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Adaptation as Investment: Balancing Public and Private Roles in Climate Adaptation

ADAPTATION: AN INVESTMENT DECISION (UN)LIKE ANY OTHER

Climate change is one of the most pressing challenges societies face today, making investment in adaptation essential. Like other capital investments, adaptation requires cost-benefit considerations but comes with unique challenges, including climate-related uncertainty, long time horizons, and complex environmental, economic, and social interdependencies.

Rising global temperatures are driving more frequent and severe extreme weather events, causing irreversible damage to infrastructure and livelihoods (IPCC 2014). Since even drastic emissions reductions cannot fully halt climate change, adaptation investments are necessary to mitigate negative impacts. Adaptation entails adjustments in economic, social, or ecological systems to minimize harm or capitalize on opportunities (Smit et al. 2001; Mendelsohn 2012). However, full adaptation is constrained by economic, biophysical, and social limitations, leaving some residual damage unavoidable (IPCC 2014).

While some adaptation measures, like adjusting planting dates, have little or no cost, most require substantial investment. The objective of efficient adaptation is to prioritize projects with the highest net marginal benefits. Private adaptation is often efficient as individuals seek to maximize utility (Mendelsohn 2000), but market failures and behavioral barriers can lead to underinvestment from a societal perspective, justifying public intervention (Stern 2007).

Adaptation costs include initial investments, ongoing maintenance, and adjustment costs as actors learn and adapt to new climatic conditions (Hallegatte et al. 2011; IPCC 2014). Uncertainty in climate projections adds complexity, requiring continuous reassessment of adaptation strategies.

The investment framework reveals that adaptation, like other capital decisions, is subject to cost-benefit trade-offs. However, its unique challenges may deter investment even when economically justified. Addressing the barriers to adaptation investment and designing effective incentives are essential steps toward a more climate-resilient economy. Forward-looking adaptation strategies will reduce future climate damages and also contribute to long-term economic and social stability.

KEY MESSAGES

- **Adaptation to climate change is an investment decision with unique challenges including uncertainty, long time horizons, and market imperfections that hinder optimal private action**
- **Public sector involvement should address market failures while avoiding moral hazard and the crowding out of private investment through targeted knowledge dissemination and incentives**
- **Significant disparities in adaptive capacity between and within countries create fundamental inequities in climate resilience, necessitating special policy consideration**
- **Effective adaptation policy requires balancing public enablement with private investment through collaborative approaches that address market failures while ensuring equitable outcomes**

INCENTIVES AND BARRIERS FOR PRIVATE ADAPTATION

The adverse impacts of climate change create numerous incentives for firms and individuals to invest in adaptation. Key benefits include safeguarding current and future assets, reducing expected climate change-related costs, and improving long-term health outcomes. For instance, individuals who invest in home cooling systems mitigate heat stress, while firms that implement shaded or cooled workspaces enhance employee productivity and well-being (Szewczyk et al. 2021; Amoadu et al. 2023). Moreover, adaptation investments help businesses stabilize production and reduce vulnerability to climate risks. One approach is regional diversification, as diversified business models tend to improve resilience and performance. A beverage company whose main suppliers are all concentrated by the coast in Southeast Asia will face problems due to an increase in typhoons and other extreme weather events impacting both crop yield and community well-being. It will be advantageous for this company to invest in adaptation measures safeguarding its current suppliers while also extending its supplier network into different regions so its

supply chain will not be affected as strongly in the event of a typhoon (WEF 2023).

Additionally, adaptation fosters new market opportunities by stimulating demand for climate-resilient solutions. These range from drought-resistant crop varieties to climate-smart construction techniques and early warning systems (EWS). The latter present unique business opportunities. In the US, 95 percent of businesses rely on EWS to reduce operating costs by anticipating risks. While all businesses depend on this information, only half of all countries can currently utilize EWS. A gap that can be bridged by private provision (WEF 2025).

In regions where food security depends heavily on agriculture, adaptation increases food security and ensures survival. In northern Java, Indonesia, for example, communities have begun to restore and protect natural resources critical to both food production and climate adaptation. They construct sediment catchers to promote mangrove regeneration. These mangroves provide natural flood and erosion protection in the future while also enhancing aquaculture productivity, increasing food security for the communities (UNEP 2023).

