

ENVIRONMENT DIRECTORATE
ENVIRONMENT POLICY COMMITTEE

Working Party on Climate, Investment and Development

THE ROLE OF GOVERNMENT IN MAKING INFRASTRUCTURE INVESTMENT CLIMATE
RESILIENT: DRAFT SURVEY OF CURRENT PRACTICES

23-24 February 2016

This draft survey paper forms part of the work programme on "Implementing Adaptation in OECD countries". It summarises and categorises the main policy initiatives that have been undertaken at the national level to enhance infrastructure resilience in OECD countries.

Delegates are invited to:

- * Provide comments on this draft survey paper*
- * Note any relevant activities that could be added to this paper*
- * Comment on the suggested follow-up work*

This paper will be discussed at WPCID on 24 February. Written comments are welcome by 4 March 2016.

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Note for delegates

This draft survey paper forms part of the work programme on “Implementing Adaptation in OECD countries”. It builds upon the ideas presented in – and feedback received on - the scoping note [ENV/EPOC/WPCID(2015)8]. Building on previous theoretical literature, it categorises and summarises the main policy initiatives that have been undertaken at the national level to enhance infrastructure climate resilience in OECD countries. Desk-based research has been used to identify and assess the evidence on these initiatives’ effectiveness. Examples from other contexts, such as climate risk screening by Development Finance Institutions, have been included where the approaches taken could also be relevant to OECD countries.

The Secretariat will host an Expert Workshop on Investment in Climate-resilient Infrastructure on 24 February 2016 in Paris. This will provide practitioners’ views on the most effective means by which governments can enhance the resilience of their infrastructure networks. This will be followed by case studies on the integration of climate resilience considerations within 2 or 3 completed infrastructure projects. In line with the work proposed for 2017/18 in [ENV/EPOC(2015)16/ANN7], case studies in the water sector (infrastructure for drinking water supply, wastewater treatment, urban drainage and flood protection) may be prioritised.

The output from this work will be an Environment Working Paper, which will be released by the end of 2016. This paper will provide guidance on how governments can facilitate climate resilient infrastructure, building on the lessons learned from the survey paper, expert workshop and case studies.

WPCID delegates are invited to:

- **Provide comments on this draft survey, including the categorisation of policy levers.**
- **Note any relevant activities that could be added to this survey.**
- **Comment on the suggested follow-up work to this survey and identify potential case studies for the subsequent phase of this analysis.**

Note on terminology: The documents surveyed use both ‘climate adaptation’ and strengthening ‘climate resilience’ to refer to the process of preparing for the effects of climate change, sometimes interchangeably. Both terms are defined in the glossary. As the concept of resilience can be applied more broadly to a range of current and future man-made and natural disasters, it tends to be more commonly used in the infrastructure community and in this paper. The term ‘climate proofing’ is sometimes also used, although it is technically a misnomer as no project or activity can be made completely climate proof.

EXECUTIVE SUMMARY

Ensuring that infrastructure is resilient to climate change is a critical element of countries' efforts to adapt to climate change. Reliable, cost-effective energy, water and transport infrastructure networks underpin economic growth. Climate change poses new challenges for achieving this, as networks have to adapt to changing patterns of extreme events and trend changes. Climate change will need to be considered in the construction of new infrastructure, and it may also be necessary to retrofit existing networks.

The risks from climate change are diverse, ranging from melting roads to flooding of electricity transformers. The appropriate responses to these risks will be context specific, depending on factors including the type, lifespan and location of infrastructure assets. These risks will also evolve over time, in response to changing socio-economic pressures and improved climate projections. As such, the standards and approaches used to manage these risks need to be flexible to respond to changing circumstances.

This survey examines four main ways in which OECD countries are supporting the resilience of their national infrastructure, through information provision, exemplary investment practices, regulation and standards, or by encouraging the disclosure of climate risks. The main findings from each of these categories are presented below.

- The majority of OECD countries have published analyses of the risks faced by their energy, transport and water infrastructure, albeit predominantly qualitative. Some provide finer resolution climate projections and dedicated tools to support climate risk assessment for infrastructure developers and local authorities. Providing evidence for decision making also requires investing in capacity-building and several governments have implemented programmes and created fora to exchange best practices targeting both local authorities' spatial planners and private sector operators.
- Countries are increasingly referring to the need for climate resilience in their national infrastructure planning documents. However, there is currently little evidence that climate risks are being explicitly considered in infrastructure projects financed or commissioned by governments or infrastructure banks. Experience of climate risk screening and infrastructure adaptation is much more documented by national and multilateral development providers and, to a lesser extent, in some multilateral financial institutions investing in OECD countries. Climate adaptation is not considered as a criterion in public procurement, but a better knowledge of climate risks may change the current risk sharing practices in public-private partnership.
- Public policy and regulation offer many levers to support the private sector to integrate climate resilience in infrastructure planning and management. Climate resilience has been mainstreamed in some countries' policies such as spatial planning, mainly through the Environmental Impact Assessment, as well as technical and economic regulation which influence infrastructure. Over a third of OECD countries are revising one or more national technical standard(s) for infrastructure, and two major international organisations for standardisation have started reviewing their technical and management standards to account for climate change adaptation.

- There is increasing interest by governments and the financial sector in climate risk disclosure, but this is still at an earlier stage than reporting for mitigation. There are no commonly agreed methods of reporting climate risks. Several new voluntary initiatives are emerging from investors, as they increasingly recognise this information's relevance for their investment decisions. There is scope for Governments to support privately-led information collection and sharing regarding climate change risks, with a particular focus on critical infrastructure.

A common theme of this analysis is the lack of evidence regarding the evaluation of those mechanisms, their actual impacts and implementation challenges, which may include lack of enforcement capacity and split incentives. Future research could shed light on the integration of climate-related risks in public infrastructure investments (section 2), and the acceptability and cost-effectiveness of regulatory tools (section 3) in driving private sector adaptation. Other relevant areas for further research include the difference in adaptation needs by infrastructure sector, as well as the management of transboundary risks where infrastructure spans several regions or nations.

1. INTRODUCTION

1.1. The importance of climate-resilient infrastructure

1. Infrastructure is essential for sustainable economic and social development. OECD countries and emerging economies are going to invest significant public and private resources into infrastructure, both to upgrade existing systems and build new networks. As an indication of the scale of resources deployed, it has been estimated that approximately USD 90 trillion will be invested globally in new infrastructure between 2015 and 2030 (NCE, 2014). These investments will be shaped by a range of factors including: the ageing of existing infrastructure, changing demographics, as well as policy objectives such as climate change mitigation. By default or by design, these investments will affect countries' resilience to climate change.

2. Infrastructure is vulnerable to current climatic events and, left unmanaged, this vulnerability will increase. Climate change will cause more frequent and severe extreme weather events. These events already cause significant damages to infrastructure, which can have knock-on impacts on other infrastructure sectors and the economy. During Hurricane Sandy, for example, all tunnels connecting Brooklyn and Manhattan were flooded along with other important transportation means including several trains and subway lines. Consequently, 5.4 million weekday riders were stranded without means of transportation (City of New York, 2013). The summer floods in 2007 in the United Kingdom left more than 350 000 people without access to main water supply for 17 days, and cost the economy GBP 3.2 billion in 2007 prices (Pitt, 2008; Chatterton et al., 2010). Impacts on infrastructure will differ widely between OECD countries. For instance, the UK's infrastructure will be impacted by a range of climate impacts including flooding¹ (Table 1), but Canada and Scandinavian countries' infrastructure will also be impacted by the thawing of permafrost, while Australia's will have to cope with extremely high temperatures and reduced water availability.

3. As climate change brings more frequent and extreme weather events, as well as gradual changes in temperatures and sea-level rise, design thresholds which are built into project designs may be breached more frequently in a future changing climate. Projects may have to function within tighter margins between "normal" operation and critical thresholds, resulting in decreased efficiency of equipment and more frequent periods of restricted operation. Ultimately, climate change may result in asset deterioration and reduced asset lifetime, increases in operational expenditure (OPEX) and the need for additional capital expenditure (CAPEX), loss of income, increased risks of environmental damage and litigation (EC, 2013).

4. Infrastructure will be crucial for the success of countries' efforts to build resilience to the effects of climate change. Decisions about design, location and operation of new and upgraded infrastructure will affect countries' exposure to climate risk. By having the right policies in place, there is the opportunity to ensure that this investment supports resilience and avoids locking-in vulnerability. Relatively small upfront expenditures and design changes have the potential to reduce much higher costs further in the future.

¹ Most recently, England's northern region of Cumbria has suffered economic losses of GBP 275 million following storms in 2009 and GBP 500 million after the 2015 storms.

5. A wide range of adaptation measures exist for infrastructure, some of which entail specific actions now while others aim to incorporate flexibility to adjust to future responses (Box 1). Infrastructure assets and networks are both capital-intensive and long-lived. Early action makes economic sense when the project's benefits are highly sensitive to current climate variability, in the presence of strong co-benefits to adaptation, or where decisions today are irreversible. Conversely, when there is flexibility to modify infrastructure design to respond to changes in climate conditions, or improved climate information is expected in the near-future, it might make more sense to build in flexibility for the future (ADB, 2015).

Box 1. Selected infrastructure projects integrating climate resilience in OECD countries and developing countries.

