GARI

Bridging the Adaptation Gap:

Approaches to Measurement of Physical Climate Risk and Examples of Investment in Climate Adaptation and Resilience

A Discussion Paper by:

Global Adaptation & Resilience Investment Working Group

November 2016

Acknowledgments & Disclaimer

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Table of Contents

Foreword

The Global Adaptation & Resilience Investment Working Group (GARI) was conceived of in the run up to the Paris COP21 conference. Launched at COP21 in conjunction with the UN Secretary General's A2R Climate Resilience Initiative, GARI was designed to bring together private investors and a range of other stakeholder groups to focus on investment and climate adaptation and resilience. The idea was to bring together in as open a manner as possible interested investors, climate experts, and other stakeholders to focus on how to practically invest in the face of climate adaptation and resilience needs.

At the launch of GARI, it was quite unclear how much interest if any there would be on the topic of investment and adaptation and resilience. Public climate finance in adaptation was limited and early, and private climate finance extremely difficult to identify. Today there are still no dedicated private investment vehicles focused on climate adaptation and resilience.

Despite this uncertainty, GARI held its first meeting in January 2016 in the wake of the Paris Agreement. Over the course of five meetings in 2016, it has engaged over 150 private investors and other stakeholders, and its 2016 GARI Survey received 101 responses. The degree of engagement and the quality of participation has been frankly very pleasantly surprising.

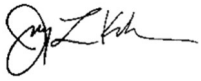
The idea of "a short discussion paper" to memorialize the discussions of the working group was agreed in the first GARI meeting. It was supposed to be a simple 5-10 page reporting out of the GARI discussions to provide context for interested parties around COP22. The richness of discussions and the recommendation for the 2016 GARI Survey have resulted in the document before you.

The GARI meetings, 2016 GARI Survey, and this discussion paper are indications of the interest of the private sector and specifically, private investors, in investment and climate adaptation and resilience. The paper is designed to provide context and feedback – not to be comprehensive or to suggest that the comments expressed are broadly representative. It aims to provide some practical starting points for discussion and specific feedback from a set of engaged private investors and other stakeholders.

GARI, the 2016 Survey, and this discussion paper would not be possible without the support of Siguler Guff and other institutions that provided in-kind support as well as a number of tireless, dedicated individuals. I wish to acknowledge Tony Liu, Xiao Cong, Bibhusha Dangol, Stacy Swann, Emilie Mazzacurati, Joyce Coffee, Barbara Buchner, John Firth, Ian Kline, and Paulus Ingram for their specific comments and editorial contributions. Thanks also to all GARI participants and 2016 GARI Survey respondents.

We hope you find this discussion paper useful. Comments or questions can be sent to chair@garigroup.com.

Sincerely,



Jay L. Koh
Founder & Chair
GARI

Executive Summary

Although substantial progress has been made on the path toward mitigating climate change through the Paris Agreement and other initiatives, the physical impacts of a changing climate are already being experienced and are expected to increase. The frequency and severity of extreme weather events are increasing, and global average temperature continues to rise. The need for an assessment of the physical risks created by the changing climate and for investment into resilience to those risks is substantial and increasing. Unfortunately, although there are growing calls to investors to take account of climate risk in general – including the physical risk of climate change in specific – the problem is complex and approaches to addressing it are early and unfamiliar to investors and other stakeholders. In addition, uncertainty and a perceived lack of investible opportunity have limited public and private investment in adaptation and resilience to the physical risks of climate change.

To address these and other issues at the intersection of investment and climate adaptation and resilience, the Global Adaptation & Resilience Investment working group (GARI) was launched in 2015. GARI is a private sector, private investor-led initiative announced at the Paris COP21 talks in December 2015 in conjunction with the UN Secretary General's Climate Resilience Initiative. The working group brings together private and public sector investors, bankers, leaders and other stakeholders to discuss critical issues at the intersection of climate adaptation and resilience and investment with the objective of helping to assess, mobilize and catalyze action and investment.

In 2016, GARI convened five in-person and remotely-accessible meetings in New York, Washington DC, and London, bringing together over 150 private sector investors and other stakeholders from pension funds, endowments and foundations, insurance companies, banks and investment managers to corporations, start-ups, think tanks, advisory firms and development finance institutions. GARI also conducted a follow up on-line survey (the 2016 GARI Survey) based on the discussions of the working group, reaching out to 236 GARI participants and other interested stakeholders, and receiving 101 responses, including over 30 investors.

This discussion paper focuses on two issues at the heart of addressing the physical risk of climate change that were the focus of GARI conversations in 2016:

I) Approaches to Measurement of Physical Climate Risk; and

II) Examples of Investments in Climate Adaptation and Resilience.

The paper reports on the discussions of the working group and on additional materials and research provided by GARI participants as well as the results of the 2016 GARI follow-up survey analysis of working group participants and other stakeholders.

First, the discussion paper reflects GARI discussions and the 2016 GARI Survey results that identify different approaches to metrics and methodologies for measuring aspects of the physical risk of climate change and reports on private investor and other stakeholder perspectives on those approaches. The most important findings were the following:

- ***Importance***. Based on the 2016 GARI Survey, 78% of respondents ranked analyzing the risk of Physical Effects of Climate Change as "Very Important," and more important than both the low-carbon transition and climate regulation.
- ***Range of Approaches to Measurement***. At least six different types of approaches to physical climate risk measurement were identified by the working group
- ***Limitations on Current Approaches***. Feedback from GARI participants include discussions of limitations of data consistency and coverage, scenario planning, implications of analysis, and diversity of use cases and physical risks.
- ***Criteria for Success***. The paper then suggests approaches to addressing those limitations as well as eight criteria for a successful approach to measuring physical climate risk, the most important being Transparency (75% strongly agree) and Practicality (72% strongly agree).