Adaptation decisions may resemble standard investments on the surface, but climate change introduces distinct complexities that systematically hinder adaptation across all sectors – from government agencies to private businesses to individual households.

Uncertainty about the magnitude and spatial distribution of future climate change complicates the calculation of adaptation costs and benefits. This uncertainty forces decision-makers to consider multiple scenarios rather than optimizing for a single predicted outcome. Evidence from various sectors illustrates this challenge. For example, managers of Canadian mining operations acknowledge the potential negative impacts of climate change but struggle to implement adaptation strategies due to limited knowledge of climate projections. They consistently emphasize the need for more precise information to guide their adaptation investments (Ford et al. 2011). Farmers in Malaysia face a similar problem. While they are aware of the risks associated with climate change and feel themselves to be very vulnerable with regard to it, one of the most often cited reasons for struggling to adapt is the unpredictability of future weather patterns (Masud et al. 2017). Furthermore, uncertainty may even lead to maladaptation. An example is given by decisions made by farmers in Mozambique following devastating flooding in 2000, the worst in 50 years. Despite being provided new, safer housing beyond the flood plains, many refused to be resettled to safer locations, as they were not adequately informed about the likelihood of the flood reoccurring (Patt and Schröter 2008).

In addition to uncertainty, adaptation investments typically require long-term planning. While such investments are often more profitable in the long run, their extended time horizon adds complexity to decision-making (Fankhauser et al. 1999). Moreover, individuals exhibit present bias, frequently deferring decisions with long-term benefits, especially if the associated costs occur in the present or near future (O'Donoghue and Rabin 2015; Sunstein and Thaler 2021). This tendency contributes to delays in adaptation measures, even when they offer clear advantages. This present focus plays a role in Tanzanian farmers' adaptation to worsening land degradation. Soil conservation practices are associated with high initial costs in labor and capital, while any benefits may not show up before the next season's yields. This causes especially smallholder farmers in sub-Saharan African countries to underinvest in these very effective measures (Tenge et al. 2005). Politics are also affected by actors' present bias, as policymakers similarly tend to prioritize short-term, visibly beneficial measures over the socially optimal long-term investments needed for adaptation (Kehler and Birchall 2023). An example would be allowing the development of an industrial complex in nearby marshland to promote economic growth in the region rather than strengthening the protection of an ecosystem that can provide flood protection for the city in the future.

Adaptation also entails significant transaction costs. Acquiring the necessary information to make informed adaptation decisions can be expensive, particularly in contexts where climate data dissemination is inadequate. In developing countries, accessing relevant climate information often incurs prohibitively high costs, further limiting adaptation efforts (Fankhauser and Soare 2013; Hallegatte et al. 2011).

Additionally, market imperfections, including incomplete and frictional markets, can hinder adaptation. Externalities often prevent private adaptation efforts from reaching socially optimal levels (Cornes and Sandler 1996; Mendelsohn 2000 and 2012). An example is biodiversity protection in coastal areas.

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A manufacturing firm investing in mangrove restoration benefits from improved flood protection, yet surrounding communities also gain from enhanced food security and aquaculture productivity (Gunnel et al. 2016). Since the firm cannot fully monetize these additional benefits, its incentive to invest may be insufficient, leading to suboptimal protection of mangrove ecosystems.

While innovation can facilitate adaptation, it may also produce public goods and is thus underprovided in the absence of policy interventions or strong market incentives. Without appropriate incentives, innovation may emerge reactively in response to climate shocks rather than proactively in anticipation of them. Moreover, even when adaptation technologies are developed, they may not be widely adopted without public support, limiting their effectiveness and attractiveness to investors (Carleton et al. 2024).

Although there are strong incentives for adaptation investments, climate change introduces additional barriers that compound those present in conventional investment decisions. These challenges are further exacerbated by the public good nature of some adaptation measures, necessitating strategic policy interventions to address market failures and encourage efficient adaptation efforts.

WHEN IS IT TIME FOR PUBLIC SECTOR INVOLVEMENT IN ADAPTATION?

