UK public financial institutions should launch new sustainability-linked instruments tied to adaptation outcomes to help prime the market, potentially by offering guarantees to private issuers and lenders for adaptation-linked instruments.

Endnotes

There were no endnotes in this chapter.

Investment for a well-adapted UK
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