Second, this discussion paper reports on examples of investments in adaptation and resilience identified by GARI participants. The most important findings were the following:

- ***Importance and Immediacy***. Based on the 2016 GARI Survey, it notes that 70% of respondent organizations that had investment portfolios were interested in considering investments in climate adaptation and resilience now, and an additional 23% would consider them within 1-3 years.
- ***Resilient Investments vs. Investments in Resilience***. The paper distinguishes between resilience as a feature of an investment versus resilience as the core output of an investment.
- ***Broad Investment Landscape***. Based on GARI feedback, the paper describes a landscape for resilient investments, such as infrastructure and fixed assets, and investments in resilience, such as companies and infrastructure and fixed assets that assess or address resilience to climate change.
- ***Feedback on Investment Opportunities***. It provides comments from GARI participants regarding the need for more examples, a broad definition, screening tools, comparable risk/return, investment vehicles and instruments, additional research, and overcoming investor bias.
- ***Suggestions and Areas of Investment Interest***. It also provides six summary suggestions from the working group participants and provides feedback from the 2016 GARI Survey which indicates that Infrastructure (61%) and Companies whose products and services address specific aspects of climate risk (60%) were of greatest interest to respondent organizations.

Third, the discussion paper reports on suggestions raised by GARI participants and respondents to the 2016 GARI Survey and other stakeholders for regulators, policy-makers and public finance institutions, industry groups and think-tanks, and investors and financiers. Key feedback includes:

- ***Regulators: Establish standards***. The top recommendation for regulators was to establish standards and methodology on how to assess climate impacts (73%).
- ***Policy-Makers/Public Finance Institutions: Infrastructure & Blended Finance Vehicles***. A strong majority of respondents recommended that policy makers and public finance institutions invest in resilient infrastructure and fixed assets that support resilience (77%), while 70% recommended support for blended finance vehicles or other instruments to mobilize finance into resilience.

- ***Industry Groups/Think-Tanks: Stress Testing/Risk Screening***. The top recommendation was to develop guidance, methodology and industry standards for stress testing and risk-screening.
- ***Investors/Financiers: Price Risk, Promote Disclosure***. The top recommendations were to price climate risk into investments (77% strongly agree) and promote disclosure practices (77%), followed by making resilient investments and allocating capital to resilient investments (72%).

Finally, the discussion paper closes by reporting next steps suggested by the participants in the working group for GARI in 2017.

- A plurality of 2016 GARI Survey respondents (45%) indicated that **focusing on opportunities for investment in resilience** was the #1 priority for 2017.
- The highest percentage of respondents (79%) thought that **guidance, standards or best practices for measuring resilience** should be the output goal for 2017.

This discussion paper is designed to serve as an initial starting point for broader discussions about metrics and methodologies for identifying and assessing climate change risk at the asset level and about examples of investments in adaptation and resilience. It provides feedback and commentary from an initial set of private investors and other stakeholders on those approaches with the objective of leading to appropriate ways of measuring physical climate risk that can facilitate concrete investment in adaptation and resilience.

This paper is not designed to reflect a comprehensive review of the adaptation and resilience landscape, nor a technical or academic paper designed to recommend specific solutions, but rather to serve as a reporting out of discussions of the GARI working group designed to serve as context for other discussions in the emerging and important area of climate adaptation and resilience investment.

The respondent population for the 2016 GARI survey also reflects GARI participants and other stakeholders who demonstrated interest and commitment of time and effort to engage on the topic of investment and adaptation and resilience, and may not reflect the broader private investment community.

Comments can be sent to: chair@garigroup.com

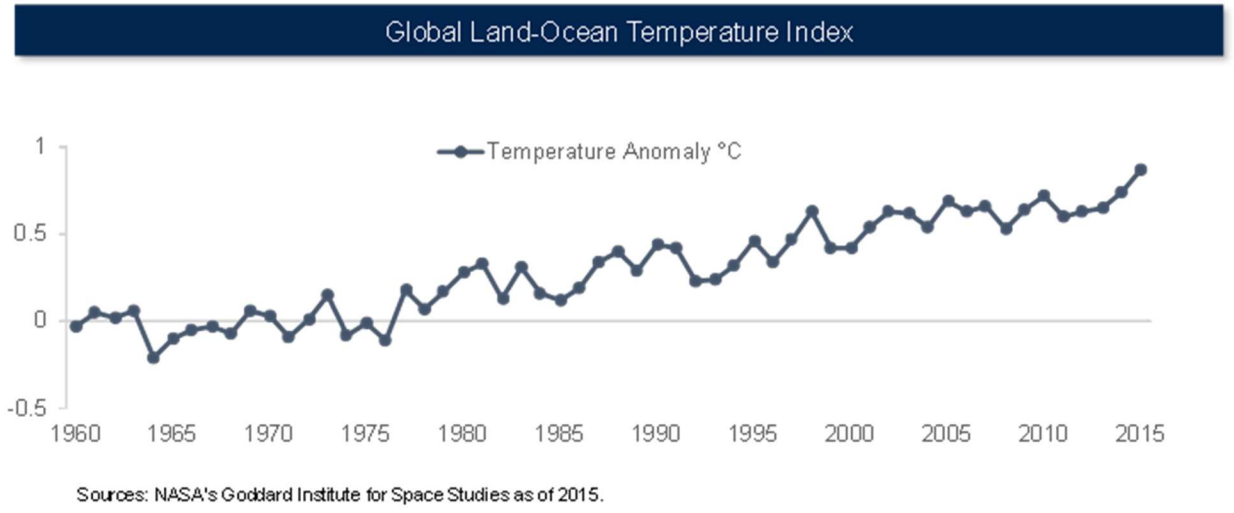
PART I

Background

PART I: Background

A. The Need for Climate Adaptation and Resilience

The Paris COP21 Agreement marked a significant global commitment to addressing the challenge of climate change by creating pathways to low-carbon and climate-resilient societies. The Agreement recognized that the importance of addressing both climate mitigation – reducing greenhouse gas emissions and transitioning to a low carbon economy – and climate adaptation and resilience – adjusting society to the impact of climate change and building the capacity to respond to and recover from climate risk is substantial and increasing[1]. In addition to landmark progress on commitments on mitigation, the Paris Agreement specifically recognized that "adaptation is a global challenge faced by all with local, subnational, national, regional and international dimensions." The UN Secretary General also launched the A2R Climate Resilience Initiative[2] at Paris COP21, calling on public and private stakeholders to focus on adaptation and resilience. A2R – "Anticipate, Absorb, Reshape" – calls for parties to work together to use early warning and action to anticipate and act on climate hazards and stresses, absorb shocks through access to climate risk insurance and social protection systems, and reshape development through management of physical infrastructure and ecosystems[3].