If private actors face barriers that hinder sufficient adaptation, public sector intervention may be warranted to improve incentives and adaptive capacity or directly provide necessary adaptation measures (Stern 2007; Dannenberg et al. 2010; Fankhauser and Soare 2013). However, while there are clear reasons for public involvement, it is important to consider the potential risks of moral hazard and the crowding-out effect on private adaptation investments when making decisions regarding public sector involvement.

In cases where market failures arise due to externalities, policymakers can employ regulations or pricing mechanisms to ensure market signals promote adequate adaptation. These policy tools help align private incentives with socially optimal adaptation outcomes.

When addressing frictional or incomplete markets, the public sector has multiple options tailored to specific barriers. Where private actors lack essential information for adaptation, the state can focus on disseminating knowledge rather than directly providing adaptation. For instance, broadcasting weather and climate forecasts enables farmers to adjust planting dates or take protective measures against extreme weather.

Making adaptation benefits more salient has proven particularly effective in encouraging private action. Evidence from East Africa demonstrates that government contact substantially increased the likelihood of households adopting soil and water conservation techniques (Deressa et al. 2009; Di Falco et al. 2011; Arslan et al. 2017). Similarly, farmers in the Netherlands, Denmark, Austria, Italy, and Greece cited a lack of knowledge as their primary reason for not participating in voluntary agri-environmental schemes supported by the EU (Pavlis et al. 2016). This suggests that information provision combined with targeted outreach can effectively stimulate private adaptation.

In many regions, informational asymmetries interact with a lack of access to financial instruments such as credit or insurance, further hindering private adaptation. Tanzanian rice farmers, for example, increased fertilizer use only when they received both information on its efficacy and a voucher covering the cost (Harou et al. 2022). In such cases, the public sector can either signal or subsidize instruments with high adaptation co-benefits.

Equity and moral responsibility considerations also provide justification for public sector involvement in adaptation (Carleton et al. 2024). Since both climate change impacts and adaptive capacity correlate with income levels, low-income households tend to suffer more severe consequences and have fewer resources to adapt. Even in the absence of clear market failures, targeted public adaptation efforts may be warranted. This is further supported by findings that wealthier nations and individuals contribute disproportionately to greenhouse gas emissions while also having greater adaptive capacity (Callahan and Mankin 2022; Nielsen et al. 2021 and 2024).

Public intervention, while often necessary, carries its own set of risks. Moral hazard stands as perhaps the most significant concern, undermining adaptation incentives. National insurance programs in the United States, for instance, have incentivized development in fire- and flood-prone regions while reducing private insurance uptake. Similarly, disaster relief programs have been shown to slow private adaptation measures, such as migration, as affected individuals are repeatedly bailed out without having to adjust their behavior (Carleton et al. 2024).

Another risk relates to political economy constraints. Political action often follows electoral cycles, leading to short-term adaptation measures that may be inefficient or suboptimal (Kehler and Birchall 2023). Additionally, adaptation policies may be driven by political considerations rather than efficiency and necessity (Carleton et al. 2024).

However, there are cases where private sector firms, public institutions, and communities collaborate to incentivize nature-based solutions. These approaches leverage adaptation measures inspired by natural systems that provide economic, environmental, and social benefits while being cost-effective (GIZ 2023).

One such initiative is the RISCO (Restoration Insurance Service Company) project in the Philippines. RISCO quantifies the risk reduction benefits of mangrove restoration and monetizes them through reduced insurance premiums for local businesses and

the sale of blue carbon credits. The project, supported by The Global Innovation Lab for Climate Finance, benefits insured parties through lower premiums while also reducing overall annual losses for insurance companies due to decreased climate exposure (Global Innovation Lab for Climate Finance 2019 and 2020).

