3 Government exposure, financing needs and current and future vulnerabilities

Climate hazards affect public expenditures and revenues in multiple ways and across different levels of government. Following a disaster, revenues can fall due to declining economic activity while, at the same time, expenditures increase due to immediate relief needs and longer-term recovery costs. This chapter provides a deeper understanding of government exposure and the impact of climate hazards on public finances in terms of climate-related fiscal risks, while underlining the difficulties in identifying the full costs borne by public finances. It discusses the role of private insurance coverage of losses and damages from climate hazards across different countries, highlighting the linkage between higher insurance coverage and lower demands for social protection and government compensation. It then discusses the integration of climate change in fiscal risk assessment, including in fiscal forecasting and reporting, across OECD countries.

3.1. Understanding government exposure and the impact of climate hazards on public finances

3.1.1. Government expenditure needs

Climate risks affect government expenditures (as explicit and implicit contingent liabilities) and revenues in different ways. Revenues can fall due to the decline in economic activity. A reduction in tax revenues may be automatic given legislation (e.g. mechanisms triggered to lower the tax burden on individuals and businesses to compensate for losses and damages). It may also have discretionary causes such as targeted tax cuts as a way to cushion the impact on affected populations and businesses. Climate-related disasters generally cause an upward pressure on public expenditures. There may be costs incurred for rebuilding damaged assets and infrastructures. There may also be emergency costs from providing emergency support and relief for displaced people and impacted businesses.

Some of these costs may stem from explicit liabilities while others arise implicitly. There may be explicit commitments to bear the costs of climate losses and damages stemming from legal obligations, such as public compensation or financial assistance arrangements in place to support affected segments of society. Other examples of explicit contingent liabilities materialising include losses stemming from public (re)insurance arrangements or government guarantees and costs related to emergency management and public asset reconstruction. Institutional responsibilities for bearing the costs of climate hazards are often determined in public financial management frameworks (OECD/The World Bank, 2019[1]). However, in other instances, when acting as *de facto* insurers of last resort, governments can also face implicit contingent liabilities as they may feel politically obligated to bear disaster-related costs.

There is also a multilevel governance dimension to how the impact of extreme weather events affects public finances, either at central or subnational government level. Central governments may bear the losses and damages to public assets owned or managed by subnational levels. In such circumstances, local governments in affected areas generally ask for support from the central government to compensate for their losses, and particularly those generated by damages to public assets such as roads, bridges or other infrastructures. Countries often have rules governing the distribution of cost-bearing across levels of governments.

Box 3.1. Responding to climate-related losses and damages: the role of social protection and financial compensation programmes

Climate-related events can lead to damages to homes and business premises and losses in terms of lost income, business interruption and extra expense, including among the self-employed and agricultural producers. In many countries individual citizens may be able to mitigate some of these losses through access to social protection and/or financial compensation programmes.

Social protection programmes

Social protection programmes, including social assistance, social insurance and labour market programmes, play a critical role in protecting individuals from poverty and deprivation (whether long-term or temporary). While most social protection programmes have been designed to address chronic or longer-term poverty and/or vulnerability, these programmes provide a mechanism to respond to some of the financial vulnerabilities that may arise in the aftermath of a climate-related event - particularly where the availability or take-up of insurance coverage is limited (see below):

- Social assistance programmes such as expenditure-financed cash and in-kind transfers can play a critical role in meeting the basic needs of vulnerable households that have been displaced or face livelihood disruptions in the aftermath of climate-related catastrophes. These types of programmes are in place in many countries (developed and developing) to avert chronic poverty and/or food insecurity (Costella et al., 2021[2]) and can be expanded, in terms of reach and/or level of support, in the aftermath of climate-related catastrophes to meet the needs of displaced households (including those that are not normally covered by such programmes) and reduce the pressure on households to resort to harmful coping strategies (O'Brien et al., 2018[3]), (Costella et al., 2021[2]), (OECD, 2021[4]).
- Social insurance programmes such as (contribution-based) unemployment insurance (Costella et al., 2021[2]) are critical for those that face a loss of employment as a result of a climate-related catastrophe, which may be more likely if there are low levels of insurance coverage for business interruption losses. Some unemployment insurance programmes are partially-funded by government expenditure and benefits can be expanded in response to large-scale disruptions from climate (and other types of catastrophes) - as occurred in many countries in response to the COVID-19 containment measures.

Vulnerable households in most (if not all) developed economies have access to social assistance and social insurance programmes such as unemployment insurance. In developing countries, access to social protection varies more widely across countries/regions with much more limited protection available in low and lower middle-income countries (Costella et al., 2021[2]). One estimate suggests that approximately 2.1 billion people in developing countries benefitted from social protection programmes in 2012 although with more limited access to social insurance relative to social assistance programmes (Lowder, Bertini and Croppenstedt, 2017[5]).

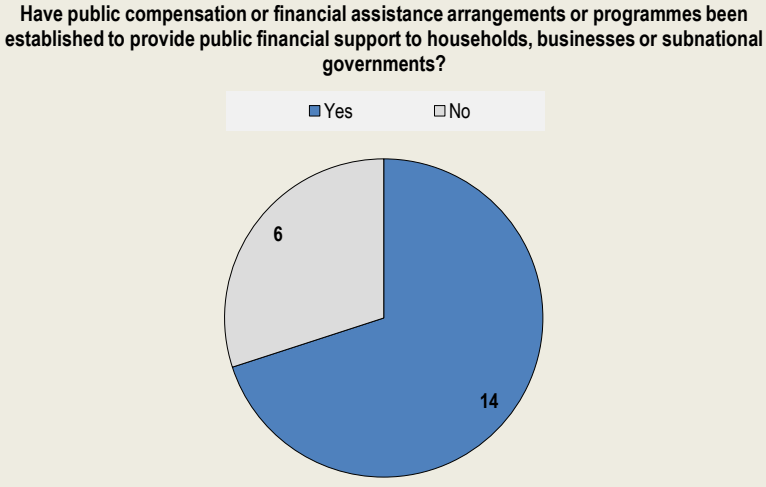
Financial compensation programmes

While social assistance and social insurance programmes can provide (some) support for basic needs and livelihood disruptions, this type of support is not normally targeted (and is not sufficient) as a source of funding for reconstruction of damages to homes or businesses. In many developed countries, governments have established financial compensation programmes to provide financial support to households (and sometimes businesses) for reconstruction after catastrophic events, either established as standing programmes or on an *ad hoc* basis in response to a specific event (see Figure 3.1). The financial support may be provided as tax deductions (e.g. in Czech Republic after flooding in 2013 (Radu,