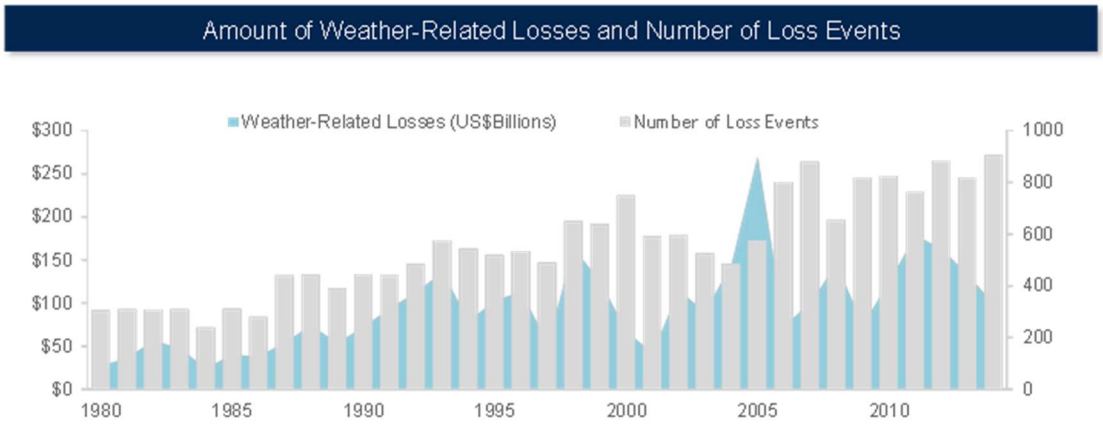


[1] Paris Agreement, Article 2, April 22, 2016,

[2] The UN Secretary-General's Climate Resilience Initiative — Anticipate, Absorb, Reshape — brings together private sector organizations, governments, UN agencies, research institutions and other stakeholders to address climate adaptation and resilience through a network of 13 UN agencies and private sector institutions.

[3] "UN Secretary-General's initiative aims to strengthen climate resilience of the world's most vulnerable countries and people", November 30, 2015. <http://www.un.org/sustainabledevelopment/blog/2015/11/un-secretary-generals-initiative-aims-to-strengthen-climate-resilience-of-the-worlds-most-vulnerable-countries-and-people> See also <http://www.a2rinitiative.org>

Although progress is being made on climate mitigation, the urgency of the need to evaluate the physical risk of climate change and to develop investment strategies to address that risk is increasing. Experts from climate scientists and meteorologists report that climate change is already underway, with average global temperatures continuing to rise annually[4], and reinsurance companies reporting that the frequency and severity of extreme weather events are increasing, along with their associated losses[5].



Sources: Munich Re Group as of 2015, Geo Risks Research as of 2015, and NatCatSERVICE as of 2015.

Experts report an increasing number of examples of climate change-exacerbated weather events, from a 10-25% more severe drought in California[6] to more frequent sunny day flooding in Florida[7]. With these changes also come impacts on a wide range of parts of society, from relocating populations in the face of sea level rise, to challenges to food and agriculture, such as changes in temperature and humidity accelerating the spread of coffee rust in Central America[8], to even shortfalls in the performance of wind farms in the western United States as a result of a climate change-enhanced El Nino suppressing wind speeds and resulting financial performance in 2015[9]. The consensus of experts is simple: Climate change is happening now.

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[4] Thompson, Andrea. "First Half of 2016 Blows Away Temperature Records." Scientific American. July 16, 2016. <https://www.scientificamerican.com/article/first-half-of-2016-blows-away-temperature-records>

[5] Munich Re Group. "Loss Events Worldwide 1980 – 2014." January 2015. <https://www.munichre.com/site/touch-naturalhazards/get/documents_E2080665585/mr/assetpool.shared/Documents/5_Touch/_NatCatService/Focus_analyses/1980-2014-Loss-events-worldwide.pdf>

[6] Gillis, Justin. "California Drought Is Made Worse by Global Warming, Scientists Say." New York Times. August 20, 2015. <http://www.nytimes.com/2015/08/21/science/climate-change-intensifies-california-drought-scientists-say.html>

[7] Gillis, Justin. "Flooding of Coast, Caused by Global Warming, Has Already Begun." New York Times. September 3, 2016. <http://www.nytimes.com/2016/09/04/science/flooding-of-coast-caused-by-global-warming-has-already-begun.html>

[8] Stone, Daniel. "Fungus, Climate Change Threatening Big Part of Global Coffee Supply." National Geographic. May 31 2014. <http://news.nationalgeographic.com/news/2014/05/140531-coffee-rust-columbia-brazil-cost-problems/>

[9] Meyer, Gregory. "US clean energy suffers from lack of wind." September 1, 2015. <https://www.ft.com/content/b967b6d4-5058-11e5-8642-453585f2cfcd>. See FitchRatings, "Fitch Affirms FPL Energy National Wind Opco and Holdco; Outlook Remains Negative." November 17, 2015. <https://www.fitchratings.com/site/fitch-home/pressrelease?id=994281>. See also Lawrence Livermore Laboratory, Climate Change Impacts on Generation of Wind, Solar, and Hydropower in California, September 2014. <http://www.energy.ca.gov/2014publications/CEC-500-2014-111/CEC-500-2014-111.pdf>.

