2 Risks of losses and damages from climate change: context for action

This chapter provides a short overview of current and projected losses and damages from climate change globally, including physical impacts, as well as their short-term and longer-term economic consequences, summarising the latest evidence. It also briefly discusses the options for managing the public financial consequences of climate risks through risk financing.

2.1. Losses and damages from climate change are already happening

Half of the world's population today is highly vulnerable to the risks of climate change, which pose a severe threat to development gains and economic prosperity, including through the potential for significant damage to lives, livelihoods, human health, culture, nature and biodiversity, among others (IPCC, 2022[1]). Global mean temperature has increased by 1.09°C compared to pre-industrial levels (Masson-Delmotte et al., 2021[2]), with significant variation across the Earth's surface. Current levels of action on climate change are inadequate; further warming and long-lasting changes are projected in many components of the Earth system, which will amplify current risks and generate new risks. It is today unequivocal that climate change has started to disrupt human and natural systems (IPCC, 2022[1]).

This report discusses the risks of losses and damages from climate change from a financial management perspective, specifically the approaches and tools that governments can use to assess, reduce and fund the spending needs that are likely to arise as a result of extreme weather events. It builds and elaborates on the discussion on risk financing in the *Managing Climate Risks, Facing up to Losses and Damages* report (OECD, 2021[3]). It is important to differentiate between economic losses and damages[1], referred to in the present report which come from a disaster risk management perspective, from the Loss and Damage (with upper case) discussion under the UNFCCC (see Box 2.1 for a summary of recent progress on Loss and Damage under the UNFCCC).

Climate-related extreme events have created significant losses and damages. For instance, the 2018 droughts, floods and storms in India caused around USD 6 billion in damages (Guha-Sapir, Below and Hoyois, 2021[4]). Hurricane Dorian caused economic impacts that are estimated at a quarter of the Bahamas' GDP (Zegarra et al., 2020[5]). The 2019-20 Australia wildfire season resulted in 19 million hectares of land being burned, with the economic impacts estimated at AUD 20 billion (Filkov et al., 2020[6]). More recently, the floods caused by heavy rainfall in Western Europe in 2021 led to widespread economic damage (Dewan, 2021[7]). In addition, the extreme temperature events of 2021 and 2022 (e.g. the North American heatwave, the European winter heatwave, the Indian heatwave) demonstrate how the intensity of the extremes is already changing at 1.09°C of warming (OECD, 2021[3]). There is robust scientific evidence that climate change made these events more likely, and many types of extreme weather events are more likely to occur as a result of climate change (Shultz et al., 2020[8]; Hunt and Menon, 2020[9]; van Oldenborgh et al., 2021[10]; Kreienkamp et al., 2021[11]).

Box 2.1. Loss and Damage under the UNFCCC

The Alliance of Small Island States (AOSIS) initiated discussions on Loss and Damage from climate change within the UN climate process in the early 1990s. This discussion emerged in the context of compensation for losses in these countries from sea-level rise and other climate change impacts. The Warsaw International Mechanism (WIM) was established in 2013 with a mandate to "address loss and damage associated with impacts of climate change, including extreme events and slow-onset events in developing countries that are particularly vulnerable to the adverse effects of climate change" (UNFCCC, 2022[12]). The Paris Agreement in its Article 8 further states that "Parties recognize the importance of averting, minimising and addressing loss and damage associated with the adverse effects of climate change [….]" (Paris Agreement, 2015[13]).

The discussions on Loss and Damage within the UN climate process focus on developing countries. The impacts due to climate change are conditional on exposure and vulnerability, which primarily depend on historical processes and national decision making. Given the political difficulties that surround the issue of responsibility for Loss and Damage, this report does not attempt to define or provide direct guidance on this issue. It is important to note that the Paris Decision "agrees that Article 8 of the Agreement does not involve or provide a basis for any liability or compensation (UNFCCC, 2016[14])".