2021[6])], grants [e.g. Disaster Financial Assistance Arrangements in Canada (OECD/The World Bank, 2019[1])] or low-interest rate loans [e.g. United States' Small Business Administration (SBA, n.d. [50])) – which have different implications in terms of government expenditure accounting. In some countries, compensation is only available for damages that are not insured (e.g. United States) or not insurable (e.g. Canada). Some countries have established dedicated compensation programmes for specific perils for which household insurance is not available (e.g. flood-related damages in Hungary and the Netherlands (Radu, 2021[6])).

A number of developing countries (particularly upper middle-income countries) have also provided financial compensation to affected households in the aftermath of climate events. For example, the government of Dominica provided the equivalent of USD 4 100 to all households impacted by Hurricane Maria in 2017 (USD 116 million in aggregate, equivalent to approximately 60% of general government revenues in 2017) (Government of the Commonwealth of Dominica, 2017[7]). Local governments in Bosnia & Herzegovina provided approximately USD 1.7 million to households after floods in Bosnia in 2014 (Government of the Federation of Bosnia and Herzegovina, 2014[8]). In Georgia, the Tbilisi municipal government provided USD 10.7 million in compensation to support recovery among households after flooding in 2015 (Government of Georgia, 2015[9]). In Thailand after the 2011 floods, the government provided approximately USD 165 to all affected households (with an additional USD 66 for households in need of additional support). A further USD 6 600 (maximum) was offered to households with partially damaged homes and USD 9 900 to households with homes that were completely damaged by the floods (for a total of approximately USD 52 million) (World Bank, 2012[10]). However, governments in low income and lower middle income countries may not have the financial capacity to provide financial compensation to households or businesses impacted by climate-related events, particularly in the context of severe events or when faced with frequent climate losses and damages to households.

Figure 3.1. Financial compensation programmes in OECD countries



Source: Responses to the *OECD survey for assessing implementation of the OECD Recommendation on Disaster Risk Financing Strategies*.

There are a number of challenges to deriving accurate estimates of the fiscal impact of past climate-related extreme events. Estimates of the fiscal impact of climate losses and damages tend to be incomplete. Accounting systems do not directly record disaster-related expenditures as they take place across entities, functions and programmes (OECD and World Bank, 2019[11]). Similarly, reporting systems cannot fully

account for budget transfers that take place to finance emergency relief. For example, some expenditures may be financed from transfers of unspent funds of other budget lines. Finally, expenditures are scattered across levels of government which may not be consolidated to reflect the comprehensive burden of climate losses and damages borne by public finances.

For some major past events, governments or multilateral development organisations (multilateral development banks, UN agencies) have developed post-disaster needs assessments that aim to quantify the damages and losses of the event across all sectors, usually with a separation between damages and losses affecting public and private assets. Some of these assessments also provide estimates of the financial needs for recovery and reconstruction[1], sometimes with a separation between public and private funding needs. Table 3.1 provides an overview of damages, losses and recovery needs for a selection of climate-related catastrophes.

Table 3.1. Past climate catastrophes: loss, damage and recovery need estimates (USD millions)

Event	Damage and loss		Recovery and reconstruction needs (% public, where available)	Needs as a share of GDP	Estimated share of damages and losses insured
	Public	Private			
Storms (El Salvador, 2020)	60 (17%)	301 (83%)	1 212	4.9%	
Hurricane Dorian (Bahamas, 2019)	337 (11%)	2 845 (89%)	2 945	22.4%	71%
Cyclone Idai (Mozambique, 2019)	929 (33%)	1 867 (67%)	2 900	18.8%	4%
Kerala floods (India, 2018)	1 871 (49%)	1 948 (51%)	4 392	0.2%	10%
Hurricane Maria (Dominica, 2017)	467 (36%)	845 (64%)	1 368	253.3%	
Cyclone Winston (Fiji, 2016)	206 (16%)	1 121 (84%)	1 958	39.7%	9%
Floods (Sri Lanka, 2016)	71 (10%)	653 (90%)	959	8.0%	9%
Cyclone Pam (Vanuatu, 2015)	139 (31%)	310 (69%)	316 (52% public)	42.4%	1%
Tbilisi Floods (Georgia, 2015)	21 (73%)	8 (27%)	118	0.8%	
Bosnia floods (Bosnia & Herzegovina, 2014)	687 (25%)	2 064 (75%)	2 386	9.5%	
Floods (Thailand, 2011)	4 711 (10%)	42 759 (90%)	49 632 (26% public)	13.4%	33%
Elbe floods (Germany, 2002)	5 591 (56%)	4 383 (44%)			21%

Source: (Gobierno de El Salvador, 2021[12]), (Bello et al., 2020[13]), (Government of Mozambique, 2019[14]), (Government of Kerala, 2018[15]), (Government of the Commonwealth of Dominica, 2017[7]), (Government of Fiji, 2016[16]) , (Ministry of Disaster Management and Ministry of National Policies and Economic Affairs, 2016[17]), (Vanuatu Prime Minister's Office, 2015[18]), (Government of Georgia, 2015[9]), (Government of the Federation of Bosnia and Herzegovina, 2014[8]), (World Bank, 2012[10]), (Mechler and Weichselgartner, 2003[19]). Data on GDP is from (IMF, 2021[20]). Data on average annual losses is from (Swiss Re sigma, 2020[21])(OECD calculations).