- Following a detailed risk assessment, consideration of interdependencies and 22 months of stakeholder engagement, the second runway of Brisbane **airport** was built at a height of 4.1 metres above sea level, exceeding both the minimum level recommended by engineering consultants (3.5 metres) and the current 1-in-100 year storm tide level (2.3metres). In addition, the tidal channels and a new sea wall along the northern boundary of the airport were built, and the taxiways linking the new runway with the apron areas were also designed to withstand a 1–in-100 storm surge event (Australian Government, 2013; IGCC, 2015).
- To plan its **flood prevention** plan (Cloudburst Management Plan), the City of Copenhagen undertook a high-level assessment followed by a sensitivity analysis, evaluation of exposure, a vulnerability analysis, an economic risk assessment and appraisal of adaptation options. Working with nature to reduce the need for costly upgrades of its drainage system, Copenhagen invested in a network of permeable roads, greenspaces and waterways (Acclimatise, 2012; City of Copenhagen, 2012).
- When financing the modernisation and rehabilitation of the 126 MW Qairokkum **hydropower plant** in Northern Tajikistan, EBRD modelled future hydrology, taking into account a range of climate scenarios and potential impacts. Economic analysis identified the upgrade option with the best economic performance across the entire range of climate scenarios (namely, replacing all existing turbine with higher efficiency equipment) compared with other technical options (replacing only part of the existing turbines, or replacing all turbines and adding an extra one). Training and operating rules were updated to reflect the best knowledge on seasonal hydrology forecasting, and a protocol was created to set out the provisions for sharing and using climatological and hydro-meteorological information (EBRD, 2015). EBRD also worked with Tajikistan municipalities to secure **water supplies** through three climate-resilience measures: switch to deep groundwater intake, upgrade leaky pipe networks, use metering and water pricing to change consumer behaviour (EBRD, 2014).
- For a major **road transport** project including two major bridges, a 15 kilometre road connecting them, and approach roads, the ADB conducted an exposure, vulnerability and adaptation assessment. The preliminary results recommended a phased adaptation approach, first addressing medium-term impacts (with a 30-year horizon) through a 0.3 m elevation for low-lying stretches of the road and 0.3 m elevation for the abutments and piers of six bridges (ADB, 2014). ADB also recommended further research to improve understanding of extreme events and the response of water levels to changing flows.

Table 1: Illustration of climate impacts to infrastructure in OECD countries: summary of potential climate impacts on UK infrastructure (Dawson, 2015)

	Sea level rise				Rainfall						Temperature						Other factors				
	Damage or disruption from coastal flooding	Tide locking	Saline intrusion	Coastal erosion	Damage or disruption from river flooding	Damage or disruption from pluvial flooding	Droughts and low precipitation	Altered capability or efficiency	Biological processes	Stability of earthworks	Severe heat	Severe cold, snow, ice	Altered capacity or efficiency	Subsidence and/or desiccation	Biological processes	Demand for service	Lightning strike	Humidity	Solar radiation	Fog	Storminess and wind damage
Rail	x			x	x	x	x	x		x	x	x	x	x		x	x	x			x
Road	x			x	x	x		x		x	x	x	x	x		x		x		x	x
Ports and marine transport	x	x		x		x					x	x	x							x	x
Potable water	x		x	x	x	x	x	x			x	x	x	x	x	x					x
Waste water and sanitation	x	x	x		x	x	x		x		x	x	x	x	x						
Flood and coastal erosion management	x	x		x	x	x			x		x		x	x							x
Nuclear and fossil-fuel energy generation	x			x	x	x	x		x		x	x	x								x
Renewable energy generation	x				x	x	x					x							x		x
Power systems, transmission and distribution	x				x	x					x		x				x				x
Energy demand	x				x	x	x				x	x				x			x		

1.2. The case for public intervention

6. The extensive literature on investment in infrastructure illustrates the breadth of policy levers that can affect both the availability of finance for investment and how that finance is deployed (OECD, 2007, 2014, 2015a). Within the environmental domain, there is a deep body of analysis on financing the low-carbon transition and financing water and sustainable transport infrastructure (Merck, 2012; Ang and Marchal, 2013, WWC and OECD, 2015). The IEA, ITF and NEA have been taking forward programmes of work examining adaptation in relation to their respective sectors.

7. National governments have increasingly recognised climate resilience for infrastructure as a key area worthy of a dedicated risk assessment (US Global Change Research Program, 2009; Department of Climate Change and Energy Efficiency, 2011) and coordinated policy approach (Canada National Round Table on the Environment and the Economy, 2009; HM Government, 2011). However, transversal analysis in OECD countries is still at an exploratory stage. Research to date tends to focus on identifying the range of factors that are likely to be relevant and outlining a framework for analysis (Kennedy and Corfee-Morlot, 2012; Stenek et al., 2013).

8. The expected benefits of well-designed adaptation measures should outweigh the costs over time. Analysis following recent climatic shocks in the developed world suggests that the current cost of remediating climate-related losses is on average four times the cost of protecting infrastructure and businesses against climate impacts (Viner et al., 2015). However, lack of information, market failures and regulatory distortions all have the potential to deter adaptation. Governments are also responsible for ensuring the resilience of infrastructure that they own and manage. In this context, governments can also intervene to address these barriers using a range of policy levers (adapted from Stenek et al., 2013):

- **Providing evidence for decision making (Section 2)**, for instance by ensuring data availability and accessibility on projected natural hazards, awareness-raising and capacity-building for relevant decision-makers, or by conducting risk assessments accounting for existing infrastructure's exposure.
- **Factoring climate risks in projects they finance or commission directly (Section 3)**. When commissioning infrastructure, Governments can require contractors and suppliers to demonstrate they consider climate risks.
- **Enabling infrastructure resilience through policy and regulation (Section 4)**. The private sectors' incentives to adapt are shaped by the policy and regulatory environment. Governments can support climate-resilient infrastructure by removing regulatory distortions, or adding regulatory requirements to consider climate risks.
- **Supporting disclosure of climate risks (Section 5)**. Climate risk disclosure can encourage action to manage those risks, as well as revealing interdependencies and supporting the design of public policy.

9. Depending on each country's organisation of competencies, actions may need to happen in a coordinated manner at the national and sub-national levels, particularly in federal countries. For example, Australia has clearly defined the roles and responsibilities between different levels of governance when it comes to climate adaptation (Select Council on Climate Change, 2012). In general, national governments focus on providing the tools and information needed to underpin sound decision-making and coordinating the economic and regulatory reforms needed to support resilience. State, territory and local governments have a major role in direct adaptation action, given their greater role in service delivery, land use planning, and management of assets.

2. PROVIDING EVIDENCE FOR DECISION-MAKING

Many OECD countries have assessed at least qualitatively what the key risks might be for their energy, transport and water infrastructure at the national level. Some provide finer resolution climate projections and dedicated tools to support climate risk assessment for infrastructure developers and local authorities. Nonetheless, there are inherent uncertainties in climate modelling, with some aspects being better understood than others. Given the value of the infrastructure investments that they will influence, it is important for uncertainties to be considered in the decision-making process. Several are also raising awareness regarding cascading risks to infrastructure and the need to collaborate between infrastructure owners.

10. Information, data and tools are pre-requisites for adapting infrastructure: decision makers need to be aware of climate change as an issue, of its potential risks and opportunities, as well as adaptation responses. Governments have a role in providing public goods (e.g. climate projections, awareness raising), but can also facilitate the provision of more specialised evidence and capacity. By helping to provide the evidence base and methodological capacity for these decisions, national governments can achieve economies of scale and provide the conditions for cost-effective adaptation to infrastructure

2.1. Access to climate projections and risk assessments

11. The International Panel on Climate Change presents the state of the evidence from a hierarchy of global climate models regarding projected changes to the world's climate (IPCC, 2013). Global and regional² patterns of climate change computed from global climate model output are a useful starting point, but they are unsuitable for informing the design of specific infrastructure in any given location. Projections with a finer geographical resolution require good historical climate data, taking into account uncertainties in observations and consideration of the physical basis of the findings, in order to characterise the credibility of the projections and assess their sensitivity to uncertainties. However, climate modelling and the climate projections derived from them are works in progress. While there is confidence in many of the changes related to the surface temperatures and sea-level over the globe, there is far less confidence in projections that rely on how climate change might affect the dynamics of the climate, e.g. rainfall patterns and extreme weather (Sheperd, 2014).

12. Many OECD countries have produced their own national-level climate projections or statistically downscaled projections from IPCC modelling to understand which climate hazards might affect them. Examples include Austria (Natural Hazard Overview and Risk Assessment or HORA), France (Drias les futurs du climat), New Zealand (Ministry for the Environment, 2008; projections to be updated by end of 2016)³, UK (UK Climate Projections 2009 or UKCP09), United States (NASA Earth Exchange Downscaled Climate Projections, or NEX-DCP30). However, given the need for continued advances in

² The IPCC AR5 presents projections for 35 world regions.

³ Climate Changes, Impacts & Implications for New Zealand. <http://ccii.org.nz/climate-changes-impacts-and-implications-nz/>

climate modelling, the results of such downscaled projections must be treated with some caution given their potential influence on large-scale investments. Some researchers are arguing that such approaches should be complemented by more granular interrogation of past, present and projected future weather events in particular regions to more fully understand the envelope of potential climate behaviour (Hazeleger, 2015). Decision-making approaches are being used that explicitly account for some of the uncertainties (OECD, 2015b)

13. National climate change projections aim to present how changes in climate variables (such as precipitation) will translate into impacts such as drought or flooding, at varying geographical resolution (from 10x10km in Austria and some Australian regions to 25x25km in the UK). Confidence in these projections vary by type of hazard: temperature and precipitation trends are generally better understood than wind patterns, but some degree of uncertainty is inevitable, even with the best models. Countries with large territories where climate impacts may differ widely in direction and intensity have paid particular attention to providing information at the local level. Australia has for instance regionalised its projections following three levels of disaggregation: mega cluster (Southern Australia), cluster (Southern Slopes) and sub cluster (Southern Slopes- East Tasmania).

14. Localised models exhibit greater levels of uncertainty. Both national and local level climate projections, such as those listed above, are increasingly developing user guidance and online platforms to help potential infrastructure end users access and interpret climate model information, the outputs of which are not very accessible in their raw form to non-specialists.

15. In some instances, the downscaling of national climate projections' outputs and provision of user interface is explicitly aiming to assist the long-term planning efforts of climate-sensitive infrastructure sectors, such as hydropower and road transportation. At the national level, Geoscience Australia improved the National Exposure Information System (NEXIS) database in 2012 so it could better support studies of the national implications of climate change impacts on significant Australian infrastructure. At the Australian regional level, the Climate Futures for Tasmania project led by the Antarctic Climate and Ecosystems Cooperative Research Centre has involved HydroTasmania from the start of the research, and produced sophisticated hydrological projections (changes in runoff and river flows) to 2100 that support the company's planning efforts (Bennet et al., 2010). In the United States the Federal Highway Agency has developed the CMIP Climate Data Processing Tool geared towards transportation agencies to help them select appropriate pavement binders or understand what types of flooding an area is likely to experience in the future.