The recent Conference of the Parties (COP26) at Glasgow saw two important steps in the negotiations under Loss and Damage. First, the Glasgow Dialogue "to discuss the arrangements for the funding of activities to avert, minimise and address loss and damage associated with the adverse impacts of climate change" was established (UNFCCC, 2021[15]). The Dialogue will run until 2024. Second, the functions of the Santiago Network were agreed as "catalysing demand-driven technical assistance, including of relevant organizations, bodies, networks and experts, for the implementation of relevant approaches to averting, minimizing and addressing loss and damage in developing countries that are particularly vulnerable to the adverse effects of climate change".

Source: Expanded from (OECD, 2021[3])

Efforts in both climate mitigation and adaptation are key to reducing and managing risks from climate-related losses and damages, along with other interventions including disaster risk reduction, disaster risk finance and humanitarian assistance. This includes taking a precautionary approach by aiming to limit the temperature increase to 1.5ºC, by accelerating transition to net zero and short-term targets and plans, as well as creating a more ambitious international development co-operation landscape supporting efforts to reduce and manage current impacts and projected risks of losses and damages. Relatedly, there is a need to strengthen the global architecture for climate and disaster risk finance, through enhancing the availability and access to financial protection instruments and increasing the co-ordination of international support (OECD, 2021[3]). The present report aims to address these latter points.

2.2. Projected risks of losses and damages

The risk of losses and damages can be seen as the result of the interactions of climate-related hazards, exposure of people and assets and their vulnerability to hazards (IPCC, 2018[16]). Each of these closely interlinked components require separate analyses and projections, which are complex. For hazards, some of the key parameters are unknown and local or regional projections are incredibly difficult. In addition, for exposure and vulnerability the projections are also difficult, because socio-economic developments are not subject to laws of physics like the climate projections, but are the results of economic and demographic changes, and current and future policy choices.

Climate-related hazards are divided into three broad categories by the IPCC (IPCC, 2018[16]): extreme events, slow-onset event, and tipping points. Extreme events are events in weather which are considered rare for a particular time and place[2] (IPCC, 2018[16]). Examples could include strong cyclones, heatwaves or floods. By contrast, slow-onset events are "phenomena caused or intensified by anthropogenic climate change that take place over prolonged periods of time – typically decades, or even centuries – without a clear start or end point" (Schäfer et al., 2021[17]), for example sea-level rise or temperature change. Finally, climate system tipping points are "critical threshold[s] beyond which the system reorganises, often abruptly and/or irreversibly" (Chen, 2021[18]). Examples would be the Atlantic overturning circulation or the melting of the Greenland ice sheet (OECD, 2021[3]). Slow-onset events and tipping points, are outside the scope of the present report beyond a brief discussion in Box 2.2.

In addition, events can be categorised as either "extensive", or chronic, versus acute. The 'extensive events' has received attention in the disaster risk literature.[3] Extensive events are more frequent, more localised and result in less severe hazard events than extreme events, but can still result in substantial losses over time. As they are less severe, they cannot be described as 'extreme', but they have high localised impacts, and may have consequences for local public budgets and, where insurance markets are present, for the cost and coverage of insurance in the affected areas.

Projections show that the frequency and severity of *extreme events* will increase, which is already observable for heatwaves and floods (Masson-Delmotte et al., 2021[2]). If extreme events will become more frequent, the window for recovery and rebuilding will become shorter, and relief efforts will draw away resources from investments in long-term resilience, and will increase government debt unless revenue generation measures are put in place. In 2019, for example, Mozambique was hit by Tropical Cyclones Idai (March) and Kenneth (April). This pushed government debt to 103% of gross domestic product (GDP) that year. Mozambique was hit again by two major cyclones in January and February 2021; debt is projected to reach 125% of GDP by the end of 2021 (IMF, 2021[19]). In a sense, such events can turn into real "black swan" events, with cascading and unpredictable economic effects if they result in broader supply chain disruptions.

Box 2.2. Possible economic impacts of slow-onset events and tipping points

In addition to extreme and extensive events, *slow-onset events* are also slowly materialising, with projections indicating an increasing risks. The impacts of slow-onset changes such as temperature increase or sea-level rise might be over time even larger than those of extreme events (Kalkuhl and Wenz, 2020[20]) (Haer et al., 2013[21]). For example, several studies showed stark impact of year-to-year temperature changes on macroeconomic outcomes, such as GDP (Burke, Hsiang and Miguel, 2015[22]). Sea-level rise will likely challenge existing financial risk management practices. Moreover, different types of hazards interact. For example, sea-level rise is likely to make coastal flooding following hurricanes more severe (Knutson et al., 2021[23]). Slow onset events can also result in the gradual disappearance of major lakes due to desertification, resulting in lack of irrigation, economic deprivation and migration.