Table 3.2. Recovery and reconstruction funding needs (USD millions)

	Recovery (% of total)	Reconstruction (% of total)	Other needs in USD millions	Basis
Cyclone Winston (Fiji, 2016)	100 (11%)	800 (87%)	14 (resilience)	Recovery needs
Bosnia floods (Bosnia & Herzegovina, 2014)	345 (14%)	2 041 (85%	2 (financial compensation)	Government expenditure needs
Tbilisi Floods (Georgia, 2015)	76 (64%)	32 (27%)	11 (financial compensation)	Government expenditure needs

Source: (Government of Fiji, 2016[16]), (Government of the Federation of Bosnia and Herzegovina, 2014[8]), (Government of Georgia, 2015[9]).

For some events, a breakdown of funding needs (or specifically government expenditure needs) for recovery and reconstruction is provided (see Table 3.2). While the sample of events included above remains small, a few observations can potentially be derived:

- In most cases, the largest share of damages and losses are incurred to private assets (more than two thirds of damages and losses in eight of the twelve events included were identified as private sector);
- While a breakdown between public and private funding needs was only available for two events, in both cases, the public sector share of funding needs was larger than the public sector share of incurred damages and losses, suggesting that public sector funding needs include costs beyond the replacement/repair of public assets (i.e. the public sector funding needs likely include funds that will also be used to respond to private sector damages and losses, including reconstruction);
- As might be expected, expenditure needs for reconstruction are significantly greater than expenditure needs for recovery, suggesting that a large share of funding for post-event response may not be required in the immediate aftermath of an event (although this does not diminish the need to ensure rapid funding for relief and recovery as a means to mitigate the impact of climate events on livelihoods);
- While governments in OECD and upper middle income countries have provided financial compensation to households to support recovery and reconstruction, it is not clear that governments in low income and lower middle income capacity have sufficient financial capacity to provide this type of support.

3.1.2. The role of private insurance coverage and other financing tools for households and businesses in mitigating climate-related fiscal risks

In many countries, particularly (but not exclusively) developed countries, households and businesses can often acquire insurance to provide financial protection against climate-related losses and damages (although, as discussed below, coverage for many climate-perils is not automatically included in property insurance policies in many countries). There are a number of "survey" types of insurance coverage that provide some financial protection against the losses and damages that households and businesses could face as a result of a climate-related event:

- Households can acquire property (or fire) insurance coverage for their homes (and/or possessions) that will cover some of the cost of rebuilding (or relocating) their home and/or replacing their possessions. Some residential property insurance policies include coverage for temporary living expenses if the policyholder's home is inhabitable or inaccessible.
- Businesses (including infrastructure owners) can acquire property (or fire) insurance coverage for their offices/facilities/infrastructure assets along with their machinery, equipment and inventories that will cover some of the cost of rebuilding property and replacing equipment. Some commercial

property insurance policies include (usually as an optional addition) coverage for business interruption losses that replace lost revenue or profit while the policyholders business activity is disrupted.

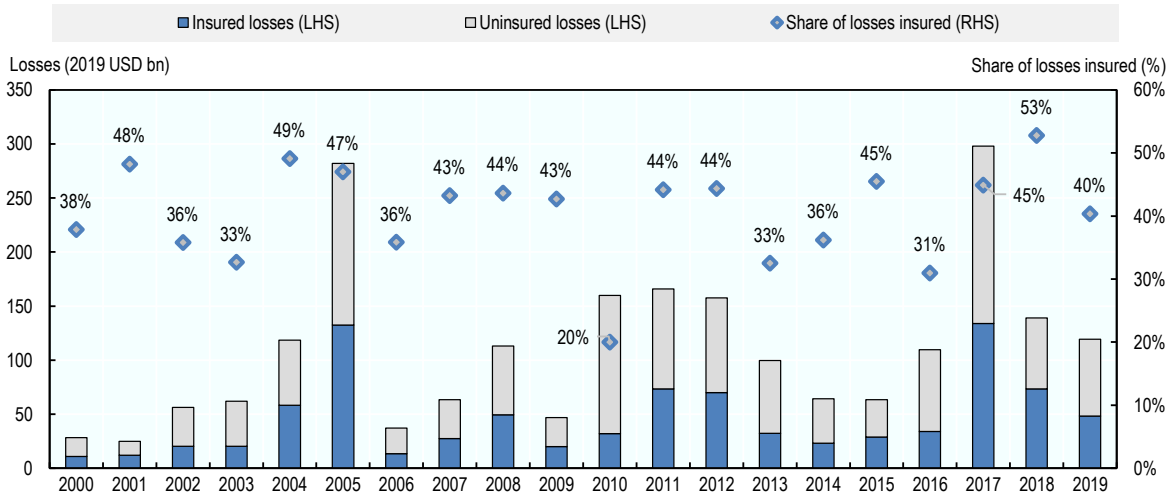
- Agricultural producers can acquire agriculture insurance coverage that protects against lost income as a result of weather-related (and sometimes market-related) reductions in yield or revenues/prices.

In many countries, micro-insurance products have been developed to provide some coverage for climate-related losses and damages for households, (small) businesses and agricultural producers, including various types of crop and livestock insurance coverages, property damage coverage and business interruption covers (Milliman, 2021[22]). Micro-insurance policies tend to provide more limited payouts than "traditional" property and agricultural insurance which lowers the cost of coverage and increases access for low-income households, small businesses and agricultural producers.

High levels of insurance coverage that respond to climate-related damages and losses can reduce the need (and demand) for social and financial support or compensation programmes from the government, thus mitigating the pressures on public finances in the aftermath of a major event. While there are no comprehensive examinations of this link, some studies have found evidence that higher levels of insurance coverage lead to lower post-event public expenditure. For example, one examination of specific past large events estimated that an increase in insurance penetration of 1 percentage point is linked to a reduction in post-disaster government expenditure equivalent to 22 percentage points of the damages incurred (Lloyd's, 2012[23]). Similarly, government expenditures on post-disaster recovery and reconstruction (as assessed by the OECD and World Bank (2019[1])) appears to have been much higher in Japan (approximately 81% of economic losses) relative to Australia and Canada (approximately 40% and 22% of economic losses, respectively) where the share of losses insured was significantly higher.[2] The role of insurance in mitigating the fiscal implications of climate-related catastrophes has also been recognised by the major sovereign credit ratings agencies (Standard & Poor's Ratings Service, 2015[24]), (Moody's, 2021[25]).