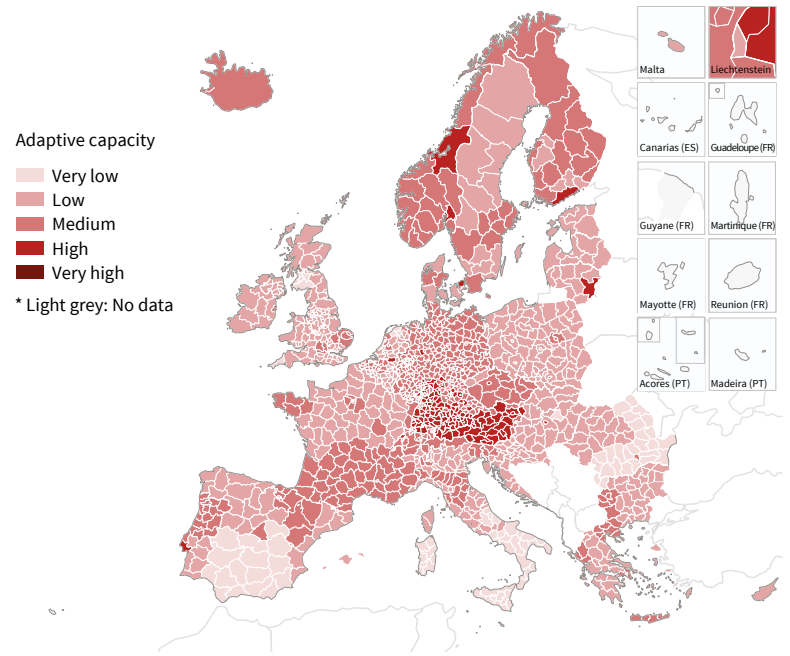
Another example is the reef insurance initiative in Quintana Roo, Mexico. Coral reefs serve a protective function by reducing wave height and strength (Guannel et al. 2016). To preserve this ecosystem service, the local government established the Coastal Zone Management Trust, funded by taxes collected from coastal businesses. The trust purchases an insurance policy from a participating insurer, with payouts triggered when storm winds reach a threshold known to significantly damage coral reefs. These payouts finance marine biologists and volunteers tasked with reef restoration, ensuring continued coastal protection. This mechanism safeguards local tourism, prevents costly infrastructure damage, and monetizes biodiversity protection, making it an attractive avenue for private investment (Green Finance Institute 2024; Nature Conservancy 2024, 2021a and 2021b).

In both cases, public sector involvement was crucial due to the difficulty of monetizing positive externalities associated with nature-based solutions. Government participation also helped reduce investment uncertainty. Furthermore, local community engagement played a key role, necessitating collaboration between investors and communities. These examples illustrate how public-private cooperation can facilitate the integration of nature-based adaptation solutions into standard business practices (GIZ 2023).

Ultimately, effective adaptation requires a balanced approach where public sector involvement addresses market failures and equity concerns while leveraging private sector innovation and investment, ensuring that adaptation efforts are efficient.

Figure 1

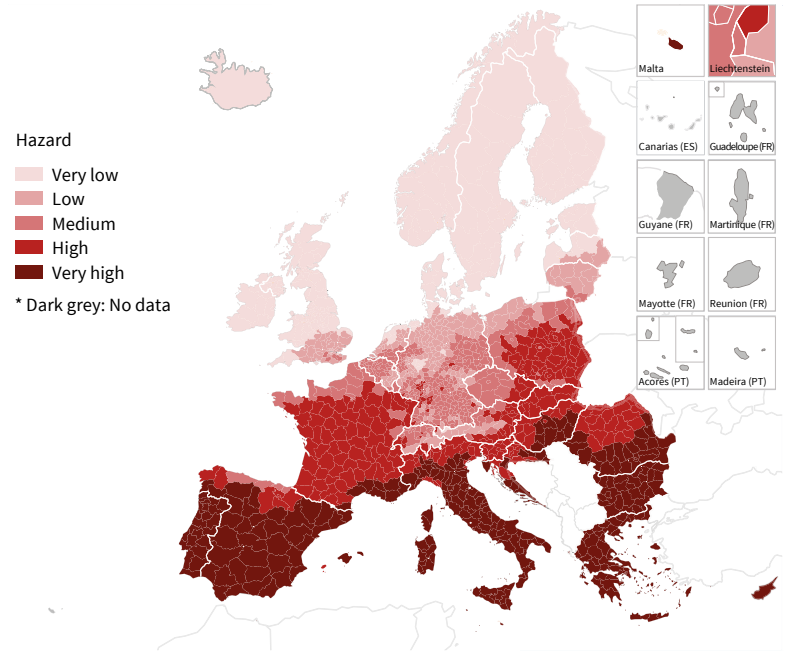
Adaptive Capacity in Europe (NUTS3)