16. Climate data is necessary to infer climate exposure, which refers to the presence of people, ecosystems, infrastructure, or assets in places that could be adversely affected (IPCC, 2013). Climate risk assessments at the national or sectoral levels can help to identify relevant impacts, and provide a basis for identifying risks for specific projects or pieces of infrastructure. All OECD countries have undertaken assessments of the potential impacts from climate change on some form of infrastructure, with varying levels of detail: most have identified qualitative impacts, while others have aimed to quantify the importance of impacts (Table 2). Some countries, such as Australia, have done both. After a first qualitative assessment of the impacts of climate change on the country's physical infrastructure by the Academy of Technological Sciences and Engineering (ATSE, 2008), the Department of Climate Change conducted a national quantitative assessment of infrastructure's exposure to coastal change (Department of Climate Change, 2011). By estimating the value of transportation network at risk of coastal flooding and shoreline recession, this analysis highlighted the importance for new developments to limit an increase in risk and to protect existing assets.

Table 2. Coverage of infrastructure in selected national and regional climate risk assessments (national sources)

	Sectoral coverage			Coverage of climate hazards			Nature of coverage	
	Multi-sectors	Transport only	Water only	Multi-hazard	Coastal change only	River flooding only	Qualitative assessment	Quantitative assessment
AUSTRALIA		x			x		x	x
AUSTRIA	x			x			x	
BELGIUM	x			x			x	
CANADA	x			x			x	(case studies)
DENMARK	x			x			x	
EUROPEAN UNION	x			x			x	
FRANCE	x			x				x
GERMANY	x			x			x	
ITALY	x			x			x	
JAPAN			x	x				x
NETHERLANDS			x		x	x		x
NEW ZEALAND	x			x			x	
SPAIN	x			x				x
SWEDEN								
SWITZERLAND	x			x			x	
UNITED KINGDOM	x			x				x
UNITED STATES	x			x				x

17. An issue of growing importance is the interdependencies between different infrastructure sectors, for instance water treatment plants depending on the electricity network to function, or ports on the accessibility of neighbouring roads. Cascading risks can provoke a chain of failure with important domino effects, but analysis of these remains at an early stage. In the UK, the Infrastructure Transitions Research Consortium has modelled the complex interdependencies between energy and water networks and estimated the economic impacts of cascading failures. In Canada and in France, the DOMINO (Robert et al., 2012) and ROSAU decision-making tools using spatial analysis and geographical information systems (GIS) identify hotspots at the local level where networks are interdependent and may be vulnerable to natural hazards.

2.2. Capacity building

18. In addition to the relevant data being available, infrastructure developers, owners and operators as well as local planners need to have the relevant skills and methods to use this data in conducting their own risk assessments and making adaptation decisions. There are several high-level public guidelines for the integration of climate risks in infrastructure projects, aimed at a range of infrastructure stakeholders. The EU guidelines for making vulnerable investments climate-resilient outlines the roles and responsibilities of the project team in integrating climate resilience and the different steps to follow throughout the conventional asset lifecycle (Acclimatise, 2012). Other guidelines highlight how economic analysis can be used to assess the possible impacts of climate change on investment projects as well as the technical and economic feasibility of a range of climate-proofing options (HM Treasury and Defra, 2009; C3 for Natural Resources Canada, 2012; ADB, 2015). Cost-benefit analysis, which uses key concepts such as time horizon, discount rate, sensitivity analysis and a decision criterion (either net present value, economic internal rate of return or benefit-cost ratio) can be a useful tool tools to support decision-making regarding whether to conduct a project, whether to build in resilience, how and when.

19. To help identify and prioritise risks from a range of climate hazards, tools have been developed to assist infrastructure operators in their risk assessment. In the United States, the Federal Highway Agency has developed specific tools geared towards transportation agencies, such as the Vulnerability Assessment Scoring Tool (VAST), which can help an agency identify, compare, and rank vulnerabilities of specific assets to certain climate ‘stressors’ (temperature changes, precipitation changes, sea level rise, storm surge, and wind). The New Zealand National Institute of Water and Atmospheric Research has developed a toolbox and regularly organises a series of workshops to support planners, engineers, asset managers and hazard analysts to understand and evaluate the potential impacts of climate change on urban infrastructure (NIWA, 2012).

20. Information sharing and collaboration between public and private authorities can also support climate resilience. A combination of several public and private operators as well as regulators and policy-makers may manage or have a strong influence over the infrastructure network. Strengthening resilience requires building trust between partners and giving nudges to share the relevant information, for instance to identify vulnerability hotspots and prepare contingency plans, or share capacity in times of disruption. For example, in the US, the Department of Energy has established the voluntary Energy Resilience Partnership, which brings together 18 utilities providing electricity to about a third of the countries’ consumers as of November 2015.⁴ By creating a community of parties committed to increase their resilience to extreme events and climate change, the partnership facilitates the exchange of knowledge and best practices at the working level and allows information sharing and capacity building.

⁴ Personal comment from Department of Energy, 3 December 2015.

3. CLIMATE RISKS IN INFRASTRUCTURE PROJECTS FINANCED OR COMMISSIONED BY GOVERNMENTS

Beyond the aims set in national infrastructure plans, there is limited evidence that OECD national public investors in infrastructure screen their investments for climate risks. There is growing experience of risk screening by national and multilateral development providers and, to a lesser extent, in some multilateral financial institutions investing in OECD countries. Climate adaptation is not considered as a criterion in public procurement, but there is a growing awareness of its importance for the management of infrastructure. The consideration of a 'new normal' under a changing climate may question traditional risk-sharing mechanisms in public-private partnerships.

3.1. Screening of public sector finance

21. When infrastructure projects are financed by governments, climate risks can be integrated either through complying with regulatory requirements (see section 4.2) or through risk management choices at the project or programme level. Where countries have forward-looking overarching infrastructure plans (either to plan for new infrastructure or maintain existing infrastructure), these plans mention the need to make networks and assets more resilient to climate change, albeit in generic terms (Infrastructure UK, 2014 p.21; NZ National Infrastructure Unit, 2015 p.49; Infrastructure Australia, 2013 p.13; USA Homeland Security, 2013 p.14).

22. Development finance institutions have pioneered the use of mandatory risk screening: they increasingly require the systematic integration of climate risk to their decision-making and planning processes, and several have developed sophisticated screening and decision-support tools, such as Japan's JICA C-FIT Adaptation tool (JICA, 2011). There are several types of governance processes used by development finance institutions to integrate climate resilience. Some, such as ADB, AFD and KfW development bank adopt a two-step approach of systematic climate vulnerability assessment, and a conditional more in-depth analysis, while others such as EBRD adopt a continuous integration process (Figure 1). All of these processes aim to ensure resources dedicated to the risk assessment and resilience solutions are proportionate to the potential damages incurred. Annex 1 presents a more detailed overview of the requirements to climate risk integration, dedicated tools and evaluation of their implementation (when available) for ten of the largest development finance institutions.

23. Despite this proactive approach, the integration of climate risk management to traditional project investment procedures has encountered some difficulties. In particular, multilateral development banks have reported difficulties in the implementation of their in-house tools. The main challenges have been the integration of these tools into project risk analysis, and providing adequate technical support and training for task managers (AfDB, 2013; IDB, 2014).

24. In addition to development finance institutions, some multilateral institutions in the OECD area are increasingly screening the investments that they fund, helping to raise the overall fiduciary standards for the projects they co-finance.

- The European Investment Bank (EIB) aims to develop the use of climate risk and vulnerability assessment and make operations more resilient to climate impacts (EIB, 2015). The Bank is rolling out a systematic climate risk screening tool at the pre-appraisal and appraisal stage and

piloting in-depth climate risk and management analysis to its projects in the water sector, with a view to extend it to other sectors and include regional specifications (EUFIWACC, 2015).

- The Nordic Investment Bank and the Council of Europe Development Bank, which finance mostly infrastructure projects, are preparing guidelines to introduce mandatory screening of climate risks in their projects (EUFIWACC, 2015).
- The European Union has taken an explicit commitment to “climate-proof” the major projects co-financed by the European Structural and Investment Funds for the 2014-2020 period and requires an ‘analysis of the environmental impact taking into account climate change adaptation needs’ (Regulation (EU) No 1303/2013, Commission Implementing Regulation (EU) 2015/207, from Paunescu, 2015).

25. Some emerging economies’ infrastructure banks have indicated an intention to integrate climate risks to their operations. The China Development Bank sustainability report (CDB, 2014) states it used the Global Reporting Initiative Sustainable Reporting Guideline (GRI, 2014) indicator on “Financial implications and other risks and opportunities for the organization’s activities due to climate change” (Specific Standard G4-EC2) although it does not detail how. In India, the India Infrastructure Development Finance Company (IDFC) Sustainability Report (IDFC, 2015) recognises “climate change and the resulting environmental sensitivity to be both a threat and an opportunity”. The IDFC has an internal environment policy aimed at minimizing the environmental impact and carbon footprint of projects (not publicly available) but it is unclear whether this policy accounts for long-term climate risk.