However, in many countries, developed and developing, there is a significant gap between insured losses and the overall (or economic) losses and damages resulting from climate-related events – i.e. a significant share of overall losses are uninsured and therefore absorbed by households, businesses and governments (where social protection, financial support or compensation is provided) (see Figure 3.2).

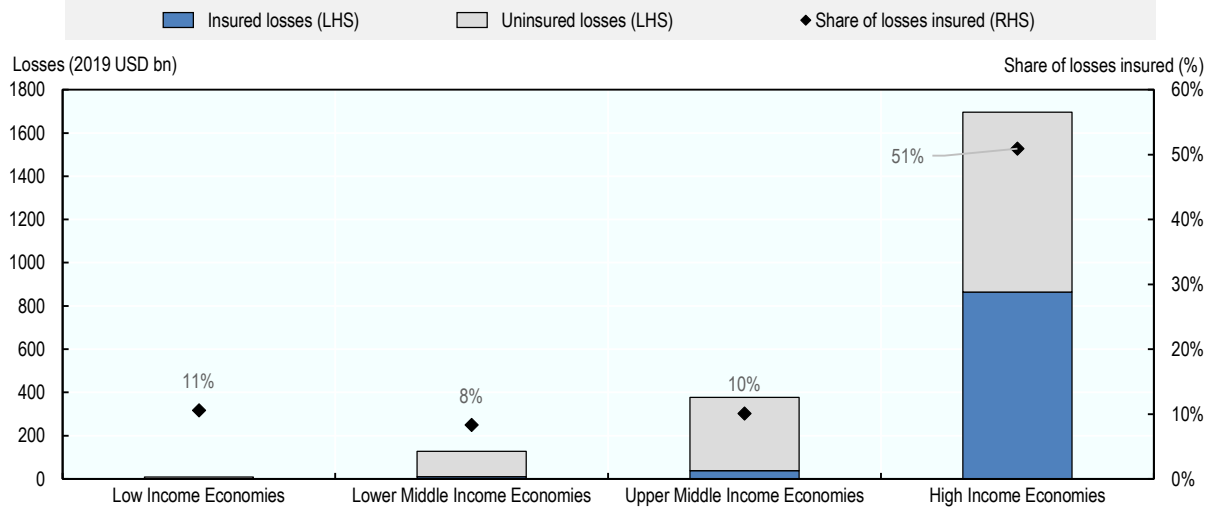
Figure 3.2. Insurance coverage of climate-related catastrophe damages and losses (2000-2019, all countries)



Note: Includes catastrophe events classified as drought/bushfire/heatwave, flood, storm (as main peril) and only events with both an economic and insured loss estimate.
Source: OECD calculations based on (Swiss Re sigma, 2020[21]).

While data is more limited for lower-income countries (relative to high-income countries), there is clearly a much more significant gap between insured and overall losses in lower-income countries (see Figure 3.3), reflecting lower levels of financial and insurance market development.

Figure 3.3. Insurance coverage of climate-related catastrophe damages and losses (by income level, all countries)



Note: Includes catastrophe events classified as drought/bushfire/heatwave, flood, storm (as main peril) and only events with both an economic and insured loss estimate. Countries were classified by income group based on (World Bank, 2021[26]).
Source: OECD calculations based on (Swiss Re sigma, 2020[21])

However, transferring even the vast majority of climate-related risks from households and businesses to insurance companies will not completely eliminate fiscal risks as governments may still face exposures to loss if (individual) insurance companies do not have sufficient financial capacity (including in terms of risk transferred to reinsurance markets) to absorb the losses they face in the aftermath of a significant climate catastrophe. High-levels of uncertainty leading to significant underestimation of the impact of climate change on the magnitude of losses and damages covered by insurance companies could potentially lead to insufficient reserves within the insurance sector although a robust insurance regulatory and solvency framework – along with the establishment of resilient insurance guarantee schemes[3] – may reduce the risk that insurers' commitments to policyholders will not be met.

Access to credit can also provide an important source of funding for households and businesses impacted by climate-events (and therefore potentially reduce fiscal risks) – particularly where insurance coverage of the resulting damage and losses is limited. Studies have shown that access to credit is linked to quicker recovery after natural disasters as countries that are less constrained by credit limitations have access to the funding needed to invest in recovery and reconstruction (McDermott, Barryy and Tol, 2014[27]). In Nepal, one study that examined the impact of livelihood restoration loans after the 2015 earthquake found that – by 2018 – those that had received the loans had income levels that exceeded their pre-earthquake income while non-beneficiaries had yet to recover (Ozaki, 2019[28]).

3.2. Identifying and integrating climate change in fiscal risks assessment

3.2.1. Identification and quantification of climate-related fiscal risks

Climate losses and damages constitute a fiscal risk insofar as they can cause fiscal outcomes to deviate from the forecasts. The OECD Principles on Budgetary Governance recommend that countries clearly identify, classify and quantify fiscal risks, including contingent liabilities (OECD, 2015[29]). For these risks to be governed and managed, their sources first need to be identified. The identification of fiscal risks can provide governments with an idea of the potential financial commitments the government will have to make if climate hazards materialise. In this way, risk assessments inform the allocation of resources to manage climate losses and damages. Many countries perform some form of national climate risk assessment by building on existing experience with overall national risk assessments (OECD, 2018[30]).