Source: Navarro et al. (2022). © ifo Institute

Figure 2

Wildfire Hazard in Europe Under an Intermediate Emissions Scenario



Source: Navarro et al. (2022). © ifo Institute

IMPACTS OF CLIMATE CHANGE DEPEND ON AN ECONOMY'S ADAPTIVE CAPACITY

Adaptive capacity – the fundamental ability to respond adequately to climate threats – determines resilience and varies dramatically both between and within nations. Building on the discussion of public and private sector roles in adaptation, it is evident that both structural and socioeconomic factors determine how effectively different regions respond to climate challenges. While adaptation strategies can mitigate many risks, their feasibility and implementation depend on a region's resources, institutions, and sociopolitical landscape.

The severity of climate change impacts is not uniform; some regions are more vulnerable than others due to differences in baseline climate conditions, projected changes, and biosphere characteristics. Generally, countries in the Global South face greater risks than industrialized nations in the Global North, largely due to economic and institutional constraints. Vulnerability is shaped by multiple factors beyond geographic location alone. Reliance on climate-sensitive sectors such as agriculture amplifies risk. Demographic patterns like the proportion of elderly populations, the overall health of communities, and the quality of infrastructure also determine how severely climate impacts are felt (McGlade et al. 2019).

Exposure also plays a crucial role – urbanization and infrastructure placement in high-risk areas can amplify climate-related damages. For example, coastal

cities and settlements concentrated in flood-prone regions are more susceptible to sea-level rise and extreme weather events.

To counteract these challenges and enhance resilience, countries, firms, and individuals must invest in adaptation. However, the extent to which they can do so – referred to as adaptive capacity – varies considerably and is influenced by overlapping and additional factors beyond vulnerability alone (IPCC 2007 and 2023).

A key determinant of adaptive capacity is economic strength. Higher-income countries and regions are better positioned to finance adaptation measures, while economically weaker regions – whether in the Global South or within industrialized nations – face a double burden of both greater climate exposure and limited resources for adaptation. This economic disparity creates a fundamental inequity in climate resilience. State and institutional capacity play an equally significant role in determining adaptive capacity. Effective governance, investments in education, gender equality, and robust social safety nets all contribute to a society's ability to formulate and implement adaptation strategies. These institutional factors often determine how effectively economic resources can be mobilized for adaptation.

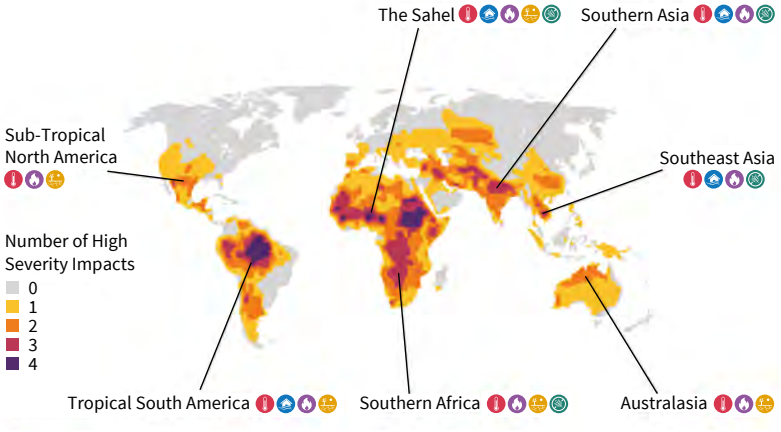
Demographic structures also influence adaptation potential. Regions with aging populations, for instance, may have greater health-related adaptation needs but lower workforce capacity to implement them. Similarly, cultural norms and existing policy frameworks shape public perception and willingness to adopt climate-resilient measures. Innovation and technological progress can further enhance adaptive capacity by improving risk assessments and expanding available adaptation solutions (IPCC 2023).

These variations are evident even within industrialized nations. In Europe, for instance, while wildfires pose a threat across the continent, their severity is expected to be greatest in southern European countries like Spain, Italy, and Greece (European Climate Risk Typology 2024). These regions, which already experience extreme heat and drought, have lower adaptive capacity within the EU (Navarro et al. 2022). Even within these nations, economic disparities influence adaptive capacity, with wealthier regions such as northern Italy and the Roman Metropolitan Area more capable of implementing adaptation measures than economically weaker regions in the south (Navarro et al. 2022).