The need to assess and address the physical risks of climate change – for climate adaptation and resilience – is projected to be substantial. Of course, the more successful efforts at climate mitigation are, the lower the potential physical impact of climate change and the need for climate adaptation and resilience. Nevertheless, even under moderate projections of climate change, the World Bank's Economics of Adaptation to Climate Change Synthesis Report in 2010 estimated the costs of climate adaptation to be $70 to $100 billion per year globally by 2050.[10] The 2015 UNEP Adaptation Gap Report's new analysis suggests that adaptation costs could be as much as four to five times higher.[11] And the UN and others identify substantial non-financial potential costs from the physical impact of climate change on equity, communities, and ecosystems[12].

Individual governments at the national, state and local level have begun to recognize the importance of preparing for adaptation and focusing on resilience. For example, U.S. President Barack Obama has recognized climate change as a national security issue[13] and has directed federal agencies to develop coordination mechanisms and a national climate plan[14]. At COP21, U.S. Secretary of State John Kerry also highlighted the country's commitment to double the public, grant-based adaptation investments by 2020.[15] Similarly, state and local entities in the US have begun to focus on climate adaptation and resilience plans[16]. As part of the UNFCCC process, many countries are also developing National Adaptation Plans to coordinate their response to climate change[17], and subnational entities in other countries have also begun to develop their own adaptation plans[18]. The Green Climate Fund of the UNFCCC has committed to deploying 50 percent of its funding toward climate adaptation and 50 percent to climate mitigation, with specific windows for each area as well as the Private Sector Facility, which is also projected to deploy financial resources 50:50[19].

Unfortunately, while substantial resources have been focused on assessing the transition risk to a low-carbon economy and on driving mitigation investments (largely renewable energy and energy efficiency), both evaluating the physical risk of climate change and catalyzing investment in climate adaptation and

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[10] World Bank. The Economics of Adaptation to Climate Change. August 2010. <http://siteresources.worldbank.org/EXTCC/Resources/EACC_FinalSynthesisReport0803_2010.pdf>

[11] UNEP. The Adaptation Gap Report 2016. United Nations Environment Programme (UNEP). May 2016. <http://web.unep.org/adaptationgapreport/sites/unep.org.adaptationgapreport/files/documents/agr2016.pdf>

[12] IPCC. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers. < http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf >

[13] David Nakamura 2015. At Coast Guard Graduation, Obama Warns of Climate Change Threat to National Security. Washington Post, May 20, 2015.

[14] Executive Office of the President 2013. The President's Climate Action Plan. See also Center for Climate and Energy Solutions 2012. Climate Change Adaptation: What Federal Agencies Are Doing.

[15] Kerry, John. "Remarks on COP21 and Action Beyond Paris", December 9, 2015, Le Bourget, Paris, France.

[16] In 2013, for example, Mayor Bloomberg proposed a $20 billion climate adaptation plan for New York City in the aftermath of Superstorm Sandy. Katherine Bagley and Maria Gallucci. "Is NYC's Climate Plan Enough to Win the Race Against Rising Seas?" Inside Climate News. June 20, 2013. (reporting on Mayor Bloomberg's $20 billion plan for NYC adaptation investments). <http://insidelcimatenews.org/news/20130620/mycs-climate-plan-enough-win-race-against-rising-seas.>

[17] Least Developed Countries Expert Group. National Adaptation Plans. Technical Guidelines for the National Adaptation Plan Process. Bonn: UNFCCC Secretariat. Bonn, Germany. December 2012. <http://unfccc.int/NAP>

[18] MIT researchers in 2011 reported that roughly 20 percent of cities worldwide have developed adaptation plans. Bagley and Gallucci 2013.

[19] Green Climate Fund. "GCF Paradigm Shift Revisited." October 30, 2015. <http://www.greenclimate.fund/-/gcf-paradigm-shift-revisited>

resilience have received dramatically less attention and support. The gaps and challenges of two aspects of climate adaptation and resilience will be detailed below.

B. Barriers to Private Sector Physical Climate Risk Analysis

Post Paris COP21, private sector investors have begun to place enhanced emphasis on climate risk as a consideration for their own portfolios, but have primarily focused on carbon-intensity risk. Reports by institutional investor advisors have begun to identify both (a) the "transition risk" of investments that are highly carbon-intensive and thus potentially vulnerable to changes in the cost of carbon, societal preferences, or regulation and (b) the "physical risk" of climate change to investments.[20] Recent reports provide a framework for considering the risk of climate change in investment strategy, but note the uncertainty and early nature of the analysis.[21] Similarly, both insurance companies[22] and credit rating agencies[23] have committed to incorporating climate change risk into their analysis to price insurance premiums and underwrite credit risk, but limited information has been disclosed about how they plan to approach that risk and how it can be used by private investors or other stakeholders.

In addition, public and private sector efforts have begun to focus on identifying and disclosing the risks of climate change, but these initiatives are just emerging and do not yet provide much clarity for private sector investors. Most notably, the French government passed the Energy Transition law, in 2015 in advance of COP21, in which Article 173 requires all institutional investors to disclose the risks of climate change to their investments – specifically identifying "transition risk", "physical risk" and "liability risk"[24]. Similarly, at COP21, Mark Carney, the FSB and the G20 launched the Task Force on Climate-Related Disclosure (TCFD) to focus on voluntary approaches to disclosure of climate risk, including transition, physical and liability risk[25]. Both of these efforts are still emerging, with the deadline for Article 173 compliance being July 2017, and the TCFD expecting to report out by Q1 2017. Dozens of institutional investors have submitted letters to the Securities and Exchange Commission requesting quick action to require stronger reporting of sustainability risks such as climate change[26], but reporting practices are still at an early stage of development and adoption.