However, there are two challenges in identifying and quantifying climate-related fiscal risks. First, national risk assessments are mostly qualitative in nature. The United Kingdom may be an exception to this. While the risks identified in the United Kingdom's 2017 Climate Change Risk Assessment (CCRA) were mostly not quantified, they are quantified in the 2021 report (Sayers et al., 2020[31]). For example, the expected annual damages from floods should increase from GBP 2 billion currently to GBP 2.7-3.0 billion in the 2080s under a 2°C increase and to GBP 3.5-.9.0 billion under a 4°C increase. The second challenge is to move from a physical quantification of risks into a practical application of how they may impact public finances, and thus constitute fiscal risks.

In many instances, the fiscal impact of climate risks is discussed through broader macroeconomic analyses, notably of potential pressures to long-term fiscal sustainability. These analyses are prepared as part of overall sound fiscal management. The assessment of potential fiscal costs in macroeconomic modelling helps countries outline realistic budget targets and develop sound fiscal strategies. Underestimating structural budget challenges related to climate-related risks, on the other hand, would impair fiscal credibility and have negative consequences for debt sustainability in the longer run.

Whether qualitative or quantitative, fiscal risk assessments can be used as a first step towards the quantification of climate risks and fiscal risks assessment. For example, in Switzerland, the Federal Department of Finance publishes a yearly Long-Term Fiscal Sustainability Outlook. In its 2016 report, it dedicated a qualitative analysis of the relationships between climate change and public finances. In 2021,

the analysis remained qualitative but the report suggested to move to a quantitative analysis of the impact of climate change and public finances in further work. It also indicated that "a review of all the budgetary risks would prevent other risks falling under the radar and rank the risk of climate change in relation to the other risks" (Swiss Federal Department of Finance, 2021[32]).

While climate-related fiscal risk measurements rarely draw from broader climate or natural disaster risk assessments, some countries have made the choice of bridging the two together (e.g. New Zealand, United States, United Kingdom, Canada). This is the case for the United Kingdom: the 2021 Fiscal Risks Report by the Office for Budget Responsibility (OBR) extensively refers to the country's latest CCRA. In New Zealand, the government produced a national Climate Change Risk Assessment in August 2020 which identifies 43 risks from climate change. New Zealand is currently preparing a National Adaptation Plan to develop its response to the risks identified in the National Climate Change Risk Assessment. The Treasury's 2021 Half-Year Economic and Fiscal Update explains that the National Adaptation Plan that is being developed in response to the CCRA will identify sources of fiscal risk (New Zealand Treasury, 2021[33]). The CCRA considers "risks to governments from economic costs associated with lost productivity, disaster relief expenditure and unfunded contingent liabilities due to extreme events and ongoing, gradual changes" as one of its ten most urgent risks. In the United States, such analysis is undertaken both within the executive branch by the Office for Management and Budget (OMB) and by the Independent Congressional Budget Office (CBO) and has explored the fiscal impact of climate losses and damages (see Box 3.2).

Box 3.2. Efforts to identify and quantify climate-related fiscal risks in the United States

Office for Management and Budget

The Office for Management and Budget (OMB) announced in 2021 that it will produce, as part of the 2023 budget, a discussion of potential impacts of climate risks in the Long-term Budget Outlook as well as an evaluation of the federal government's climate risk exposure. Prior to this, a 2016 OMB report discussed the effect of climate change on public finances (Office for Management and Budget, 2016[34]). The report draws from analyses made in the National Climate Assessment. The report concentrates on climate risks to five specific programmes: crop insurance, health care, wildfire suppression, hurricane-related disaster relief, and Federal facility flood risk. Fiscal risks are understood in the report as "increases in expected multi-year average costs due to unmitigated climate change, holding demographic, economic, and policy factors constant or in line with current trajectories". Mitigation and adaptation measures (e.g. preventive investments) were not taken into account in the assessment.

Congressional Budget Office

The US Congressional Budget Office (CBO) was also active in the identification of fiscal risks stemming from climate hazards and extreme weather events. It published, in 2016, a study of fiscal damage (i.e. the combined impact of higher spending and lower revenues) caused by higher intensity hurricanes and higher sea level, which fed the OMB report that was produced the same year.

A similar study was produced in 2019, focusing on hurricane winds and storm-related flooding. In 2021, the CBO published a qualitative assessment, brief but broader in scope than the precedent publication, of the effect of climate change on the budget.

Note: This box aims at presenting some examples of quantification of fiscal impact of climate risks rather than an exhaustive list.
Source: (Office for Management and Budget, 2016[34]; Vahlsing and Yagan, 2021[35]; Congressional Budget Office, 2021[36])

Once sources of risk are identified, the potential size of impact can then be estimated, including from a fiscal standpoint. The OECD suggests two approaches to estimate the size of disaster-related contingent

liabilities: direct estimation and estimation via probabilistic modelling (OECD and World Bank, 2019[11]). The first method consists in deriving estimates from historical data on past hazards. Such information may be obtained from data repositories, payouts from relief funds, disclosed data on the spending to respond to hazards and disasters as well as from insurance programmes. Japan is notable in this regard as it records *ex post* disaster-related expenditures and also records the expenditure invested *ex ante* into prevention efforts (OECD and World Bank, 2019[11]).

The costs of climate-related losses and damages can also be estimated via a modelling of losses based on the probability of a catastrophe. Such methods can complement direct estimates of contingent liabilities but also serve to estimate the cost of extreme events that have not previously occurred. Models of losses from climate change, similar to overall natural disasters, are fragmented across the public and the private sector. For example, (re)insurance companies, intermediaries and specialised catastrophe modelling firms have developed probabilistic models to estimate potential losses and damages for many climate perils, with broad coverage in countries with high-level of insurance coverage for those perils (OECD, 2021[37]). These models have been developed for use by insurance and reinsurance companies in underwriting and pricing the coverage that they provide and could potentially be applied in modelling fiscal risk (although these models have not been designed for that purpose).