Globally, the differences are even starker. Parts of Africa, South Asia, and tropical South America face compounding risks, including heat stress, flooding, drought, wildfires, and food insecurity (MET Office 2025). Many of the most affected countries rank low on development indicators such as the Human Development Index (UNDP 2022), have high levels of multidimensional poverty (UNDP 2024), and are some of the most fragile states globally (Fund for Peace 2024).

Figure 3

Regions Facing Multiple Severe Climate Change Impacts



Note: Extreme heat stress risk. River flooding. Wildfire risk. Draught. Food insecurity.
Source: Met Office (2024).
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These structural challenges severely limit their capacity to adapt, underlining the need for targeted interventions that bridge gaps in resources, governance, and institutional capacity.

Strengthening adaptive capacity through targeted investments, effective governance, and inclusive policy interventions is essential to reducing climate vulnerabilities and ensuring that all regions, regardless of economic status, can build resilience to the growing challenges of climate change.

POLICY CONCLUSIONS

Understanding adaptation as an investment decision provides crucial insights for policy design. Like other investments, adaptation requires weighing costs against benefits under uncertainty. However, its distinctive features – including climate uncertainty, long time horizons, and complex externalities – create unique challenges that private actors struggle to address alone.

This investment perspective further reveals why full public provision of adaptation is problematic. When governments assume complete responsibility, they risk crowding out private investment and creating moral hazard, as demonstrated by cases where national insurance programs have encouraged development in high-risk areas. Instead, public policy should focus on enabling and incentivizing private adaptation investments while addressing market failures.

The public sector's role should center on reducing barriers to private adaptation investments. This includes providing climate information and risk assessments, developing financial instruments, and creating frameworks that help monetize adaptation benefits. Successful examples like the RISCO project in the Philippines and Mexico's Coastal Zone Management Trust demonstrate how public involvement can catalyze private investment by reducing uncertainty and enabling the monetization of ecosystem services.

However, the investment nature of adaptation also highlights equity challenges. Low-income regions and communities face both higher climate risks and greater barriers to adaptation investment, including limited access to capital and information. In these cases, targeted public support becomes essential, not to replace private investment but to enable it through capacity building and risk-sharing mechanisms.

The timing and efficiency of adaptation investments are crucial considerations. Like any investment decision, adaptation measures should be implemented when marginal benefits exceed marginal costs. However, the public sector must also consider distributional impacts and create frameworks that encourage early, preventive adaptation rather than reactive responses to climate impacts.

Successful adaptation policy requires a careful balance. Governments must support private adaptation investments while avoiding the moral hazard that undermines individual responsibility. They must address market failures while maintaining strong incentives for private action. And crucially, they must ensure equity in adaptation outcomes while promoting overall economic efficiency. The fundamental goal is not to choose between public or private adaptation approaches. Rather, effective climate policy creates enabling conditions where both sectors can contribute to building comprehensive climate resilience. This balanced approach recognizes adaptation as a shared investment responsibility requiring coordinated action across society.

REFERENCES

Amoadu, M., E. W. Ansah, J. O. Sarfo and T. Hormenu (2023), "Impact of Climate Change and Heat Stress on Workers' Health and Productivity: A Scoping Review", *The Journal of Climate Change and Health* 12, 100249.

Arslan, A., F. Belotti and L. Lipper (2017), "Smallholder Productivity and Weather Shocks: Adoption and Impact of Widely Promoted Agricultural Practices Tanzania", *Food Policy* 69, 68–81.

Callahan, C. W. and J. S. Mankin (2022), "National Attribution of Historical Climate Damages", *Climatic Change* 172, 40, https://doi.org/10.1007/s10584-022-03387-y.

Carleton, T., E. Duflo, B. K. Jack and G. Zappalà (2024), "Adaptation to Climate Change", in L. Barrage and S. Hsiang, Eds., *Handbook of the Economics of Climate Change*, North-Holland, Amsterdam, 143–248.