A range of private stakeholders from companies to investors have had a long-standing interest in understanding the physical risk of climate change, but have faced substantial barriers of uncertainty, lack of

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[20] BlackRock Investment Institute. "Adapting Portfolios to Climate Change." BlackRock. September 6, 2016. <https://www.blackrock.com/investing/insights/blackrock-investment-institute/climate-change> See also Mercer. "Investing in a Time of Climate Change." September 2015. < http://www.mercer.com/content/dam/mercer/attachments/global/investments/mercer-climate-change-report-2015.pdf> Cambridge Associates. "Risks and Opportunities from the Changing Climate: Playbook for the Truly Long-Term Investor." December 2015. <https://www.cambridgeassociates.com/our-insights/research/risks-and-opportunities-from-the-changing-climate-playbook-for-the-truly-long-term-investor>

[21] BlackRock Investment Institute. Mercer. Cambridge Associates.

[22] National Association of Insurance Commissioners. "Climate Change and Risk Disclosure," NAIC, June 13, 2016. <http://www.naic.org/cipr_topics/topic_climate_risk_disclosure.htm>

[23] S&P Global Ratings. "Climate Change: Assessing The Potential Long-Term Effects," <https://www.spratings.com/en_US/topic/-/render/topic-detail/climate-change-assessing-the-potential-long-term-effects>

[24] PRI. French Energy Transition Law: Global Investor Briefing. 2016. <https://www.ceres.org/press/press-releases/investors-call-on-sec-to-improve-reporting-of-climate-risks>

[25] Task Force on Climate-Related Financial Disclosures. "Phase I Report." March 21, 2016. <https://www.fsb-tcfd.org/publications>

[26] Fleming, Peyton. "In Unprecedented Response, Investors Call On SEC To Improve Reporting Of Climate Risks And Other Sustainability Challenges." CERES. July 20, 2016. <https://www.ceres.org/press/press-releases/investors-call-on-sec-to-improve-reporting-of-climate-risks>

addressable data, and awareness. A Caring for Climate survey from 2011, for example, revealed that 83 percent of 72 responding companies believe climate change poses a risk to their products or services, while 86 percent think that responding to climate change risks or investing in adaptation solutions presents a business opportunity for their company.[27] However, private sector companies and investors alike have expressed limited ability to assess the physical risk of climate change and to take action as a result because of uncertainties about what climate adaptation is and what it means for private markets, particularly because of lack of clarity about the location, magnitude, potential timing and consequences of climate risks. Businesses also report difficulties in incorporating scientific climate change data, especially in shorter term, location-specific practical business decision-making.[28] Other analyses report low levels of awareness (particularly of indirect risk), challenges in the interpretation of existing data, uncertainty complicating decision-making, limited appetite or capacity to engage, a focus on short term costs and cash flows, and lack of capacity and authority as substantial barriers to private sector action.[29]

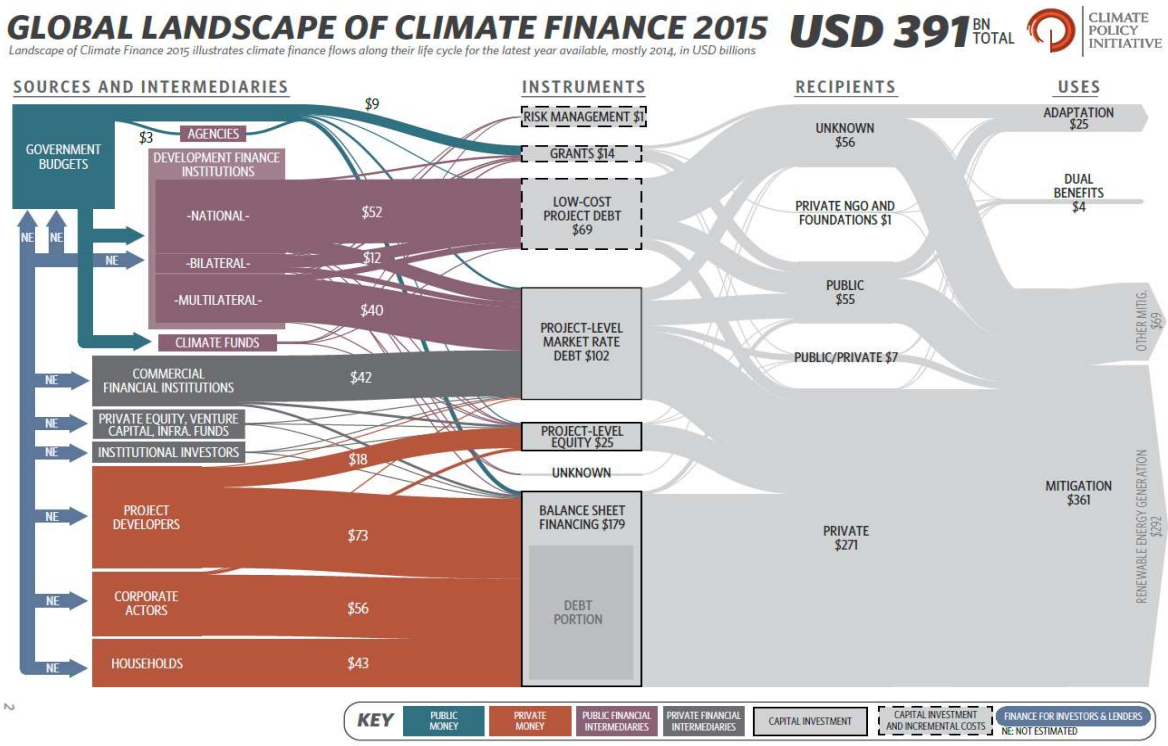
C. Barriers to Private Sector Climate Adaptation and Resilience Investment

At the same time that assessing physical climate risk remains challenging, investment flows into adaptation and resilience to climate change have been dramatically lower than in climate mitigation, for reasons that will be discussed below. Earlier attempts to track public climate finance estimated climate adaptation as receiving less than ten to twenty percent of approved public funding.[30] The latest figures from the Climate Policy Initiative (CPI) indicate that less than seven percent of public climate finance can be identified with climate adaptation[31].