Catastrophe modelling can also be developed in the public sector. In Mexico, the Federal Risk Loss Estimation System (R-FONDEN) was developed to quantify probable losses of low-impact frequent events for public assets (OECD, 2017[38]). This probabilistic catastrophe risk assessment system was created in 2007 as a result of a partnership between the country's Ministry of Finance and the Mexican Natural Disasters Fund (FONDEN), which was discontinued in 2020 (Helfgott, 2021[39]). It focused on the losses and damages on public assets caused by four types of disaster, including climate-related risks: earthquakes, floods, tropical cyclones and storm surges. In its 2016 study, while it used probabilistic modelling to estimate the contribution of stronger hurricanes and higher sea levels to total expected damage, the US CBO used historical data on Federal disaster relief to measure the expected Federal fiscal cost caused by climate change (Office for Management and Budget, 2016[34]). The Philippines Catastrophe Risk Model was developed in 2014 to provide probabilistic estimates of total losses from typhoons and earthquakes, on an annual long-term average basis (World Bank, 2021[40]). In Colombia, the Government has developed probabilistic risk assessments for a number of climate-related perils, including floods, wildfires and tropical cyclones. The results of the probabilistic risk assessments are published in a risk atlas ("*Atlas de Riesgo de Colombia: revelando los desastres latentes*"), including estimates of expected average annual losses and probable maximum losses.

3.2.2. Integration of climate related losses in economic and fiscal forecasting

When integrating climate related risks in budget forecasts, planners should distinguish between the fiscal consequences of both climate change mitigation and adaptation.

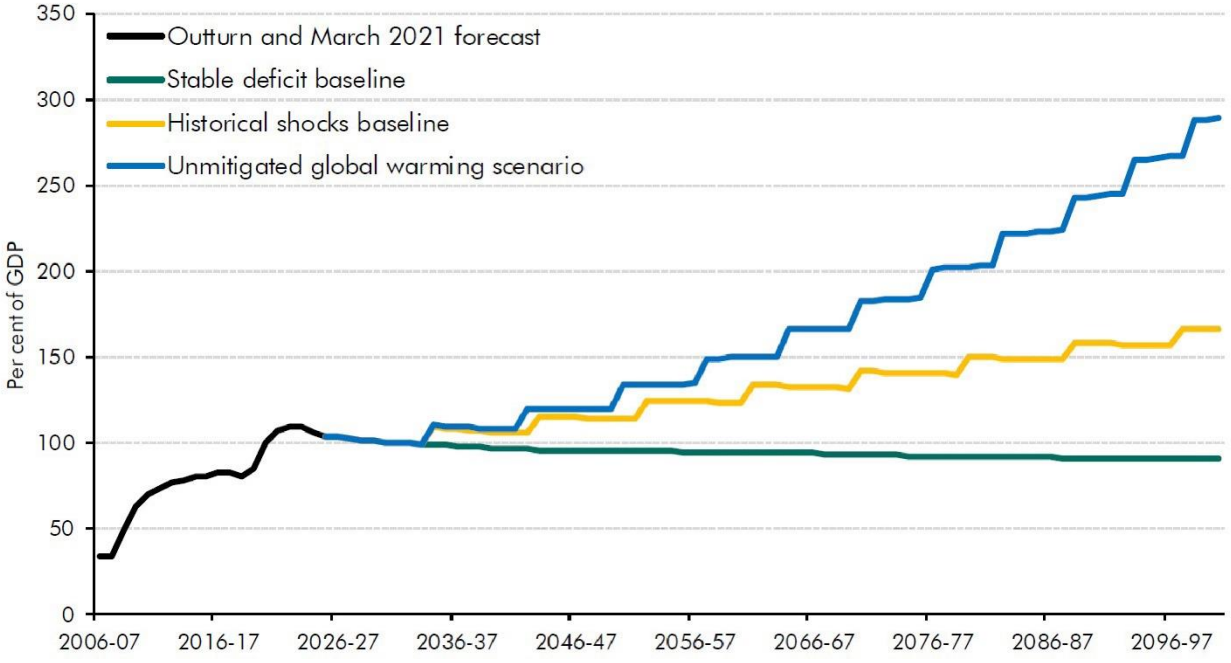
Among countries that have begun to incorporate the climate change transition into forecasts, either through their independent fiscal institutions or their Ministries of Finance, most have focused on mitigation costs**.** Mitigation costs arise from action to address the causes of climate change, mainly through programmes to reduce greenhouse gas emissions (e.g. through the use of electric vehicles) that have both a direct and indirect effect on the public finances. For example, mitigation costs have been incorporated in short-term forecasts in Denmark, Belgium, United Kingdom and New Zealand, among others. In New Zealand, fiscal forecasts include various revenue and spending flows from the country's emissions trading scheme as well as provisions from government agencies to respond to natural hazard events (New Zealand Treasury, 2021[33]). Long-term forecasts of transitions risks are often performed through scenario analysis: a number of countries examine the budgetary costs of achieving their climate targets under different horizons.[4]

Adaptation costs, which represent an investment for the future, on the other hand, are often neglected. Adaptation investments are associated with adjusting the economy and public finances to climate-related

losses that cannot or have not been prevented. Incorporating adaptation investments into budget planning assumptions can be complex, uncertain and resource intensive. Estimates of physical risks to public finances are still scarce. As part of its Long-Term Budget Outlook, the US CBO only includes physical risks in its macroeconomic model to forecast GDP (Council of Economic Advisers and Office for Management and Budget, 2022[41]). Among other things, US executive agencies are currently working towards measuring the financial risks and exposure to unmitigated climate change. The European Commission's 2021 European Fiscal Sustainability Report recently estimated the fiscal impact of physical risks on 13 European countries (European Commission, 2022[42]). The federal government of Mexico has developed a strong capacity in monitoring shorter to longer term macroeconomic risks, including those stemming from specific natural disasters (OECD and World Bank, 2019[11]). In the past, such assessments were used to feed the budgeting decisions of Mexico's major disaster fund, FONDEN. In the Philippines, catastrophe risk modelling is used to assess the government's potential losses and inform the design of risk transfer instruments to adequately finance disaster and climate risks. In Colombia, probabilistic risk assessments are enhanced by an analysis of social vulnerability and resilience (e.g. unemployment, unsatisfied basic needs, risk management capacity) to provide an integrated risk index that supports the prioritisation of risk reduction and preparedness investments.