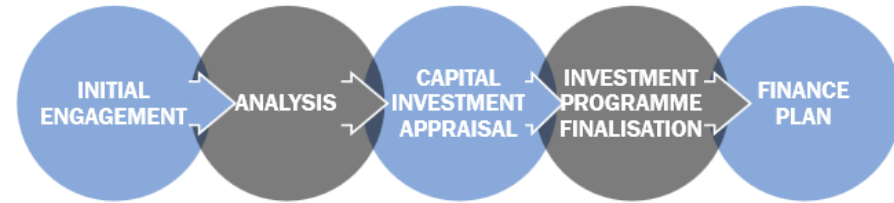
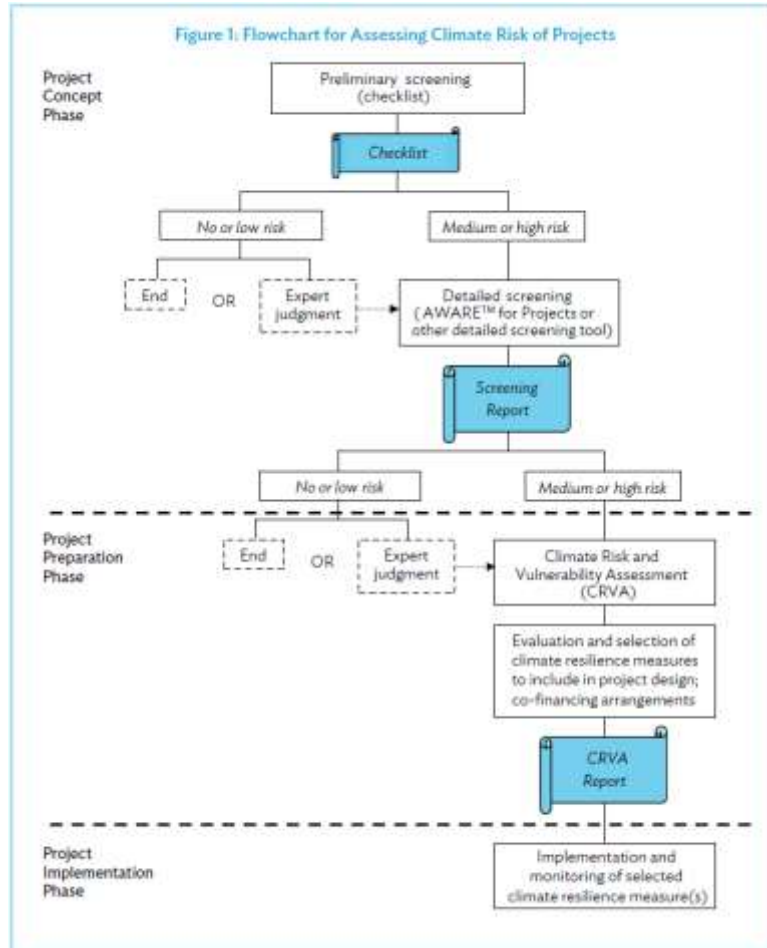
3.2. Resilience criteria’ in public procurement or contractual arrangements for infrastructure

26. Whether a national government is the main investor of an infrastructure project (through, for instance an infrastructure bank) or not, it can delegate the financing and commissioning to a third party. There are several points of entry that governments can use to ensure that such infrastructure accounts for climate change:

- Contractual arrangements and public-private partnership guidelines, when that third party is from the private sector;
- Eligibility criteria to access infrastructure grants, when that third party is a local government bidding for funding.

27. While public procurement is increasingly considering the lifecycle costs (including greenhouse gas emissions) under the EU Procurement Directive, there is only one documented instance of climate resilience being integrated in public procurement, based on a screening of National Communications to the UNFCCC. Belgium’s 2014 management contracts between the state and national railway operator (SNCB) now refers to climate adaptation in its environment chapter. As the contract defines the missions of public utility of SNCB and payments for delivering them, it may be used as a basis for demanding reliable service in the face of climate impacts.

Figure 1: Flowchart for assessing climate risk of projects: ADB’s two step approach (left), and EBRD’s continuous one (right) [ADB, 2015; EBRD, 2014]



- Review the company's sensitivity to climate change and, if available, business strategy for climate resilience
- Collect data through a written questionnaire and checklist
- Meet with the company's operations management
- Define the scope of the technical cooperation
- Launch a climate resilience audit, funded by the EBRD.
- Make site visit (three to five days) for detailed discussion with company staff
- Carry out in-depth review of climate change vulnerability and resilience options, including benchmarking against international best practice.
- Conduct technical and economic assessment of recommended climate resilience opportunities
- Define a programme of priority investments and actions for climate resilience.
- Follow up the results of the audit and the recommended climate resilience investments and actions.
- Develop a financial plan together with EBRD bankers.

28. Current policies for PPPs or grant access and infrastructure planning documents generally do not require explicit consideration of climate change impacts (Infrastructure Australia, 2011; New South Wales Treasury, 2007; European Commission, 2003; UK Treasury, 2013). There are however some exceptions, notably at the regional level in Australia (Australia Productivity Commission, 2012; Australian Government, 2013):

- Queensland and Tasmania require cabinet submissions for government projects to include possible climate risks. The Queensland Climate Ready Infrastructure initiative requires local governments to consider climate change adaptation when applying for Queensland Government grants for infrastructure (Queensland Government, 2011)
- The Council of Australian Governments requires state and territory governments' strategic plans (including infrastructure needs) for capital cities to include resilience. These plans must cover a range of criteria, including climate change adaptation. Infrastructure funding will be linked to meeting these criteria (COAG 2009).
- The West Coast Infrastructure Exchange (WCX) results from the collaboration between the states of California, Oregon and Washington in the United States and Canada's British Columbia. WCX aims at developing innovative methods to finance and facilitate the development of infrastructure in the region, through developing a framework for infrastructure investment and principles for certification. The consideration of resilience and climate risks features among the WCX's standards for infrastructure projects (WCX, 2013).

29. In PPPs, risks should be allocated to the party best positioned to manage them (OECD, 2012). The starting point for this is to ensure that risks are identified *ex-ante* so they can be assigned and managed. Governments partnering with private entities to finance, build and/or operate infrastructure may want to include climate resilience amongst the criteria to be considered by them, and/or amongst the project risks the private partner has to bear. Where risks (in particular, the risks posed by natural hazards) are not allocated to the party best able to manage these risks, this may impose a barrier to effective project development and climate change adaptation.

30. The time horizon considered in current valuation practices of PPPs is not adapted to capture a project's full contribution to reduce climate risks, or impact from those. Current PPP guidelines suggest that costs and revenues be forecast over the life of a project, rather than the full life of the asset itself. These forecasts, which are critical to decide whether to proceed with a public-private contract, therefore exclude the costs and revenues incurred *after* the contract has been completed and control of the asset has been handed to the government. Using this approach, features of the project that could reduce climate change risks that occur after the duration of the partnership contract cannot be accounted for in the valuation of the project (Maddocks 2011).

31. When natural disasters cause damage to infrastructure, the concessionaries can in some cases maintain that the damage was caused by "unforeseeable events" and the majority of the liability may fall on the government. "Force majeure" clauses apply when an unforeseen event i) prevented full or partial performance; ii) was beyond the party's reasonable control; and iii) could not be avoided through the exercise of due diligence. There is no standard definition of force majeure, some countries giving it a broad definition, others an itemised list of events including natural disasters, but it is usually related to cases where insurance is either unavailable, or offered with prohibitively high premiums (European PPP Expertise Centre, 2013). It is important to define force majeure events when making long-term PPP arrangements, and for this definition to reflect the latest information available from climate science (see section 2).

32. Some law professionals argued that the scientific knowledge now available on climate change may change which weather events are defined as reasonably foreseeable (Donald and Kurdian, 2007; Eagle, 2007), but the direction of these changes is still unclear. If private insurance is unavailable or prohibitively expensive, government may agree to become the insurer of last resort for risks against which protective measures could have been taken. Others expect that on the contrary, the relief available to parties for force majeure will increase in scope from natural disasters to also encompass severe adverse weather conditions such as prolonged periods of extreme heat, landslides or landslips, flooding, hailstorms and fire (Warner, 2014).

33. There are limits to the risk reduction benefits of adaptation solutions, and some climate damages are inevitable in some cases. Once cost-efficient adaptation has reduced vulnerability as much as possible, insurance offers a mechanism for providing financial protection against the residual risks, and forms an integral part of any comprehensive climate risk management strategy. Insurance also allows the government to reduce its potential exposure as insurer of last resort, and provide an incentive for infrastructure providers to reduce risk and therefore the cost of insurance. An illustration of how complementary risk reduction and insurance are and the need for transparent risk-sharing agreements can be found in Colombia. After concessionaries asked Government of Colombia to cover USD 60million in damage losses following the 2010-2011 La Nina season, the Government passed a series of laws in 2013 to ensure future infrastructure projects would be better protected against natural hazards, and enhance catastrophe insurance requirements to protect these investments (GFDRR, 2013).

34. In principle, infrastructure projects that address future climate risks and are less vulnerable to natural hazards should be more attractive to investors, and reduce the insurance costs faced by operators. Insurance companies are also significant investors in infrastructure. However, the potential for private investment in resilience projects is limited by the challenge in structuring an approach that provides the investor with returns over time. The underlying challenge is finding a model that allows the beneficiaries to contribute to structural risk reduction projects such as flood barriers, while addressing challenges with free-riding. Innovative financial approaches are also being proposed, such as linking investments in resilience to pre-defined rebates on catastrophe bonds in order to fund the resilience project's costs (Vajjhala and Rhodes, 2015). A significant increase in interest in catastrophe bond issuance by public agencies would be a prerequisite for this approach to be viable.

4. ENABLING INFRASTRUCTURE RESILIENCE THROUGH POLICY & REGULATION

Public policy and regulation offer many levers to integrate climate resilience in infrastructure planning and management. Climate resilience has been mainstreamed in some countries' policies such as spatial planning, mainly through the Environmental Impact Assessment, as well as technical and economic regulation which influence infrastructure. Over a third of OECD countries are revising one or more national technical standard(s) for infrastructure, and two major international organisations for standardisation have started reviewing their technical and management standards to account for climate change adaptation. While spatial planning and technical standards apply solely to new build infrastructure, existing infrastructure can be influenced through technical and economic regulation.

4.1. Spatial planning for new infrastructure

35. Good spatial planning requires the systematic assessment of environmental, social and economic factors in such a way as to assist land users in selecting options that increase the land's productivity, are sustainable and meet the needs of society (FAO, 1993). By taking into account potential impacts from climate change, spatial planners can contribute to infrastructure's reliability at the outset: instead of focusing on reducing its vulnerability to natural hazards, spatial planning is a key tool to reduce infrastructure exposure.