Carter, J. et al. (2018), *European Climate Risk Typology*, https://european-crt.org/files/typology-final-report.pdf.

Carter, J. et al. (2022), *European Climate Risk Typology*, https://european-crt.org/map.html.

Cornes, R. and T. Sandler (1996), *The Theory of Externalities, Public Goods, and Club Goods*, Cambridge University Press, Cambridge.

Dannenberg, A. et al. (2010), "The Role of the Government in Adaptation to Climate Change", *Environment and Planning C: Government and Policy* 28, 834–850.

Deressa, T. T. et al. (2009), "Determinants of Farmers' Choice of Adaptation Methods to Climate Change in the Nile Basin of Ethiopia", *Global Environmental Change* 19, 248–255.

Di Falco, S., M. Veronesi and Y. Mahmud (2011), "Does Adaptation to Climate Change Provide Food Security? A Micro-Perspective from Ethiopia", *American Journal of Agricultural Economics* 93, 825–842.

Fankhauser, S., J. B. Smith and R. S. J. Tol (1999), "Weathering Climate Change: Some Simple Rules to Guide Adaptation Decisions", *Ecological Economics* 30, 67–78.

Fankhauser, S. and R. Soare (2013), "An Economic Approach to Adaptation: Illustrations from Europe", *Climatic Change* 118, 367–379.

Ford, J. D. et al. (2011), "Canary in a Coal Mine: Perceptions of Climate Change Risks and Response Options among Canadian Mine Operations", *Climatic Change* 109, 399–415.

Fund for Peace (2024), *Fragile States Index*, https://fragilestatesindex.org/.

GIZ (2023), *Catalysing Finance and Insurance for Nature-based Solutions. A Collection of Case Studies from around the World*, https://www.adaptationcommunity.net/wp-content/uploads/2023/08/giz2023_Catalysing-Finance-and-Insurance-for-Nature-based-Solutions.pdf.

Global Innovation Lab for Climate Finance (2019a), *Restoration Insurance Service Company (RISCO), Lab Instrument Analysis*, https://www.climatefinancelab.org/wp-content/uploads/2019/01/RISCO_Instrument-analysis-1.pdf.

Global Innovation Lab for Climate Finance (2019b), *Restoration Insurance Service Company (RISCO)*, https://www.climatefinancelab.org/wp-content/uploads/2019/01/RISCO_Instrument-overview-1.pdf.

Global Innovation Lab for Climate Finance (2020), *Restoration Insurance Service Company (RISCO), Lab Market Entry Analysis*, https://www.climatefinancelab.org/wp-content/uploads/2019/01/RISCO_market-entry-analysis_sep-2020.pdf.

Green Finance Institute (2024), *Quintana Roo Reef protection (Parametric Insurance)*, https://hive.greenfinanceinstitute.com/gfihive/revenues-for-nature/case-studies/quintana-roo-reef-protection-parametric-insurance/.

Guannel, G. et al. (2016), "The Power of Three: Coral Reefs, Seagrasses and Mangroves Protect Coastal Regions and Increase Their Resilience", *PloS One* 11(7), e0158094.

Hallegatte, S., F. Lecoq and C. Perthuis (2011), "Designing Climate Change Adaptation Policies: An Economic Framework", *World Bank Working Paper* 5568.

Harou, A. et al. (2022), "The Joint Effects of Information and Financing Constraints on Technology Adoption: Evidence from a Field Experiment in Rural Tanzania", *Journal of Development Economics* 155, 1–15.

IPCC (2014), *Impacts, Adaptation and Vulnerability, Part A: Global and Sectoral Aspects, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.

IPCC (2023), *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.

Kehler, S. and S. J. Birchall (2023), "Climate Change Adaptation: How Short-term Political Priorities Trample Public Well-being", *Environmental Science & Policy* 146, 144–150.

Masud, M. M., M. N. Azam, M. Mohiuddin, H. Banna, R. Akhtar, A. F. Alam and H. Begum (2017), "Adaptation Barriers and Strategies towards Climate Change: Challenges in the Agricultural Sector", *Journal of Cleaner Production* 156, 698–706.

McGlade, J. et al. (2019), *Global Assessment Report on Disaster Risk Reduction 2019*, UN Office for Disaster Risk Reduction, Geneva.