The existence of *tipping points* is also a cause for concern. There is evidence that the world is heading towards crossing some of the tipping points for example, the Atlantic Meridional Overturning Circulation (AMOC), which has dramatically slowed in recent years (Liu et al., 2020[24]). The collapse of the AMOC would significantly alter the climate of several regions around the world and affect ecosystems, human health, livelihoods, food security, water supply and economic growth at a global scale. This has the potential to give rise to new climates and novel hazards which countries have little or no experience in dealing with.

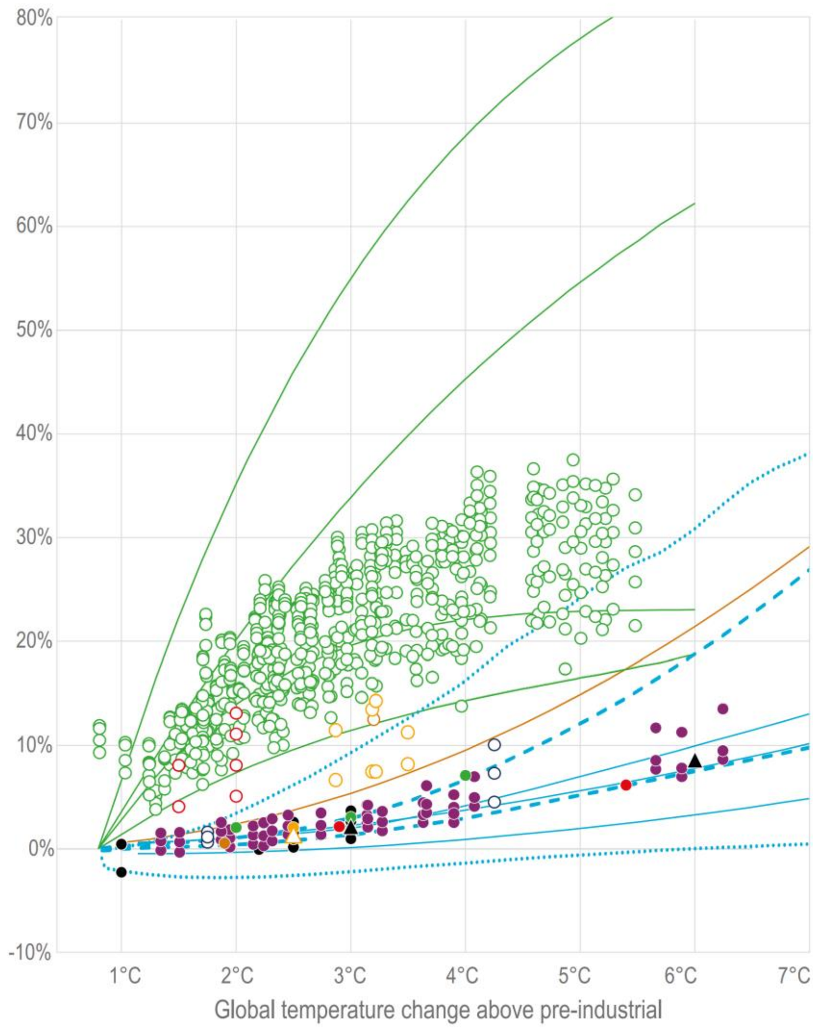
Regarding *extensive events*, while individual events are smaller scale and do not lead themselves to severe losses and damages, the fact that they are multiple and over certain periods of time, can lead to important impacts. Indeed, more than 70% of deaths caused by floods in the last forty years have been caused by extensive floods (Chen et al., 2020[25]). Projections show that extensive events will also become more frequent and severe (Masson-Delmotte et al., 2021[2]).