36. Key spatial planning tools such as the Environmental Impact Assessment (EIA), and to a lesser extent the Strategic Environmental Assessment (SEA), are increasingly used to incorporate climate change impacts and adaptation within existing modalities for project design, approval, and implementation. EIA involves assessing the possible impacts, whether adverse or beneficial, that a proposed project (generally infrastructure related) may have on the environment. Its purpose is to assess these impacts before deciding on whether or not to undertake the project, and to develop and apply measures to avoid or minimize those impacts as conditions of approval for the project. SEA is required for national plans, programmes, regional development and land-use plans as well as sector plans and policies in areas such as energy, transport, agriculture, forest management and manufacturing.

37. Australia, Canada and Netherlands all have demonstrated experiences using EIA to address climate change impacts (Agrawala, 2011). For instance in Netherlands, the 2006-2015 flood management plan 'Room for rivers' integrated climate change considerations in its EIA when considering the high water levels to be expected and possible developments in the upstream sections of the river in other countries, for example in Germany. For the year 2100 the water levels in the Rhine were calculated on the basis of the medium scenario of the Intergovernmental Panel on Climate Change (IPCC) that considers a 60 cm sea-level rise (Verheem and Laeven, 2009). The Canadian Environmental Assessment Agency has launched a guidance to incorporate climate change considerations in environmental assessments in 2003, providing case studies of projects (Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, 2003).

38. The EIA has been strengthened by the European Union amendment of the **EIA Directive** (2014/52/EU amending 2011/92/EC) in May 2014 to place a stronger emphasis on climate change mitigation, adaptation and resilience across the screening, scoping and assessment process. Member States have three years to transpose the amendments into their own regulations. The EU had previously launched guidance documents on integrating climate change considerations into EIA and SEA (European Commission, 2013).

39. In addition to EIA, infrastructure planning frameworks can integrate the consideration of climate change risks more broadly. In the UK, major infrastructure project applications are reviewed by a dedicated service of the Planning Inspectorate against a set of National Policy Statements. Produced by the relevant lead government department, each National Policy Statement (NPS) states the government's objectives for the development of nationally-significant infrastructure in the sector, including how actual and projected capacity and demand have been taken into account. There are twelve designated or proposed statements, spanning the energy, water and transport sectors. Crucially, these statements include an explanation of how mitigation of, and adaptation to, climate change should be accounted for. Developers of major projects in the UK have to provide evidence of:

- how the latest climate projections have been applied, with the applicant being required to apply the high emissions scenario where the infrastructure has safety critical elements;
- and whether the proposal may be seriously affected by more radical changes to climate beyond that projected in the latest climate projections, taking into account the latest credible scientific evidence.

A recent review of the effectiveness of the National Policy Statements' implementation for climate adaptation found that the Planning Inspectorate examining authorities had implemented the National Policy Statements' requirements and consistently considered climate risks in granting planning permission (ASC, 2014). For instance, inspectors recognised the vulnerability of the Hinkley Point nuclear power station's site to the effects of climate change and sea level rise and ensured the site's design accounted for climate change projections.

40. Other countries have stated their intention to integrate the consideration of climate change risks into the planning and construction of infrastructure. Mexico has made a general commitment for all infrastructure sectors in its National Climate Change Strategy (line of action A2.12), while Hungary wishes to focus on power system planning (6th National Communication to the UNFCCC).

41. Authority and competences regarding spatial planning in OECD countries are most often either concentrated at the sub-national level, or shared between national and sub-national levels (Silva and Acheampong, 2015). Land use planning frameworks are decided at the national level, but local authorities have a critical role in implementing it, and sometimes issuing their own regulatory requirements. When that is the case, neighbouring regional level rules should be coherent between themselves, as well as with the national framework. For instance, when conducting construction to rebuild and protect energy and utilities infrastructure following Superstorm Sandy, the regulators of the adjacent states of New York and New Jersey chose different protection standards (protection against a 1-in-100-year flood + 3 feet, and 1-in-100 +1 foot respectively). Meanwhile at the federal level, the White House set a complementary Federal Flood Risk Management Standard (Executive Order 13690) which mandated that retrofits of critical infrastructure receiving financial support from the Federal Emergency Management Agency (FEMA) should be protected against a 1-in-100-years flood event. There is a safety margin of two additional feet (66cm) for critical infrastructure, and a safety provision of one additional foot (33cm) for other infrastructure.

42. Local authorities face competing pressures when new build developments in potentially risky areas still bring short-term economic benefits in the form of property taxes. This short-term economic incentive can lead to developing in increasingly risky areas, storing up risks and hidden costs for the future, both for protecting or compensating those assets. UNISDR has conducted a case study in Spain, where liberalisation led to development in risky areas, to identify the necessary conditions for a 'risk sensitive land use planning' (Burby et al.; 1999). Risk-sensitive planning allows communities to find the right mix of both development and risk reduction, and requires financial incentives to project developers and local

authorities, as well as a greater collaboration between planning administrations and disaster reduction authorities (Sudmeier et al., 2013).

4.2. Sector regulation & economic incentives

43. Water, energy and transport infrastructure provides the services the economy and communities rely on to function. Due to their importance, regulation is a key tool for privately owned and operated infrastructure. Two-thirds of Member countries have regulators managing more than one sector, for instance water and energy (OECD, 2015c). Regulators can be dedicated to the delivery of environmental outcomes, such as environment protection, social outcomes such as safety, or economic regulation such as service affordability, effectiveness and reliability. Climate change impacts are considered in some regulatory environments, mostly by energy and to a lesser degree by water and transport regulators; examples are presented below.

Technical regulation

44. Regulators can modify technical requirements to account for future climate change. For instance, many nuclear energy regulators consider how climate change may affect flood risk and rivers' water temperature when assessing the safety of nuclear plants or allowing the discharge of the water used to cool the reactor back to the environment (NEA, 2016).⁵ **France's** Nuclear Safety Agency has updated in 2012 its water discharge regulation in case of heatwaves in light of new evidence of the impact of discharge water's temperature on fish populations (SFEN, 2015). **Switzerland** has also modified the supervision and licensing processes for hydroelectric dams and reservoirs as well as for transmission and distribution networks for gas and electricity to better account for climate change impacts, and is examining the need to adjust regulation on the temperature of cooling water released back into rivers (Swiss Confederation, 2013). In the **United States**, the New York state utilities regulator (Public Service Commission) approved in February 2014 a settlement requiring power utility Con Edison to implement state-of-the-art measures to plan for and protect its electric, gas, and steam systems from the effects of climate change, stating that climate-resilience considerations should be broadened to include all utilities (Fazio and Strell, 2014).

45. Regulators can also set an obligation of results regarding service reliability. **Finland's** 2009 Electricity Market Act requires that the distribution network be designed, built and maintained in such a way that by 2028 electricity interruptions due to a storm or snow do not exceed 6 hours in densely-populated areas and 36 hours in other areas. Disruptions to electricity services from storms are generally caused by airborne material, such as trees and branches. Accounting for longer growth season for vegetation in a changing climate and more extreme wind gusts, this may have repercussions on companies' vegetation management and tree felling practices. The Finnish Government has also plans to invest EUR 3 500 million to bury distribution cables.

46. In several OECD countries, stricter reliability and resilience requirements have been set or are envisaged for 'critical infrastructure', encompassing but not limited to natural hazards. In France, the "vital importance operators" defined in 2006 (Secrétariat Général de la Défense et de la Sécurité Nationale) are required to produce protection plans to prepare for a range of hazards. However, these plans do not take into account the possibility of simultaneous hazards or the potential cascading failures between different infrastructure networks (CGDD, 2013).

⁵ Nuclear energy requires large amounts of cooling water, and plants located in estuarine or coastal environments can both be vulnerable to erosion and flooding, or impact the environment when released water used for cooling at a higher temperature in the environment.

Economic regulation

47. Economic regulators can be mobilised to integrate climate change adaptation into infrastructure operation and management, but need to balance it with injunctions of value for money for the consumer. As an illustration, a regulator may wish to clarify the conditions under which an infrastructure provider can invest in climate adaptation measures and expect to be reimbursed or allowed to transfer that costs to its service users, or ensure that service reliability regime account for future climate and adaptation efforts. Providing economic incentives that allow flexibility in meeting regulatory requirements can also encourage infrastructure owners and operators to increase supply efficiency and reduce service demand for instance. Germany plans to examine options within the framework of incentive regulation to allow additional adaptation-relevant investments for power generation transmission and distribution to be accredited or reimbursed. This issue will be considered through the newly founded Working Group on Regulation (Future-Oriented Grids Platform) which brings together representatives of the Federal Ministry for Economic Affairs and Energy (BMWi), the Federal Environment Ministry (BMU) and the Federal Network Agency (BMUB, 2012).

48. The United Kingdom is leading the reflection on how to harness regulators' powers to strengthen infrastructure resilience to climate change. Promoting resilience, in particular from climate change, is part of the mandate and processes of its energy (Ofgem), water (Ofwat) and rail regulator (ORR). All have tried to improve the price control review mechanisms to reflect longer asset life spans, and encourage a focus on longer run issues and better management of uncertainties (Defra, 2013), and are collectively thinking about cross-sector resilience implications and climate adaptation through the UK Regulators Network (2015). The UK and Welsh governments even introduced a new legal obligation ('primary duty') for Ofwat to further resilience in the 2014 Water Act. However, in researching the implications of this duty for Ofwat, an independent review found that there was no agreed definition of resilience, a lack of consistent measures and fixed resilience standards in the water sector. Overall, there was a lack of evidence on the efficacy of the current regulation model to encourage legitimate resilience investments to be made (Resilience Task and Finish Group, 2015).

4.3. Standards

49. In the field of infrastructure building and maintenance, constructors and operators are bound by a set of technical and management standards, which can originate from regulatory requirements (such as Building Codes) or voluntary practices formalised by trade bodies. These standards can apply to the data collected in technical investigations (timescale, modelling and socio-economic projections used), the technical specifications of the material equipment and products used, or to the project design and management processes. They can be tailored at a regional or national level, or apply internationally (such as those from the global International Standard Association).