Mostly due to the complexity of the calculations, estimates of adaptation costs remain relatively rare, even in developed countries. The UK is developing its capacity to estimate the financing needs associated with adapting to the acute and chronic impacts of climate change. In illustrating the adaptation costs from climate change, the UK OBR departed from its traditional methodology of scenario analysis (e.g. on transition risks from climate change). In its scenario for the fiscal impact of unmitigated climate change, the UK's Independent Fiscal Institution made two assumptions. First, adaptation costs increase by 0.3% of GDP per year for each additional temperature degree. Second, the size and frequency of extreme weather events gradually rise with global warming and double in both respects by 2100, as compared with the baseline of historical shocks. This is illustrated in Figure 3.4.

Figure 3.4. The OBR's scenario for unmitigated global warming



Source: (Office for Budget Responsibility, 2021[43])

In the rare cases where adaptation costs have been considered, forecasters have tended to focus on one source of climate risks or one sector of the economy. The Financial Accountability Office (FAO) of Ontario in Canada has recently been estimating the budgetary costs of climate hazards on public infrastructure (Financial Accountability Office of Ontario, 2021[44]). Its first report measured the effect of changes in extreme rainfall, extreme heat and freeze-thaw cycles on the long-term adaptation costs of public buildings and facilities at the provincial and municipal level. Various long-term scenarios are established. Their costs are presented in Box 3.3.

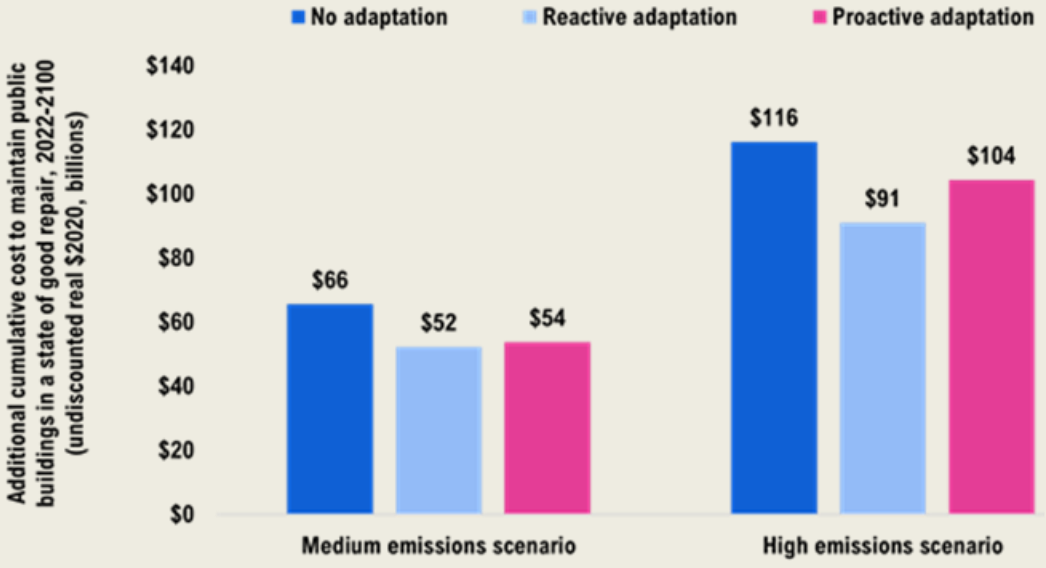
Box 3.3. The financial impact of climate adaptation on Ontario's public buildings

In the medium-term (2022-2030), the FAO argues that relevant climate hazards will add about CAD 6 billion to the existing baseline maintenance costs for public buildings and facilities.

In the long-term (until 2100), the extent of global warming (medium vs. high emissions scenarios) and the asset management strategy (proactive vs. reactive strategy) are the two main factors influencing the size of the impact on the maintenance costs of public buildings and facilities (see Figure below).

- In the high emissions scenario, the cumulative costs of maintaining the existing portfolio of public buildings in a state of good repair would increase by CAD 116 billion by the end of the century (i.e. an average of CAD 1.5 billion per year). This corresponds to a 14.5% rise above the baseline of what would have occurred in a stable climate.
- In a medium emissions scenario, the cost would increase by CAD 66 billion (i.e. an average of CAD 0.8 billion per year). This corresponds to an 8.2% rise over the baseline.

Figure 3.5. The long-term adaptation costs from climate change to maintaining Ontario's public buildings and facilities



Note: The estimates presented in the carts are to be added to the baseline costs.
Source: (Financial Accountability Office of Ontario, 2021[44])