2.2.1. Global estimates of economic costs of climate impacts

Given their political relevance, questions around the quantification of economic costs associated with climate impacts have occupied scientists and economists for decades, albeit with strong methodological challenges. The Summary of the Working Group II contribution to the IPCC Sixth Assessment report (AR6) states that “global aggregate economic impact estimates are generally found to increase with global average temperature change, as well as vary by other drivers, such as income and population and the composition of the economy”. The report notes that estimates are higher than in its Fifth Assessment Report, suggesting the global costs of aggregate impacts could be higher than previously estimated. Due to the lack of comparability across methodologies (including statistical, structural and meta-analysis), however, AR6 concludes that a range of estimates cannot be provided with confidence (O’Neill, 2022[26]).

Figure 2.1 summarises the range of estimates currently available in the literature, as reviewed by the IPCC. The figure shows a wide range of estimates, including for today's level of global warming (1ºC), stemming from differences in methodologies and scope which hinder the comparability of these estimates. For example, estimates from statistical methodologies tend to be higher than estimates obtained from structural methodologies. The wide ranges may be attributed to a number of factors, including for example assumed persistence of impacts, different types of hazards modelled, assumed stronger adaptation responses, differences in impacts included as well as different societal assumptions, with different models assuming different ways societies might evolve, respond and interact. The large majority of estimates in Figure 2.1 show a non-linear relationship between temperature and losses, with some studies suggesting higher (convex lines) and others a declining (concave lines) marginal economic impacts with higher temperature. The drivers for this non-linearity are not well understood, with potential influencing factors that include methodology, assumptions and data (O'Neill, 2022[26]).

Figure 2.1. Global estimates of the economic costs of climate impacts



Note: Estimates of global aggregate economic costs of climate impacts by global warming level expressed in terms of annual % global GDP loss relative to GDP without additional climate change for each degree of warming. The figure includes estimates form three distinct methodologies types: (a) statistical modelling, (b) structural modelling and (c) meta-analyses. Lines represent functions, with dashed and dotted lines 5th and 95th percentile functions from structural modelling.
Source: (O'Neill, 2022[26])

Despite uncertainties, these estimates provide an indication of the level of pressure climate change could exert in terms of losses and damages. Adaptation strategies can help reduce costs in the short to medium term, while climate change mitigation has an important role to play in avoiding higher levels of warming and in the longer run is the safest option for avoiding costs. Mitigation and adaptation are therefore complementary and are both necessary.

2.3. Managing the public financial consequences of climate risks through risk financing

The economic costs of climate change loss and damage will likely put increased pressure on government finances. There are multiple possible channels. Governments will face higher costs for relief and recovery and rebuilding publicly-owned building and infrastructure in the aftermath of more frequent or severe extreme events as well as increased costs related to investing in adaptation. They will also likely face increasing demands for financial support from households, businesses and sub-national governments impacted by extreme events. For example, spending on unemployment insurance is larger in the years following an extreme event (Deryugina, 2017[27]).

For governments, addressing climate-related risks requires a systematic approach. The report, *Managing climate risks, facing up losses and damages* (OECD, 2021[3]), outlined a way in which risks to public finances can be approached, dividing key functions into risk reduction, risk retention and risk transfer. The following section outlines the approach of the 2021 study, and how the present report takes it forward.

Risk reduction, mainly through prevention and adaptation, is central in the framework. This includes improving the resilience of public assets such as infrastructure and supporting climate resilient development (IPCC, 2022[28]) as well as enabling households and businesses to reduce their own risks, for example through building appropriate incentives into regulatory frameworks. The enabling environment might include the provision of disclosures and relevant information, so the adaptation needs and capacities are clear, and also a stable economic policy with strong property rights. For example, providing information on flood risks decreases the willingness to live in properties at risk (hence reducing exposure) (Hino and Burke, 2021[29]). Private finance for risk reduction and adaptation may also be leveraged by addressing regulatory, cost and market barriers, for example via public-private partnerships (IPCC, 2022[28]). Crucially, risk reduction can decrease the governments' contingent liabilities (as the insurer of last resort) and thus the risk to public finances.