50. Standards can be updated to reflect the latest technological advances and scientific knowledge. As the knowledge regarding climate hazards and their potential impacts on infrastructure improves, governments, international bodies and engineers' organisations are increasingly revising standards affecting the design and operation of all types of infrastructure (for instance by incorporating new performance requirements and design methods), or creating new ones as necessary. Standards can play an important role in supporting climate resilience as they are uniformly applied.

Revision of international standards

51. At the international level, two major standardisation organisations have started reviewing existing standards to take into account climate change potential impacts, the European Committee for Standardisation (CEN, Centre Européen de Normalisation) in May 2014, and the International Standards

Organisation (ISO) in June 2015. The ISO focuses on developing an organisational suite of standards for vulnerability assessment, adaptation planning, and adaptation monitoring and evaluation, through the newly formed Adaptation Task Force (ISO, 2015). Following the adoption of the European Adaptation Strategy, the European Commission mandated the CEN in 2013 to amend and extend in scope the European civil engineering technical standards, known as Eurocodes, focusing on transport and energy infrastructures, as well as buildings and construction (EC, 2014). Both reviews cover the assessment, re-use and retrofitting of existing infrastructures, as well as the design of new developments, and are still ongoing.

52. Both sets of climate-resilient international standards will have a wide applicability. ISO is a non-governmental organisation and its standards are voluntary. However, they can be adopted in some countries as part of their regulatory framework, or be referred to in legislation for which they serve as the technical basis. Under the Procurement Directive, EU Members are bound to accept designs to the EN Eurocodes, or require technically equivalent solutions (EC, 2004).

53. Sector-specific organisations are also contributing to the technical definition of climate-resilient infrastructure. For instance, the World Association for Waterborne Transport Infrastructure (PIANC) set up a dedicated working group to develop technical guidance on climate change adaptation for maritime and inland port and navigation infrastructure, due to report early 2017 (PIANC, 2014, 2015).

54. Some standards from different ‘families’ may cross-reference each other to avoid duplication. For instance, the revision of Eurocodes plans to incorporate ISO standards on atmospheric icing of structures and actions from waves and currents on coastal structures in the Eurocodes family.

Revision of national standards in OECD countries

55. Approximately one third of OECD countries are revising one or more mandatory national infrastructure standard(s) to account for climate change adaptation. A screening of OECD countries’ 6th National Communications to the UNFCCC and national associations’ sources shows that a revision has already been completed in seven countries (Australia, Canada, Denmark, Germany, Korea, Norway and Sweden), and is either ongoing or planned in five more countries (Table 3).

56. The first standards to have been revised regard drainage specifications, often for road transport infrastructure. Revisions account mostly for an increased likelihood and severity of precipitations, which can lead to surface or river flooding. For instance, in revising its road drainage standard in 2008, Sweden updated the return periods of critical events and introduced a climate safety factor compensating for an anticipated increase in future precipitation.

Table 3: Planned, ongoing and completed standard revisions in OECD countries

	Country	Details
Completed	Australia (Engineers Australia)	Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering (2013, 3 rd edition) Australian Rainfall and Runoff handbook (2015)
	Canada (Standards Council, Aboriginal Affairs and Northern Development Canada)	Northern Infrastructure Standardization Initiative (NISI). Four standards completed in 2014-15 on foundations supported by heat exchangers, effects of permafrost degradation on existing buildings, changing snow loads, and community drainage. On-site investigation standard still in development.
	Denmark	Road drainage design standards (Vejdirektoratet, 2009. Vejkonstruktioner, Avvandingskonstruktioner).
	Germany	The Commission on Process Safety (KAS) has updated in 2011 a Technical rule on precipitation and flooding for flood safety of plants subject to the German Major Accidents Ordinance.
	Korea	The Korea Expressway Corporation has strengthened the design requirements of its drainage capacity, bridge design and embankment slopes (Quium, 2015).
	Norway (transport agencies)	Handbook on the design of road drainage structures (2011).
	Sweden	Design rules for road drainage (VVMB 310 Hydraulisk dimensionering, 2008:61)
Ongoing	Australia (Austroads)	Australian Transport Assessment and Planning Guidelines to cover public, road and rail transport, and include appropriate guidance on climate change adaptation for transport planning and project appraisal (Australian Government, 2015).
	Canada (Canadian Commission on Building and Fire Codes)	The CCBFC is currently updating 6,000 specific climatic design values used in the National Building Code of Canada.
	France (CEREMA)	The Centre of expertise on hazards, environment, mobility and planning (CEREMA) has identified over 80 standards that may require updating, focusing on transport infrastructure and a better consideration of climate extremes (MEDDE, 2015; CEREMA, 2015).
	Germany	BMVBS/DWD and the German Institute for Standardisation are updating climate data standards for buildings and infrastructures.
	Netherlands (Delta Commission)	Update of design guidelines for infrastructure to account for changing characteristics of showers. Definition of a national basic minimum level for water safety and update of levels in rivers area, parts of the Rhine Estuary-Drechtsteden region, and at Almere.
	New Zealand	National Infrastructure Plan (2011) focus on the development of design and construction standards (where cost-effective) that ensure infrastructure is able to withstand natural hazards and long-term changes, such as those resulting from climate change. The 2015 Plan focuses on the creation of metadata standards for roads, water infrastructure, and built assets by mid-2016 in order to better understand asset performance.
	United States (National Institute of Standards and Technology)	The Panel on disaster-resilience standards for buildings and infrastructure will recommend improvements to standards and developing guidelines.
Planned	Hungary	Revision of the regulation of construction design and area use from the aspect of climate change.

57. In some countries, most notably Australia, regional governments have also released technical guidance to ensure infrastructure's design is resilient to climate change. Western Australian Government's Standard and Technical Guide on Addressing Climate Change in Road and Traffic Engineering, for example, is helping planners, designers and managers identify climate change risks relevant to construction of roads and bridges. The state road operator (WA Main Roads) is integrating climate change considerations into design standards and road upgrades across the State and requires that the implications of a 300mm sea-level rise (450mm for structures) be considered as part of planning, design and construction considerations for all rehabilitation and expansion projects near coastal areas.

58. In addition to these technical guidelines, several national standards organisations have released risk management guidelines that focus climate adaptation or resilience planning for buildings and infrastructure (British Standards Institution, 2011; Standards Australia, 2013; US National Institute of Standards and Technology, 2015). These guidelines emphasize the usefulness of predefined risk management processes, following the standards on quality management (ISO9001), environmental management (ISO14001) and business continuity management (ISO 22301).

5. DISCLOSURE OF CLIMATE RISKS

The reporting of vulnerability from potential climate impacts from corporations is much less mature than reporting on greenhouse gas emissions and mitigation action, which may be partly explained by the lack of agreed methods of reporting, and low levels of public requirements. Several new voluntary initiatives are emerging from investors, as they increasingly recognise this information's relevance for their investment decisions. There is scope for Governments to support and encourage information collection and sharing regarding climate change risks, with a particular focus on critical infrastructure, by providing voluntary frameworks or supporting privately-led initiatives.

59. The consideration of climate change risks at all levels of businesses, including the financial sector, can support companies' efforts to improve their management of risks, inform stakeholders such as investors, reveal interdependencies between sectors and provide key information to support public decision-making.

60. Although there is no officially recognised definition of climate risks, the Bank of England breaks them into three categories: physical risks arising from weather-related events or resource scarcity, liability risks arising from those who suffered losses and damages from climate change, and transition risks arising from the decarbonisation of the economy (Bank of England PRA, 2015). In the context of infrastructure's adaptation to climate change, this document has focused on the first dimension (physical risks).⁶

61. There are benefits to identifying and disclosing climate risks to infrastructure for project developers, investors and policy-makers.

- Greenfield project developers and existing infrastructure owners and operators can find reputational, commercial and financial benefits to disclosing their climate risks and communicating about the way they manage them. For greenfield developers, highlighting 'best in class' new infrastructure projects taking into account climate risks can improve a company's reputation and give it a competitive advantage in tenders (see section 3.2). Disclosing climate risks and efforts to tackle them could also improve access to finance by providing reassurance to investors about the reliability of future returns. Voluntary disclosure may also reduce the need for regulatory intervention.
- From the investor perspective, disclosure of climate risks can help to inform asset allocation. Climate change scenarios present both risks and opportunities for strategic asset allocation, which can be managed by investors (Global Investor Coalition on Climate Change, 2015; OECD, 2015a; Mercer, 2011).
- Encouraging companies in the infrastructure sector to manage and disclose their climate risks can support their resilience, and gives more confidence to policy-makers that essential services will cope with climate change. When existing critical infrastructure is owned and operated by the private sector, governments may not have the information to ensure climate risks are identified and managed appropriately. Supporting the disclosure and integration of climate risk as an investment criteria may improve Government's' capacity to plan for disaster risk management and emergency preparedness, and support national adaptation strategies.

⁶ France mandates institutional investors to disclose the carbon content of their portfolio as well as their plans to support a low-carbon transition since December 2015, but this policy does not include physical risks from climate change (MEDDE, 2015).

5.1. Rating the climate resilience of infrastructure

62. Monitoring risks from climate change and planning adaptation efforts at the corporate level brings more methodological challenges than monitoring greenhouse gas efforts. Greenhouse gas emissions can be compared using a single metric (tonnes of CO₂ equivalent), equivalences (Global Warming Potential) and internationally agreed accounting methods (e.g. Greenhouse Gas Protocol). Meanwhile climate impacts may be felt through multiple hazards (changing weather patterns, sea level rise, changes in water availability and temperature...), over different timescales. The nature of the risks arising from this, and appropriate responses are very context specific.

63. There are a few voluntary third party verified standards and tools available to provide a systematic rating for the consideration of climate risks in of infrastructure (Table 4). As an illustration, the Peace Bridge in Northern Ireland earned a CEEQUAL-Excellent rating in recognition of its preparedness for flood risk: the bridge's rim was located above the level of a 1-in-200-years tidal flood event, including an additional allowance for climate change..