Even more importantly, the small amount of public sector adaptation investment has seen only limited private sector involvement (less than ten percent in some cases) and little to no leverage of private

[27] UNCG, UNEP, Oxfam, WRI. Adapting for a Green Economy: Companies, Communities, and Climate Change. 2011. <http://pdf.wri.org/adapting_for_a_green_economy.pdf>
[28] Ibid.
[29] PricewaterhouseCoopers LLP (UK). Business Leadership on Climate Change Adaptation: Encouraging Engagement and Action. December 2010. < PricewaterhouseCoopers LLP (UK). Business Leadership on Climate Change Adaptation: Encouraging Engagement and Action>.
[30] UN Global Compact, UN Environmental Programme, Oxfam and the World Resources Institute. Adapting for a Green Economy: Companies, Communities and Climate Change. Less than ten percent of approved major public funding had been allocated to adaptation, compared to 82 percent for mitigation. (Citing Climate Funds Update figures from December 2010 <http://www.climatefundsupdate.org/graphs-statistics>. A report from the World Resources Institute's Open Climate Network found that of the $35 billion of climate finance raised by contributor countries, only 17 percent went to adaptation. Pieter Terpstra 2013. Is Adaptation Short-Changed? The Imbalance in Climate Finance Commitments. (http://www.wri.org/blog/2013/11/adaptation-short-changed-imbalance-climate-finance-commitments). The Adaptation Gap Report estimates that $23-26 billion of public finance was committed with an explicit adaptation objective, 88 percent from development finance institutions (DFIs).
[31] Buchner et al. The Global Landscape of Climate Finance 2015. November 2015. <http://climatepolicyinitiative.org/wp-content/uploads/2015/11/Global-Landscape-of-Climate-Finance-2015.pdf>

sector finance.[32] CPI further reports that while private sector climate adaptation investments may be occurring, it is extremely difficult to identify and track these financial flows[33].



The limited investment and engagement of the private sector in adaptation and resilience is concerning for several reasons. First, just as in climate mitigation, the private sector will be an essential source of financing to address climate adaptation needs.[34] Numerous government sources from the UN to individual governments have commented on the need to mobilize capital from the private sector to supplement limited public climate finance, and private investors and companies have acknowledged the importance of private finance and investment in addressing the physical impact of climate change.

In addition, private sector engagement is operationally important to address the effects of climate change: The private sector owns and controls important assets and infrastructure, creates and provides

[32] A recent review of 14 projects under the Pilot Program for Climate Resilience (PPCR) from 8 countries found that none had yet moved to implementation, only 9.2% of all PPCR financing involved private sector actors, and that there was no leveraging of private sector finance for any of the projects. Tom Fry 2013. Working Paper: The Private Sector and Climate Change Adaptation: International Finance Corporation Investments Under the Pilot Program for Climate Resilience. Bretton Woods Project and CAFOD.

[33] Brown et al. Estimating mobilized private finance for adaptation: exploring data and methods. November 2015 <http://climatepolicyinitiative.org/wp-content/uploads/2015/11/Estimating-mobilized-private-finance-for-adaptation-Exploring-data-and-methods.pdf>

[34] Bonizella Biagni and Alan Miller 2013. Engaging the Private Sector in Adaptation to Climate Change in Developing Countries: Importance, Status, and Challenges. Climate and Development, Vol. 5, Issue 3, 2013. Pages 242-252.

products and services, and engages and supports communities, all of which will be affected by climate change.[35] Moreover, the private sector can be an important source of expertise, management talent, and innovation to understand climate risks. It can produce and disseminate technologies at scale, develop technologies and business models to make current and future investments resilient, and bring the practical capacity and resources to develop and produce new products and services that will be important for climate adaptation. In addition, there is growing recognition that coordinated approaches to adaptation and resilience that bring the full range of stakeholders from the public and private sector together will be required to address the broad and inter-related impact of climate change.[36] Moreover, analysts suggest that the private sector can both contribute to and benefit from the non-financial "resilience dividends" of adaptation and resilience on equity, communities, and ecosystems.[37]

Experts have identified several challenges to climate adaptation, and, in particular, to involvement and investment by the private sector. UNEP's 2015 Adaptation Gap Report identifies funding, technology and knowledge gaps, focusing on the need for substantially more adaptation finance flows, the development and transfer of technology to developing countries, and the integration and transfer of knowledge for adaptation. Because of the primary focus of climate finance to date on mitigation (largely renewable energy and energy efficiency) and the uncertainty, unfamiliarity and limited understanding of climate adaptation risks and concrete investments that can be made to address them, adaptation financial flows have been very limited. The report further notes that while adaptation financing has increased, it remains a pressing need, and that delays in investment are likely to result in much larger costs. The Adaptation Gap report also notes that although in the short-term technology availability and transfer have not been the main barriers (uptake and dissemination have been greater challenges), research and innovation remain essential needs, and in particular, adaptation of technology to local conditions. Finally, the Adaptation Gap report focuses on three key knowledge gaps: gaps in knowledge production, inadequate integration of knowledge, and limited transfer and uptake. It notes that many regions and countries have a lack of systematic identification and analysis of adaptation knowledge gaps.[38]

(1) The Challenge of Uncertainty

The private sector faces additional specific barriers to investment in climate adaptation and resilience. First, in terms of the uses of capital in the private sector, the same challenges to physical climate risk analysis – uncertainty, lack of data, complexity, time-frame – delay or derail potential investment. As discussed above, operating businesses report hesitation in making adaptation and resilience investments because of lack of clarity about the location, magnitude, potential timing and consequences of climate risks and the challenges of incorporating scientific climate change data into shorter term, location-specific practical investments and