As climate change progresses, losses and damages will increase for the economy, and human and natural systems might reach adaptation limits. Risk reduction by itself may not be enough to manage financial impacts of climate change. The financial impacts of climate-related events may have to be absorbed (risk retention) or otherwise transferred to those willing to assume the risk (risk transfer). In practice, risk retention means that the government, household or business assumes the risk it faces, and must find the necessary funds to address impacts, be it through their own funds or by means of external financing. For governments, this can be arranged *ex ante* (e.g. contingent credit), but can also be arranged *ex post* (e.g. budgetary reallocations), with possibility of corresponding delays and increasing impacts. For larger loss events, budgetary tools and public debt financing may be employed to cover financial impacts, if there is cheap and ready access to international financial markets.

If access to international financial markets is difficult, risk transfer may also potentially be considered for larger loss events. Risk transfer involves risks being transferred to a different entity or group of entities such as insurance companies or capital markets through catastrophe bonds. Such risk transfer mechanisms may benefit from further transfer to reinsurance markets or sharing through risk pooling, in some cases with the support of development finance. Insurance can be acquired either at individual level, by citizens and private businesses, or at the collective level, through governments purchase, such as sovereign parametric insurance. Governments considering risk transfer should first consider their own financial capacity to absorb and manage the risks they face (see analytical framework in Chapter 4).

While there is no one-size-fits-all solution to these problems, Chapter 4 sets out an analytical framework through which the impacts of climate events on public finances and related financial strategies can be examined. The appropriate mix of risk reduction, retention and transfer will vary according to relative costs and benefits of the different measures in relation to the climate impacts they help avoid or mitigate, along with country-specific factors and preferences. The suitable set of measures will depend on the financial vulnerabilities as well as the budgetary and financing capacities of the country, among other country-specific factors. Furthermore, measures may be tailored to specific risks. Developing countries – and particularly lower income developing countries – will clearly face greater challenges in accessing necessary funding through fiscal frameworks, debt financing and risk transfer than developed countries with greater fiscal capacity and access to capital markets.

The importance of quick and reliable access to funds must be underlined. Governments need to ensure that financing will be available when needed – and that operational procedures are in place to disburse the funds effectively; otherwise, recovery and reconstruction will be delayed and prolonged, and macroeconomic impacts will deepen. Box 2.3 expands on the importance of adequate funding arrangements. Insofar as contingency reserves prove inadequate, developed countries might have access to international financial markets and can issue debt readily, tapping into domestic or foreign savings. For other countries, which might face financing constraints, for example, due to high levels of public debt or a low capacity to introduce revenue-generating measures (e.g. taxes), quickly securing adequate funds might often require alternate financing arrangements.

The report builds on the 2021 OECD report (2021[3]) by providing a deeper examination of the challenges and trade-offs that the central governments face in responding to the fiscal challenges arising from climate losses and damages. It also moves beyond purely conceptual considerations and examines how different financial risk management strategies and instruments are applied in practice and how they could complement each other. It explores the advantages and disadvantages of each instrument, their nature and interrelationship, the possible impediments or disincentives for their creation or use. Further, it discusses the options for managing climate risks within public finance frameworks, in OECD countries as well as in countries with lower levels of insurance market development and more limited or volatile access to international debt and capital markets.

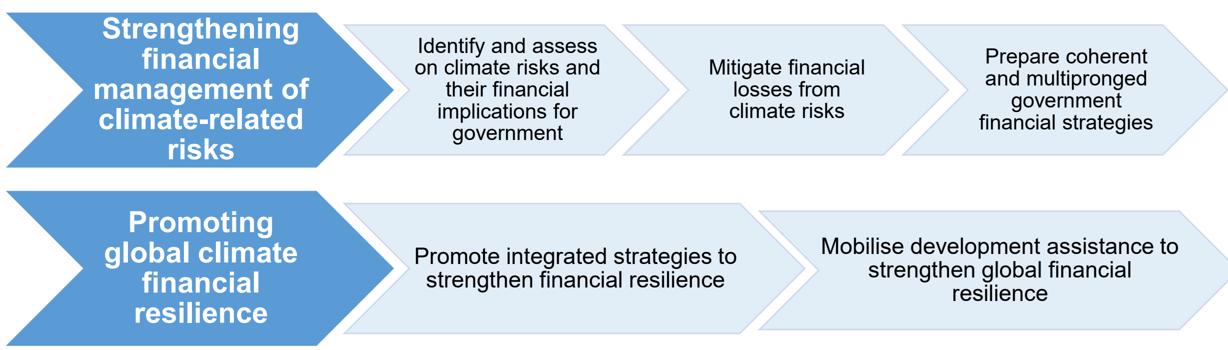
Box 2.3. The role of adequate funding arrangements in reducing economic and social impacts