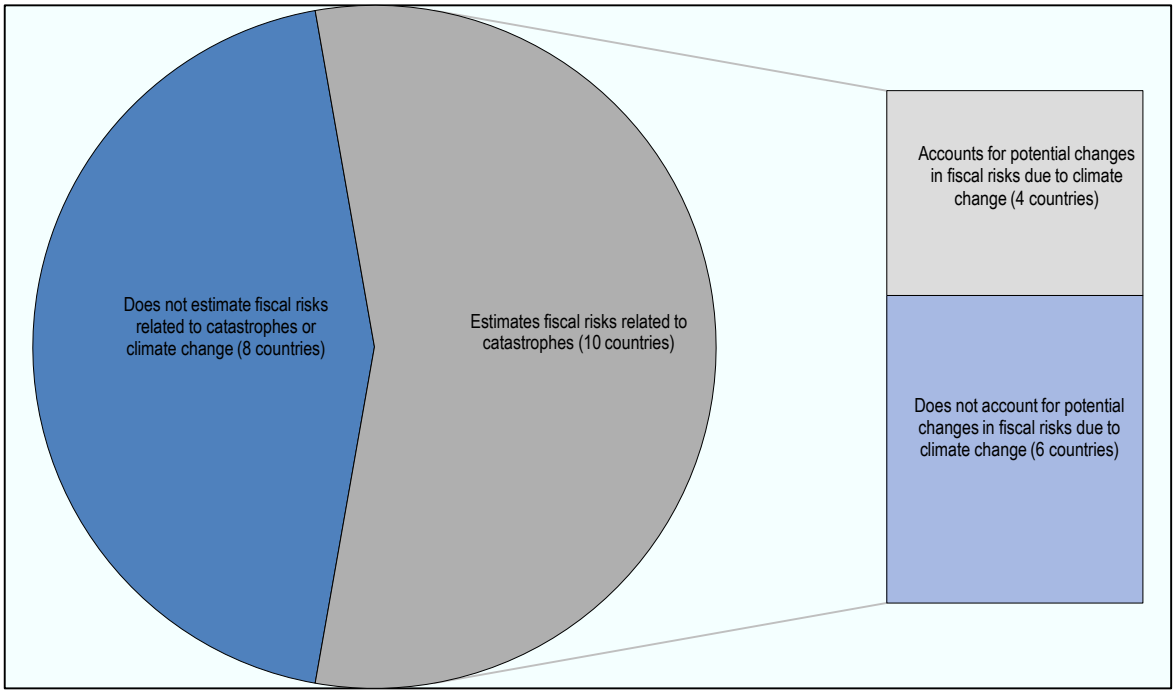
3.2.3. Integration of climate change in fiscal risks management and reporting

The reporting of disaster-related contingent liabilities, including related to climate change, is not yet widespread. Disclosure is usually achieved either as part of the budget reporting process or as part of the fiscal risk management strategy. Climate-related disaster risks may not need recognition as a contingent liability when losses are not of a major nature Notes to financial statements can be used to report and provide some details thereby providing transparency. In the European Union, reporting on disaster-related contingent liabilities is limited (Radu, 2021[6]). In Australia, there is no reference to climate change in the Statement of Fiscal Risks as part of the 2022-2023 budget documentation (The Commonwealth of Australia, 2022[45]). The Debt Statement however includes an analysis of the contribution of climate spending (mitigation and adaptation) to public debt. More generally, independent fiscal institutions and parliamentary budget offices can play a strong role in disclosing the potential impact of climate change on the economy and public finances, given their overall advisory role related to long term fiscal risks.

Still, countries with a generally strong fiscal risks management strategy tend to report these climate risks, whether for adaptation or mitigation, more than others. For example, in the United Kingdom, climate-related fiscal risks are discussed in the OBR's Fiscal Risks Report (Office for Budget Responsibility, 2021[43]). In New Zealand, climate-induced events are considered as fundamentally uncertain and therefore categorised as "general fiscal risks" rather than "specific" fiscal risks which can receive a dedicated analysis (New Zealand Treasury, 2021[33]). In the United States, the Office for Management and Budget announced in 2021 that, as part of next year's budget, it will produce a discussion of potential impacts of climate risks in the Long-term Budget Outlook as well as an evaluation of the federal government's climate risk exposure (Vahlsing and Yagan, 2021[35]). The CBO has already incorporated climate change considerations in its own Long-Term Budget Outlook (Council of Economic Advisers and Office for Management and Budget, 2022[41]).

Reporting on climate-related contingent liabilities can incentivise countries to disclose how such risks are managed and mitigated. Every autumn, the Finnish Ministry of Finance reports on the fiscal risks in the Overview of Central Government Risks and Liabilities. In 2017, climate-related liabilities were already classified as explicit contingent liabilities given the legal basis of the country's climate targets. The Autumn 2021 Overview of Central Government Risks and Liabilities indicates that additional measures are being prepared in the country's climate policy to meet climate commitments to the European Union (Finnish Ministry of Finance, 2022[46]). However, relatively few countries also report how climate risks are managed and mitigated. In its Statement of Specific Fiscal Risks, the New Zealand Treasury identifies multiple cost pressures on existing policies and government programmes emanating from climate change that it categorises as "specific fiscal risks" (New Zealand Treasury, 2021[33])

Figure 3.6. Integration of climate and catastrophe risk into fiscal risk assessment: OECD countries



Source: Responses to the *OECD survey for assessing implementation of the OECD Recommendation on Disaster Risk Financing Strategies*.

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Notes

[1] *Recovery* needs are an estimate of the cost to achieve a given level of recovery and include all interventions necessary to rebuild livelihoods and infrastructure on a sector-by-sector basis. Recovery needs include relief, recovery and reconstruction.

[2] The share of natural catastrophe economic losses insured was estimated to be 56.8% in Canada (for events between 2005 and 2014), 55.6% in Australia (for events between 2002 and 2015) and 20.5% in Japan (for events between 2000 and 2016) (OECD calculations based on data provided by (Swiss Re sigma, 2020[21])). Public expenditure on post-event recovery was estimated to be equivalent to 21.8% of economic losses in Canada (central and subnational governments, based on an assumption of 90% federal share) (PBO, 2016[48]), 40.4% in Australia (central and subnational governments, based on an assumption of 80% federal share) (Productivity Commission, 2014[49]) and 81.0% in Japan (central government) (Cabinet Office, 2016[50]). However, the differences may be explained by differences in policy objectives for financial compensation and support across the three countries.

[3] Insurance guarantee schemes are arrangements established by governments or the insurance sector to ensure that policyholders are protected against the failure of their insurance coverage provider. These schemes will normally assume (some or all) of the obligations of the failed insurer to its policyholders by paying any outstanding claims or benefits and/or transferring the policy to a solvent insurance company. Such schemes exist in both developed and developing countries although to a more limited extent than deposit insurance arrangements (i.e. the banking sector equivalent for protecting bank deposits).

[4] Austria, Switzerland, the United States, the United Kingdom, the Netherlands are among the countries that have performed such exercises. In order to quantify the costs of climate change mitigation, the CPB Netherlands Bureau for Economic Policy Analysis forecasted the fiscal implications of a number of emissions target stringency assumptions to 2030 (Cameron, Lelong and von Trapp, 2022[47])