[35] UNCG, UNEP, Oxfam, WRI 2011. Adapting for a Green Economy: Companies, Communities, and Climate Change. Also see PricewaterhouseCoopers LLP (UK) 2010. Business Leadership on Climate Change Adaptation: Encouraging Engagement and Action.
[36] UNEP, 2016. Adaptation Finance Gap Report.
[37] UNCG, UNEP, UNFCCC, CDP, Oxfam, ND GAIN, WRI 2015. The Business Case for Responsible Corporate Adaptation.
[38] UNEP, 2014. The Adaptation Gap Report 2014.

related business decision-making.[39] A lack of metrics and measurement approaches to physical climate risk and certainty around the need for and return on investment makes investment much more unlikely. The challenge of uncertainty is similarly faced by institutional and other investors, who do not as yet have well-developed or adopted tools for evaluating the risk and return of investments in adaptation and resilience.

Of course, the challenge of uncertainty affects different types of operating companies and the range of investors differently. For corporates and commercial banks, particularly SMEs and those operating in developing countries, the issues can very much be associated to: lack of awareness of risks and opportunities of climate change and/or inability to evaluate and incorporate climate change risks into investment or financing decision making. Further, also the incentive/time for action is different. For instance, the business case and the investible opportunities are relatively clearer for an SME operating in the agribusiness sector than for an institutional investor far removed from on-the-ground operations.

(2) The Need for Investible Opportunities

Second, on the sources of capital in the private sector, strategic and institutional investors also face barriers to concrete investment action, specifically lack of concrete investible opportunities, uncertainty about financial risk and return, all against the context of a lack of clarity around the specific impact of climate risks and the policy and market environment to invest to address it.[40] Although there is a growing awareness about climate change and an increasing level of investment and changes to investment around climate mitigation, climate adaptation remains relatively less understood by investors from a risk perspective and under-invested from an opportunities standpoint. Groups such as the Global Investor Coalition of Climate Change have developed analyses of capital flows in climate finance and guides for institutional investors to address both mitigation and adaptation risks and investment opportunities, but continue to note the existing challenges for investors and the need for greater action.[41] More recent reports from private sector investment advisors and asset managers have begun to identify more potential implications for the risk to investments as well as some affirmative investment strategies related to climate change risk,[42] but also note the limited number of these opportunities, particularly with regard to adaptation and resilience[43]. These combined challenges have limited public sector investment in adaptation and private sector involvement and financing of adaptation and resilience activities.

[39] Ibid.
[40] Global Investor Coalition on Climate Change. Climate Change Investment Solutions: A Guide for Asset Owners. April 22, 2015. <http://www.iigcc.org/files/publication-files/Climate-Change-Investment-Solutions-Guide_IIGCC_2015.pdf>
[41] Ibid.
[42] BlackRock Investment Institute, 2016. Mercer, 2015. Cambridge Associates, 2015.
[43] Global Investor Coalition on Climate Change 2015. Climate Change Investment Solutions: A Guide for Asset Owners.

Analysts and stakeholders have begun to catalogue private sector activity in climate adaptation and resilience[44], but continue to emphasize the short-term, "climate-proofing" nature of most investments to date and the need to mobilize the private sector to develop transformative climate adaptation and resilience investments and create new products, services, technologies and business models to address climate change risks. Reports cite a number of examples of climate adaptation projects and investments[45] – such as innovations in weather-index insurance, water efficiency in corporate supply chains, and drought resistant agriculture as well as wave and water surge resistant infrastructure products, reduced cost patented medicines, and technology/communications services to enable farmers to react to climate risks.[46] However, these reports also conclude that while there is anecdotal evidence of private sector adaptation efforts, they are not mainstream or consistent[47] and emphasize the need for much greater collaboration and action to catalyze private sector involvement and investment in climate adaptation and resilience.[48]

Other analysts specifically call out the challenge of matching investor or commercial time frames for decision-making, particularly with regard to operations and investments, with the perceived longer-term, gradual, or uncertain time-frame for the effects of climate change. Analysts note that one challenge is that not all investors have the same time horizon, but climate risk builds regardless, and even those who may have short time horizons are building/accumulating risk they may not be able to offload, or may impact value when they do[49].

The end result of these factors is a perceived lack in adaptation and resilience finance of practical investments that can be made by operating companies on the one hand, and of investible instruments that can be financed or acquired by institutional or other investors on the other.

The specific barriers of uncertainty about the definition and implications of climate risk for the private sector, lack of clarity on timing and magnitude of climate risk, and short-term, diffuse decision-making can be overcome but require additional effort, specifically to identify how climate risk will impact specific assets and activities.