Ensuring adequate funding to support relief, recovery and reconstruction may play an important role in reducing the economic and social impacts of catastrophe events. For example, a number of examinations of the impact of broad insurance coverage to post-event economic recovery have shown that countries with high-levels of insurance (and reinsurance) coverage usually recover more quickly (Melecky and Raddatz, 2011[30]) (Von Peter, Von Dahlen and Saxena, 2012[31]), (OECD, 2018[32]), (Cambridge Centre for Risk Studies and AXA XL, 2020[33]), (Fache Rousová et al., 2021[34]) – which may be at least partly explained by the availability of insurance funding to support reconstruction (Fache Rousová et al., 2021[34]). Inadequate access to funding in the aftermath of a catastrophe event may slow recovery and reconstruction and increase the macroeconomic cost of the event. For example, GDP in Honduras was estimated to be 6% lower five years after the impact of Hurricane Mitch in 1998 relative to pre-event projections, potentially as a result of widespread difficulties in repairing public infrastructure and assisting private sector recovery (Hochrainer-Stigler et al., 2014[35]). In Madagascar, the government was only able to fund an estimated 13% of recovery and reconstruction needs after the 2008 cyclone season which resulted in a decline in macroeconomic performance (Hochrainer-Stigler et al., 2014[35]).

Figure 2.2 provides an overview of the analytical framework developed for this report. It has two parts, which proceed in consecutive steps. The first part is about strengthening the public financial management of climate-related risks by government at the national level. Climate-related physical risks, first, need to be identified and better understood in terms of their components (hazards, exposure and vulnerability) and sources. This includes both data about past risks, disclosures about current risks and projections about future ones. Once the risks and the sources of the risks are identified, there is scope for mitigating financial losses from climate risks, through investment in adaptation and risk reduction. Investments in risk reduction and adaptation will be necessary across all segments of society, requiring appropriate incentives are in place to encourage such investment by households, businesses and sub-national governments. Risks will remain even after the best efforts to reduce them. The next step is to ensure sufficient funding to respond to these residual risks, through coherent and integrated multipronged government financial strategies.

The second part discusses the importance of promoting global climate financial resilience. Development partners should promote integrated strategies to strengthen financial resilience at the country or regional level, through multiple channels. It is also important to promote coordinated action in terms of international assistance, with the overarching goal of promoting global climate financial resilience.

Figure 2.2. Stylised illustration of the framework for action



The next chapter examines governments' financial exposure and vulnerabilities arising from climate-related extreme events. Chapter 3 provides an overview of the budgetary and financial instruments available for governments to respond to these events. Chapter 4 will draw up and discuss the framework for action, offering key recommendations and illustrate good practices, including concrete applications of risk management instruments in different country contexts and international co-operation.

References

Burke, M., S. Hsiang and E. Miguel (2015), "Global non-linear effect of temperature on economic production", *Nature*, Vol. 527/7577, pp. 235-239, https://doi.org/10.1038/nature15725. [22]

Cambridge Centre for Risk Studies and AXA XL (2020), *Optimising Disaster Recovery: The Role of Insurance Capital in Improving Economic Resilience.*, Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School, https://axaxl.com/-/media/axaxl/files/optimizing-disaster-recovery.pdf (accessed on 20 October 2020). [33]

Chen, B. et al. (2020), "Intensive Versus Extensive Events? Insights from Cumulative Flood-Induced Mortality Over the Globe, 1976–2016", *International Journal of Disaster Risk Science*, Vol. 11/4, pp. 441-451, https://doi.org/10.1007/s13753-020-00288-5. [25]

Chen, D. (2021), "Framing, Context, and Methods.", in Masson-Delmotte, V. (ed.), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. [18]