Table 4: Main tools for infrastructure resilience rating and certification (FIDIC)

Name and creation date	Proprietary organisation	Functioning
CEEQUAL (2003)	Institution of Civil Engineers (UK), then BRE since 2015 to be merged with BREEAM methodology	CEEQUAL assesses issues related to climate change, including responses to predicted climate change effects, in 10 of its 180 questions, most of which are mandatory. They relate to the project's purpose and its performance under: project management, land use & landscape, ecology & biodiversity, water environment, and physical resources. Rating focuses on five climate risks: flood risk, sea-level rise, intensity of rainfall, drought, temperature rise. At the end of an assessment and its verification, the CEEQUAL rating system grants either Pass, Good, Very Good or Excellent (75% of the maximum) scores.
ENVISION (2010)	Institute for Sustainable Infrastructure, (American Society of Civil Engineers)	ENVISION has 60 sustainability criteria, called credits, which are divided into five sections, one of which is called Climate and Risk.
Infrastructure Sustainability rating tool (2012)	Infrastructure Sustainability Council of Australia	IS rates infrastructure projects against 15 sustainability components, including adaptation to climate change. The first version of this category (based on the Council's 2011 guidelines) should be revised in 2016 from a process-focus towards an outcome-focus. Accompanying guidance will cover climate risks assessment, implementation of risk management options, stakeholders engagement on interdependent risks, maintaining flexibility in case of changes in information and circumstance.
Sustainable and resilient infrastructure (SuRe) standard (2015)	Swiss Global Infrastructure Basel (GIB) Foundation and Natixis bank	The standard lists resilience criteria that can be attributed one of three performance levels (commended, exceeding or leading) by the assessing entity. The 'climate resilience and adaptability' criterion s the infrastructure should be designed to handle climate conditions 21%-30% or 31-40% more extreme than those specified in the construction codes relating to climate conditions (provided those exist) to commend an 'exceeding' or 'leading' rating respectively.

64. CEEQUAL has expanded its reach to international projects in 2011 and the Australian Infrastructure Sustainability tool is planning to do so towards New Zealand and South-East Asia ISCA, 2014. Although it is hard to evaluate what proportion of total infrastructure projects have been certified, resilience ratings still appear marginal. CEEQUAL has received applications for around 700 formal verified assessments, of which around 300 have been completed, for a cumulative value of around £27 billion in 2015. Of the rest, around 120 have been shelved or cancelled through lack of funding, changes in client requirements or abandonment of the assessment for a range of reasons, for example changes in

project teams. The Australian Infrastructure Sustainability tool was applied to 56 projects as of December 2015.

5.2. Government drive for climate risk disclosure

65. There are currently few examples of mandatory reporting of climate risks. Three-quarters of G20 countries have a mandatory greenhouse gas reporting schemes in place, while currently none have mandatory reporting for climate risks. There are currently only two voluntary climate change disclosure schemes relating to climate risks, both established by national regulators in 2010 (OECD and CDSB, 2015). The Canadian Securities Administrators requires issuers of securities (other than investment funds) to disclose environmental risks and liabilities, either of physical and regulatory nature, as part of their continuous disclosure requirements, following investors' request for better information on environmental matters (CSA, 2010). The "10-K" filings to the US Securities and Exchange Commission (SEC) are an annual requirement for all publicly listed companies with over \$10 million in assets to report on their financial performance and to include information on 'the most significant risks that apply to the company'. The SEC published a guidance regarding the disclosure of climate-related information following a petition from business leaders to clarify the existing risk disclosure requirement (SEC, 2007 and 2010).

66. The UK introduced a mandatory requirement to report on physical risks from climate change, the Adaptation Reporting Power (Box 2), which has then been relaxed into a voluntary scheme for the second round of reporting. In practice, critical infrastructure has been the main target of this scheme, whether publicly or privately-owned.

Box 2- Mandatory public reporting on climate change risks to infrastructure: the UK Adaptation Reporting Power

The Adaptation Reporting Power, set by the UK Climate Change Act (2008), grants the Environment Secretary of State the power to require organisations that provide critical public services (known as 'reporting authorities') to report on their climate risks and associated adaptation actions. This power was exercised for a first round of reports that were published in 2012. These reports came from 91 key infrastructure providers from the water, transport, energy, regulators and public bodies. An independent evaluation (Cranfield University, 2012) concluded this exercise had been useful in leading to a greater consideration of climate change and adaptation and greater engagement, both internally and across the supply chain, for all the reporting organisations. This evaluation also identified the need to clarify the role and end-users of the report within and outside of Government, to ensure buy-in from reporting organisations and help them to tailor the reports to their end-users. For the second round taking place in 2015, the Secretary of State has made reporting voluntary, but still invited first round reporting organisations to provide progress updates as well as a small group of new organisations to report for the first time. As of December 2015, 28 organisations had provided a report, including the UK Prudential Regulatory Authority on the impact of climate change on UK insurance. To prevent data gaps in further work to identify and monitor adaptation risks, an inquiry on climate change adaptation by the House of Commons concluded that Government should consider making reporting under the Adaptation Reporting Power mandatory again, at least for organisations managing critical infrastructure and services (House of Commons, 2015).

Research commissioned by Natural Resources Canada on the UK's adaptation experience recommended Canada should develop a similar reporting framework for organizations in the private sector focusing on adaptation risks (EY, 2015).

67. Even when a climate risk disclosure scheme is put in place by public authorities, its successful implementation requires training targeted parties and enforcement capabilities. A survey of more than 40 000 SEC comment letters sent to companies and an analysis of S&P 500 company reporting on climate disclosure found that “41% of S&P 500 did not report their climate risks; of those reporting, the majority of financial reporting on climate change is too brief and largely superficial; most companies are failing to meet SEC requirements” (Ceres, 2014).

68. Policy makers have an important role to play in both encouraging and mandating corporate disclosure of climate risks. A report on sustainability disclosure sponsored by Aviva, S&P and ACCA found that historic growth of sustainability disclosure was slowing down and reaching a plateau, and was highest in countries where policy makers, including governments, stock exchanges and securities regulators, were requesting that information. It advised that policies encouraging or mandating listed companies were “almost certainly required” to boost reporting to meaningful levels (Corporate Knights Capital, 2014). In any case, reporting on climate risk should not be viewed as an end in itself, but as a means to drive risk reduction.

Investor tools and approaches

69. There is a growing awareness from the financial sector on the importance of climate risk. A report by Mercer (2015) finds that most investors consider impact of climate change on their returns, while the 2016 World Economic Forum’s survey of 750 global stakeholders (mainly chief executives of firms representing the main sectors of the economy) ranked the failure to mitigate and adapt to climate change the top risk in terms of impact over the next ten years. Investor coalitions increasingly develop guidance presenting a range of investment strategies and solutions for asset owners to consider in addressing the risks and opportunities associated with climate change. These include how to consider the vulnerability of their investment portfolio in private and public sector infrastructure to the physical impacts of climate change, in order to better manage these risks (GICCC, April 2015).

70. The majority of investors specialised in infrastructure investment state that they monitor and assess physical risks from climate to the infrastructure they manage. Over 70% of internally managed infrastructure assets were monitored for physical climate change risks and impacts, according to the Global Investor Survey on Climate Change of asset owners and managers (Mercer, 2013). Some investors are already routinely assessing the risks from climate change of the large infrastructure assets in their portfolio (Box 3).

Box 3: Consideration of physical risks from climate change on infrastructure by public and private investors

- **Hastings Fund Management:** Hastings is a specialist manager of infrastructure equity and debt investments, currently managing approximately AUD 7.4 billion and with assets invested across Australia, the US, the UK and Europe (airports, toll roads, seaports, gas and electricity transmission, water utilities). Climate change risks are included in the qualitative and quantitative assessment of Hastings’ infrastructure investments at the investment proposal stage and on an ongoing asset management basis. This includes the consideration of whether infrastructure assets have been built with sufficient characteristics to cope with potential changing conditions: material strength, height from sea level or wind ratings.

- AustralianSuper: The pension fund with over A\$75 billion under management, assessed the extent to which the largest infrastructure assets in their portfolio (including airports, a sea port and a toll road) may be vulnerable to a changing climate in the medium term (2030) and the long term (2070). The study identified the components of the asset responsible for the generation of investment returns and modelled each component using a variety of climate change scenarios and data supplied by the federal government agency for scientific research in Australia (CSIRO).

71. There are detailed sustainability reporting guidelines focusing on climate change, with an increasing focus on usefulness for the investor.

- The most prominent global, private climate-related reporting scheme, with 5 000 organisations reporting in 2014, is the CDP (formerly known as the Carbon Disclosure Project). The CDP Climate Change questionnaire asks respondents to report on their practices regarding climate change risks and opportunities, including identifying, prioritizing and managing risks and opportunities from climate change, whether they're driven by regulation or changes in physical climate parameters. The survey on SEC's outcomes on climate disclosure found that most S&P 500 companies which disclose climate risks under both the mandatory annual forms on financial performance and business risks (10-K filings) and the voluntary CDP provide significantly more detailed information under the CDP scheme (Ceres, 2014).
- The Global Reporting Initiative (G4) is used by an even larger number of organisations (7 500 organisations in 2015), but its focus is less on climate-related issues, though the 4th set of reporting guidelines do contain a category on the financial implications and other risks and opportunities for the organization's activities due to climate change (G4-EC2). Like for CDP, these risks and opportunities are to be classified as either of physical or regulatory nature, and are considered through the economic impact they might have on capital and operational costs, demand for products and services, capital availability and investment opportunities.
- Most recently, the Financial Stability Board (FSB) announced in December 2015 its intention to set voluntary and consistent climate-related disclosures standards, through an industry-led disclosure task force on climate-related risks. These are aimed at lenders, insurers, investors and other stakeholders in understanding material risks.⁷ This initiative is partly driven by the UK Prudential Regulatory Authority report on the 'Impact of climate change on the UK insurance sector', which was itself initiated after an invitation to report under the UK Adaptation Power (Bank of England PRA, 2015). This shows the role Government initiatives can play in raising awareness and kick-starting private sector action.