Mendelsohn, R. (2012), "The Economics of Adaptation to Climate Change in Developing Countries", *Climate Change Economics* 3(2), 1250006.

Mendelsohn, R. (2000), "Efficient Adaptation to Climate Change", *Climatic Change* 45, 583–600.

Met Office (2024), *Global Impacts of Climate Change – Projections*, https://www.metoffice.gov.uk/research/climate/climate-impacts/global-impacts-of-climate-change---projections.

Navarro, D. et al. (2022), *Updating and Integrating CLIMATE Datasets and Maps*, https://archive.espon.eu/climate.

Nielsen, K. S. et al. (2024), "Underestimation of Personal Carbon Footprint Inequality in Four Diverse Countries", *Nature Climate Change* 14, 1136–1143.

Nielsen, K. S. et al. (2021), "The Role of High-Socioeconomic-Status People in Locking in or Rapidly Reducing Energy-Driven Greenhouse Gas Emissions", *Nature Energy* 6, 1011–1016.

O'Donoghue, T. and M. Rabin (2015), Present Bias: Lessons Learned and to Be Learned", *American Economic Review* 105, 273–279.

Patt, A. and D. Schröter (2008), "Perceptions of Climate Risk in Mozambique: Implications for the Success of Adaptation Strategies", *Global Environmental Change* 18, 458–467.

Pavlis, E. S. et al. (2016), "Patterns of Agri-Environmental Scheme Participation in Europe: Indicative Trends from Selected Case Studies", *Land Use Policy* 57, 800–812.

Smit, B. et al. (2001), "Adaptation to Climate Change in the Context of Sustainable Development and Equity", in J. J. McCarthy et al., Eds., *Cli-*

mate Change 2001: Impacts, Adaptation, and Vulnerability, Cambridge University Press, Cambridge, 877–912.

Solomon, S. et al. (2007), *IPCC Fourth Assessment Report (AR4), Climate Change*, https://www.ipcc.ch/report/ar4/syr/.

Stern, N. (2007), *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge.

Sunstein, C. and R. Thaler (2021), *Nudge: The Final Edition*, Penguin, New York.

Szewczyk, W., I. Mongelli and J. C. Ciscar (2021), Heat Stress, Labour Productivity and Adaptation in Europe - A Regional and Occupational Analysis, E*nvironmental Research Letters* 16(10), 105002.

Tenge, A., J. De Graaf and J. Hella (2005), "Financial Efficiency of Major Soil and Water Conservation Measures in West Usambra Highlands, Tanzania", *Applied Geography* 25, 348–366.

The Nature Conservancy (2021a), *A Post-Storm Response and Reed Insurance Primer. Building the Response Capacity to Repair Reefs Damaged by Hurricanes*, https://www.nature.org/content/dam/tnc/nature/en/documents/A_POST_STORM_RESPONSE_REEF_INSURANCE_PRIMER_2021_final.pdf.

The Nature Conservancy (2021b), *A Reef Insurance Primer. Hurricane Damages to Reefs, Repair and Restoration Options and Costs*, https://www.nature.org/content/dam/tnc/nature/en/documents/Reef_insurance_primer.pdf.

The Nature Conservancy (2024), *Insuring Nature to Ensure a Resilient Future Integrated Solutions Linking Nature and Insurance Can Help to Reduce Risk and Build Resilience to the Impacts of Climate Change*, https://www.nature.org/en-us/what-we-do/our-insights/perspectives/insuring-nature-to-ensure-a-resilient-future/.

UNDP (2022), *Human Development Report* 2021–2022, New York.

UNDP (2024), *2024 Global Multidimensional Poverty Index (MPI)*, New York.

UNEP (2023), *UNEP Global Adaptation Network*, https://www.unep.org/gan/node/14318.

World Economic Forum (WEF, 2023), *Accelerating Business Action on Climate Change Adaptation*, https://www3.weforum.org/docs/WEF_Climate_Change_Adaptation_2023.pdf.

World Economic Forum (WEF, 2025), *Catalysing Business Engagement in Early Warning Systems*, https://reports.weforum.org/docs/WEF_Catalysing_Business_Engagement_in_Early_Warning_Systems_2025.pdf.