Deryugina, T. (2017), "The Fiscal Cost of Hurricanes: Disaster Aid versus Social Insurance", *American Economic Journal: Economic Policy*, Vol. 9/3, pp. 168-198, https://doi.org/10.1257/pol.20140296. [27]

Dewan, A. (2021), *Germany's deadly floods were up to 9 times more likely because of climate change, study estimates*, https://edition.cnn.com/2021/08/23/europe/germany-floods-belgium-climate-change-intl/index.html. [7]

Fache Rousová, L. et al. (2021), *Climate Change, Catastrophe and the Macroeconomic Benefits of Insurance*, European Insurance and Occupational Pensions Authority. [34]

Filkov, A. et al. (2020), "Impact of Australia's catastrophic 2019/20 bushfire season on communities and environment. Retrospective analysis and current trends", *Journal of Safety Science and Resilience*, Vol. 1/1, pp. 44-56, https://doi.org/10.1016/j.jnlssr.2020.06.009. [6]

Guha-Sapir, D., R. Below and P. Hoyois (2021), *EM-DAT: The CRED/OFDA International Database*, http://www.emdat.be (accessed on 7 April 2021). [4]

Haer, T. et al. (2013), "Relative sea-level rise and the conterminous United States: Consequences of potential land inundation in terms of population at risk and GDP loss", *Global Environmental Change*, Vol. 23/6, pp. 1627-1636, https://doi.org/10.1016/j.gloenvcha.2013.09.005. [21]

Hino, M. and M. Burke (2021), "The effect of information about climate risk on property values", *Proceedings of the National Academy of Sciences*, Vol. 118/17, p. e2003374118, https://doi.org/10.1073/pnas.2003374118. [29]

Hochrainer-Stigler, S. et al. (2014), "Funding public adaptation to climate-related disasters. Estimates for a global fund", *Global Environmental Change*, Vol. 25/1, pp. 87-96, https://doi.org/10.1016/J.GLOENVCHA.2014.01.011. [35]

Hunt, K. and A. Menon (2020), "The 2018 Kerala floods: a climate change perspective", *Climate Dynamics*, Vol. 54/3-4, pp. 2433-2446, https://doi.org/10.1007/s00382-020-05123-7. [9]

IMF (2021), *World Economic Outlook Database*, IMF Publishing, https://www.imf.org/en/Publications/WEO/weo-database/2021/April (accessed on 1 September 2021). [19]

IPCC (2022), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the IPCC Sixth Assessment Report*, https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/. [28]

IPCC (2022), "Summary for Policymakers", in H.-O. Pörtner et al. (eds.), *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change . In Press.*, Cambridge University Press. [1]

IPCC (2018), "Annex I: Glossary [Matthews, J.B.R. (ed.)]", in Masson-Delmotte, V. et al. (eds.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change…*. [16]

Kalkuhl, M. and L. Wenz (2020), "The impact of climate conditions on economic production. Evidence from a global panel of regions", *Journal of Environmental Economics and Management*, Vol. 103, p. 102360, https://doi.org/10.1016/j.jeem.2020.102360. [20]

Knutson, T. et al. (2021), "Climate change is probably increasing the intensity of tropical cyclones", *ScienceBrief*, Vol. March, pp. 1-7, https://sciencebrief.org/uploads/reviews/ScienceBrief_Review_CYCLONES_Mar2021.pdf. [23]

Kreienkamp, F. et al. (2021), *Rapid attribution of heavy rainfall events leading to the severe flooding in Western Europe during July 2021*, https://www.worldweatherattribution.org/wp-content/uploads/Scientific-report-Western-Europe-floods-2021-attribution.pdf. [11]

Liu, W. et al. (2020), "Climate impacts of a weakened Atlantic Meridional Overturning Circulation in a warming climate", *Science Advances*, Vol. 6/26, https://doi.org/10.1126/sciadv.aaz4876. [24]

Masson-Delmotte, V. et al. (eds.) (2021), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf. [2]

Masson-Delmotte, V. et al. (eds.) (2018), *Annex 1: Glossary*, Intergovernmental Panel on Climate Change (IPCC), https://www.ipcc.ch/sr15/. [36]

McPhillips, L. et al. (2018), "Defining Extreme Events: A Cross-Disciplinary Review", *Earth's Future*, Vol. 6/3, pp. 441-455, https://doi.org/10.1002/2017ef000686. [37]