72. In addition to these reporting guidelines led by specialist organisations or the investment sphere itself, initiatives involving both public and private actors have recently made important pushes for a greater disclosure of climate risks.

- Launched in September 2014 at the UN Climate Summit, the Statement of Fiduciary Duty and Climate Risk Disclosure⁸ is a collective commitment by a leading group of companies (including many utilities and infrastructure constructors) and institutional investors to scale the use of the Climate Change Reporting Framework (CDSB, 2012). Linked to the CDP questionnaire, the Framework requires an explanation and qualitative assessment of the organization's exposure to current, short-term and long-term significant risks and opportunities associated with climate, as

⁷<http://www.fsb.org/2016/01/fsb-announces-membership-of-task-force-on-climate-related-financial-disclosures/> Accessed on 21/01/2016

⁸<http://www2.cdsb.net/fiduciarystatement/statement> Accessed on 21/01/2016

well as details of the current and future quantified financial implications of those (or failing that, estimates and qualitative information). Public regulators can also sign the statement as Statement Associates.

- The 2014 Climate Summit also saw the launch of the 1-in-100 initiative by Willis Group, the UN Climate Change Support Team and UN International Strategy for Disaster Reduction (UNISDR), which aims to build a consortium of major financial institutions, regulatory, accounting and scientific institutions to help recognize the costs of disaster risk and the absence of resilience plans. The initiative calls for members of this consortium to test the portion of their investments and assets that are at risk when a climate-related disaster with a 1-in-100-year magnitude occurs, to account for the risk in their investment portfolios and to integrate incentives into resilience-building programs.

Annexes

Annex 1: Climate risk integration into development banks’ investment process

[Updated and adapted from Ricardo-AEA, 2013; Adaptation finance own resources from World Bank, 2015]

Multilateral or national development banks operating exclusively in developing countries

Development bank Adaptation finance own resources	a) Requirement	b) Screening & decision management tools	c) Evaluation of implementation
<i>World Bank Group (WB)</i> \$2,855 million (2014)	<p>In line with the WBG Strategy (2013), WB’s fund for the poorest countries (International Development Association, or IDA) now i) incorporates climate and disaster risk considerations into the analysis of development challenges and priorities, and, when countries agree, in the content of programs and results frameworks; and ii) screens all new project and sectoral/national programme for climate risks.</p> <p>The fund focusing on private sector in developing countries (International Finance Corporation or IFC), follows Performance Standards (2012) that define private sector client responsibilities for managing environmental and social risks, including identifying climate risks and adaptation opportunities and promoting sustainable use of energy and water resources</p>	<ul style="list-style-type: none"> - Eight Climate and disaster risks screening tools, with sectoral focus on Agriculture, Water, Roads, Coastal flood protection, Energy and Health are publically accessible since April 2015. They build on the 85 Climate Country Adaptation profiles. - World Bank Urban Risk Assessment (2013) helps cities screen for hazards and guide project and city managers in a detailed assessment of a city’s risk through risk mapping, resilience studies, and institutional gap analysis. 	<p>According to a 2013 Independent Evaluation Group report focusing on WB and IFC, climate risk identification was hoc and almost entirely devoted to climate variability rather than climate change:</p> <ul style="list-style-type: none"> - Climate risks don’t fit into the World Bank Operational Risk Assessment Framework (ORAF) [still used?]. - IFC tests [until 2013] for climate sensitivity during the period of its financial investment (<10y in 58% and <15y in 91% of cases), instead of the operational life of the project. <p>The report welcomes the inclusion of climate risks into IFC Performance Standards.</p> <p>The report does not evaluate the systematic IDA risk screening, which was introduced later.</p>
<i>ADB (Asian Development Bank)</i> \$665 million (2014)	<p>Since 2014, the IDB has institutionalized a framework to systematically identify proposed investments that may be adversely affected by climate change at the very early stages of project development and incorporate risk reduction measures in the project design (Figure 1 from ADB, 2015).</p>	<p>Guidelines for climate proofing investments by sector: road transport (2011), agriculture, rural development and food security (2012), energy sector (2013), as well as “metaguidelines” for water aimed at practitioners in Asia and the Pacific (2015).</p>	<p>-</p>

<p><i>African Development Bank (AfDB)</i> \$605 million (2014)</p>	<p>Alongside the Climate Risk Management and Adaptation Strategy (CRMA, 2009), AfDB's Climate Change Action Plan 2011-2015 (CCAP, 2010) set out to develop tools and mechanisms to assess vulnerabilities and build climate resilience into its projects.</p>	<p>The AfDB Climate Safeguard System (CSS) tool to assess vulnerabilities, screen risks and identify adaptation options has been piloted in 2013 for eventual application to all Bank-funded projects. All projects initiated between 2007 and 2009 were retrospectively screened for climate risks and the vulnerable ones made resilient (CCAP, 2010).</p>	<p>The Quality Assurance Department 2013 progress report on CCAP implementation highlights that despite the availability of different tools and methodologies for mainstreaming climate change into the Bank's policies and projects, Bank task managers are still struggling with project-level integration of climate risks to generate information for project design and implementation.</p>
<p><i>European Bank for Reconstruction and Development (EBRD)*</i> \$188 million (2014)</p>	<p>EBRD systematically integrates climate risk assessments and adaptation measures in their investment operations, through conducting climate sensitivity screening, tailoring asset design and management, training employees to manage risks, and creating adapted financial solutions (EBRD SEI, 2014). The importance of climate risks is recognised in its Environmental and Social Policy's Performance requirements on Assessment and Management of Environmental and Social Impacts, and Sustainable Resource Management (EBRD, 2014)</p>	<p>Tools for risk screening in place. Detailed analysis with sector-specific tools currently in development. (EUFIWACC, 2015)</p>	<p>-</p>
<p><i>Inter-American Development Bank (IDB)</i> \$81 million (2014)</p>	<p>The IDB Climate Change Strategy (2011) followed by the Climate Change Action Plan (2012-2015) made adaptation activities its first development priority and set out to mainstream climate change resilience across its operations and activities.</p>	<p>The IDB Environmental Safeguards Unit (ESG) has developed a screening toolkit for all new projects (October 2013), with regional declinations for the Caribbean region (2014).</p>	<p>A thematic evaluation (2014) from the Office for Verification and Oversight revealed that the tool had not yet been integrated into project risk analysis and there seemed to be limited training demand from IDB staff as of November 2014.</p>
<p><i>Asian Infrastructure Investment Bank (AIIB)</i></p>	<p>In its draft Environmental and Social Framework (under consultation until 23rd October), the IIAB "recognizes the need to support (...) adaptation measures in its operations" and "aims to support its Clients in their evaluation (...) of the implications of climate change on its operations".</p>	<p>The Environmental and Social Assessment required to the IIAB clients should "assess potential transboundary and global impacts, including climate change".</p>	<p>-</p>
<p><i>Nordic Development Fund (NDF)</i></p>	<p>Since 2009 NDF has a new mandate to provide financing for projects contributing to climate change and development objectives in selected, mostly low</p>	<p>The Project Identification and Screening Methodology (2013) was originally designed as a tool to secure</p>	<p>-</p>

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	income, developing countries.	a rigorous and systematic analysis of the climate change and development relevance of projects suggested for NDF's financing.	
France (AFD)***	Systematic climate risk assessment for each project during preparation phase, and plans to systematise in-depth analysis studies for projects at risk.	Procedure in place. Tool for preliminary risk screening being upgraded. Pilot phase ongoing for in-depth analysis. (EUFIWACC, 2015)	-
Japan (JICA)**	The Guidelines for confirmation of environmental and social considerations (2002) do not mention climate change, but the 2011 Climate Finance Impact Tool for adaptation (C-FIT Adaptation) aims to mainstream adaptation into Japanese ODA (JICA, 2011).	The C-FIT Adaptation is also designed to screen for risks in the early stages of project development, and contains sectoral guidelines for project level adaptation.	-
Germany (KfW)*** Development Bank	Systematic climate risk assessment for each project during preparation phase, in-depth analysis studies for projects at risk. (KfW Development Bank, 2011). The screening establishes whether there is any indication that a project depends to a significant degree on climate parameters, e.g. wind or precipitation. It also checks whether the adaptive capacity (resilience) of the people or ecosystem can be significantly increased, and follows-up with an in-depth assessment if needed.	Tools and procedure in place. ECA methodology pilots in 2015. (EUFIWACC, 2015)	-

* Members of European Financing Institutions Working Group on Adaptation to Climate Change (EUFI WACC), together with the European Commission

** Members of the International Development Finance Club

*** Members of both groups

Glossary

Adaptation is “the process of adjustment to actual or expected climate and its effects to moderate harm or exploit beneficial opportunities” (IPCC, 2013).

Climate resilience is the capacity of individuals and social, economic or environmental systems to absorb and recover from climate-induced shocks, while adapting and transforming their structures and means of living in the face of long-term stresses, change and uncertainty (Mitchell, 2013; UNISDR, 2013). Climate resilience is sometimes also defined as a more systems-orientated and dynamic approach compared with adaptation itself, where adaptive capacity (namely, the preconditions necessary to enable adaptation) plays a central role (Nelson, 2007).

Disaster risk management is the systematic process of using administrative directives, organisations and operational skills and capacities to lessen the adverse impacts of hazards and the possibility of disaster. It involves activities and measures for prevention, mitigation and preparedness (UNISDR, 2009).

Public-Private Partnership: PPPs are long-term contractual agreements between the government and a private entity formed to deliver a public service, such as infrastructure development, operations and management of transport systems, and provision of utility services. PPPs account for a relatively small part of total public infrastructure flows, and represent under 10% of public infrastructure investment flow only in Australia, Finland and UK. However, they still represent sizeable investments and can be expected to increase further in light of fiscal pressures (Burger and Hawkesworth, 2011).

Risks are “the potential for consequences due to climate change where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur” (IPCC, 2014).

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