Melecky, M. and C. Raddatz (2011), "How Do Governments Respond after Catastrophes? Natural-Disaster Shocks and the Fiscal Stance", *Policy Research Working Paper*, No. 5564, World Bank, https://openknowledge.worldbank.org/bitstream/handle/10986/3331/WPS5564.pdf?sequence=1&isAllowed=y (accessed on 22 March 2018). [30]

OECD (2021), *Managing Climate Risks, Facing up to Losses and Damages*, OECD Publishing, Paris, https://doi.org/10.1787/55ea1cc9-en. [3]

OECD (2018), *The Contribution of Reinsurance Markets to Managing Catastrophe Risk*, OECD, http://www.oecd.org/finance/the-contribution-of-reinsurance-markets-to-managing-catastrophe-risk.pdf (accessed on 23 January 2019). [32]

O'Neill, B. (2022), "Key Risks Across Sectors and Regions", in H.-O. Pörtner, D. (ed.), *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. [26]

Paris Agreement (2015), *15 December 2015*, United Nations Treaty Collection Certified True Copies (CTCs) of Multilateral Treaties Deposited with the Secretary-General Chapter XXVII.7.d, https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27 (accessed on 28 April 2020). [13]

Schäfer, L. et al. (2021), *Slow-onset Processes and Resulting Loss and Damage – An introduction*, https://www.germanwatch.org/sites/default/files/FINAL_Slow-onset%20paper%20Teil%201_20.01.pdf. [17]

Shultz, J. et al. (2020), "Double Environmental Injustice — Climate Change, Hurricane Dorian, and the Bahamas", *New England Journal of Medicine*, Vol. 382/1, pp. 1-3, https://doi.org/10.1056/nejmp1912965. [8]

UNFCCC (2022), *Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts (WIM)*, https://unfccc.int/topics/adaptation-and-resilience/workstreams/loss-and-damage/warsaw-international-mechanism (accessed on 17 May 2022). [12]

UNFCCC (2021), *Decision -/CMA.3: Glasgow Climate Pact*. [15]

UNFCCC (2016), *Decision 1/CP.21: Adoption of the Paris Agreement*. [14]

van Oldenborgh, G. et al. (2021), "Attribution of the Australian bushfire risk to anthropogenic climate change", *Natural Hazards and Earth System Sciences*, Vol. 21/3, pp. 941-960, https://doi.org/10.5194/nhess-21-941-2021. [10]

Von Peter, G., S. Von Dahlen and S. Saxena (2012), "Unmitigated disasters? New evidence on the macroeconomic cost of natural catastrophes", *BIS Working Papers*, No. 394, Bank for International Settlements, https://www.bis.org/publ/work394.pdf (accessed on 22 March 2018). [31]

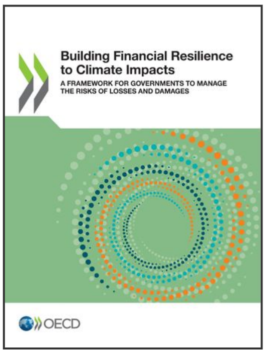
Zegarra, M. et al. (2020), *Impact of Hurricane Dorian in The Bahamas: A View from the Sky*. [5]

Notes

[1] *Damages* refer to physical assets that are totally or partially destroyed in affected areas, measured in physical units (i.e., the number of damaged houses, roads, crops, land, etc.) with monetary values assigned based on replacement costs according to prices prevailing just before the event. *Losses* refer to changes in economic flows arising from the event, from the date of occurrence until full economic recovery and reconstruction has been achieved. Typical losses include the decline in output in productive sectors such as agriculture, industry and services.

[2] Definitions of 'rare' vary over studies, but usually an event is considered rare if it is rarer than the 10th or 90th percentile of an estimated probability distribution (IPCC, 2018[36]).

[3] Some definitions of extreme events also cover extensive events (McPhillips et al., 2018[37]). The IPCC (2018[16]) definition is unclear on this point, thus the report considers it a separate hazard.



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Building Financial Resilience to Climate Impacts

A Framework for Governments to Manage the Risks of Losses and Damages

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