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[44] Vivid Economics Vivid Economics. Building an Evidence Base on Private Sector Engagement in Financing Climate Change Adaptation. Report prepared for EBRD. May 2015. <http://www.climateinvestmentfunds.org/cif/node/18342>
Trabacchi, C. and Mazza, F. Emerging solutions to drive private investment in climate resilience: a CPI Working Paper. Climate Policy Initiative. June 2015. Venice, Italy. <http:// climatepolicyinitiative.org/wp-content/uploads/2015/06/ Finance-for-Climate-Resilience.pdf>
[45] UNCG, UNEP, Oxfam, WRI 2011. Adapting for a Green Economy: Companies, Communities, and Climate Change.
[46] PricewaterhouseCoopers LLP (UK). Business Leadership on Climate Change Adaptation: Encouraging Engagement and Action. December 2010. <http://www.pwcwebcast.co.uk/encouraging-engagement-and-action-full-report.pdf>
[47] Ibid.
[48] Ibid. ("If each organization seeks to protect its own resilience then it is likely to incur higher costs than by taking a collective approach, and there is a risk that crucial interdependencies will be missed. Importantly, more vulnerable entities are unlikely to be able to afford the costs of adaptation. Enhanced adaptation will therefore require unprecedented levels of collaborative action to achieve the best outcomes possible.") See also UNCG, UNEP, Oxfam, WRI 2011. Adapting for a Green Economy: Companies, Communities, and Climate Change. ("Addressing the adaptation needs of vulnerable communities at the scale that is necessary will require unprecedented levels of cooperation, collaboration and resource mobilization among governments, businesses, civil society groups and communities themselves. The private sector has much to contribute to the development and implementation of climate change adaptation solutions, including sector specific expertise, technology, significant levels of financing, efficiency and an entrepreneurial spirit.")
[49] 2 Degrees Investing Initiative. The Long-Term Risk Signal Valley of Death: Exploring the Tragedy of the Horizon. November 2015. <http://2degrees-investing.org/IMG/pdf/the_tragedy_of_the_time_horizons_-_leaflet_-_light.pdf>

Similarly, the lack of investible opportunities and instruments to address climate change adaptation and resilience can also be overcome by identifying examples of existing investments and developing investment vehicles and products that can enable investors to deploy capital.

D. The 2016 GARI Agenda: Approaches to Measurement of Physical Climate Risk & Examples of Investment in Climate Adaptation and Resilience

In the first GARI meeting, participants discussed the background and challenges of climate adaptation and resilience investment, including many of the issues raised in the Background section above. After some debate, GARI participants agreed to focus on two topics of discussion that address these challenges over the course of 2016:

(1) Metrics and measurement approaches to physical climate risk that can help to address and reduce uncertainty, lack of clarity on timing and magnitude of physical climate risk; and

(2) Examples of investment in climate adaptation and resilience that can help to make investing more concrete and lay the groundwork for developing investible opportunities and instruments for practical deployment of capital.

GARI participants committed to concentrate discussions during the agreed-upon four (and ultimately five) in-person and remotely accessible meetings of the working group and work between meetings on these two topics, with the objective of generating this discussion paper in time for the COP22 summit in Morocco in November 2016. To supplement the discussions of the working group, GARI participants also agreed to a follow-up 2016 GARI Survey of participants and other interested stakeholders to provide additional data and suggestions from the group. The integrated discussions and survey results are presented on each of these topics in the next two sections.

PART II

Approaches to Measurement of Physical Climate Risk

PART II: Approaches to Measurement of Physical Climate Risk

A. The Need for Measurement of Physical Climate Risk

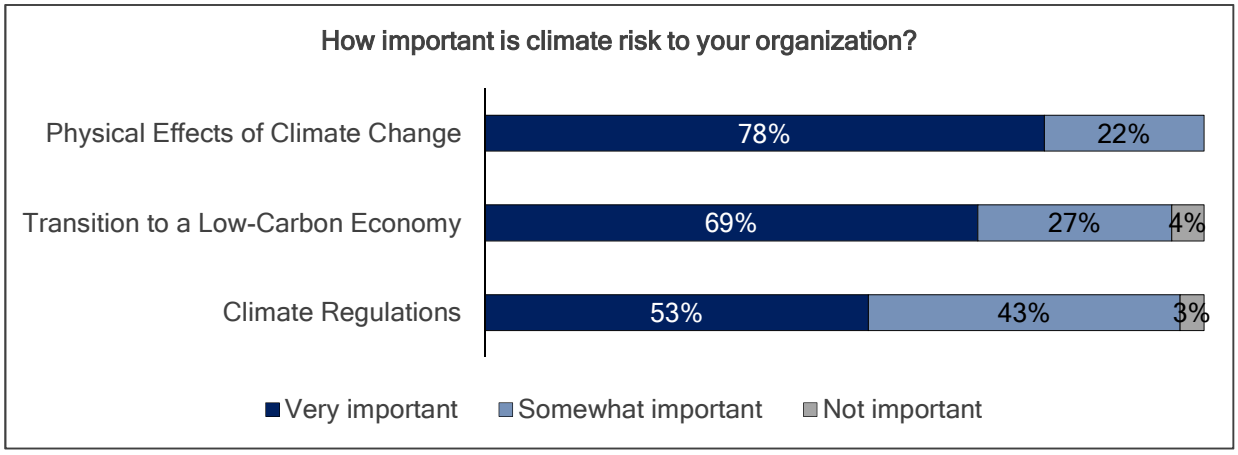
As described above, the growing awareness of the need for climate adaptation and resilience has driven a range of stakeholders to begin to focus on the question of physical climate risk (as opposed to transition risk (or stranded asset risk) related to carbon intensity) to existing investments. Both pre- and post-Paris COP21, private sector investment advisors, asset managers, insurance companies[50], and rating agencies[51] have all begun to consider the question of the risk of physical impact to existing and future investments, but while initial frameworks have been developed, experts note the uncertainty and early nature of the analysis.[52] New and potentially emerging disclosure and regulatory standards are also beginning to focus on the need to assess the physical risk of climate range, such as the French government's Energy Transition law's Article 173 (specifically identifying "transition risk", "physical risk" and "liability risk"[53]) and the work of the Task Force on Climate-Related Disclosure (TCFD) on voluntary approaches to disclosure of climate risk (including transition, physical and liability risk[54]. But these efforts, too, remain early, with a June 2017 deadline for initial implementation of Article 173, and TCFD recommendations scheduled for Q1 2017.

GARI participants confirmed the importance of exploring approaches to the measurement of physical climate risk. In the first GARI meeting, working group participants agreed to focus on measurement and metrics as one of the two key topics for 2016. Over the course of the 2016 GARI discussions, some GARI participants (particularly from the institutional investment community) specifically called for prioritizing the assessment of physical climate change risk to existing investments before focusing on new potential investments in adaptation and resilience.

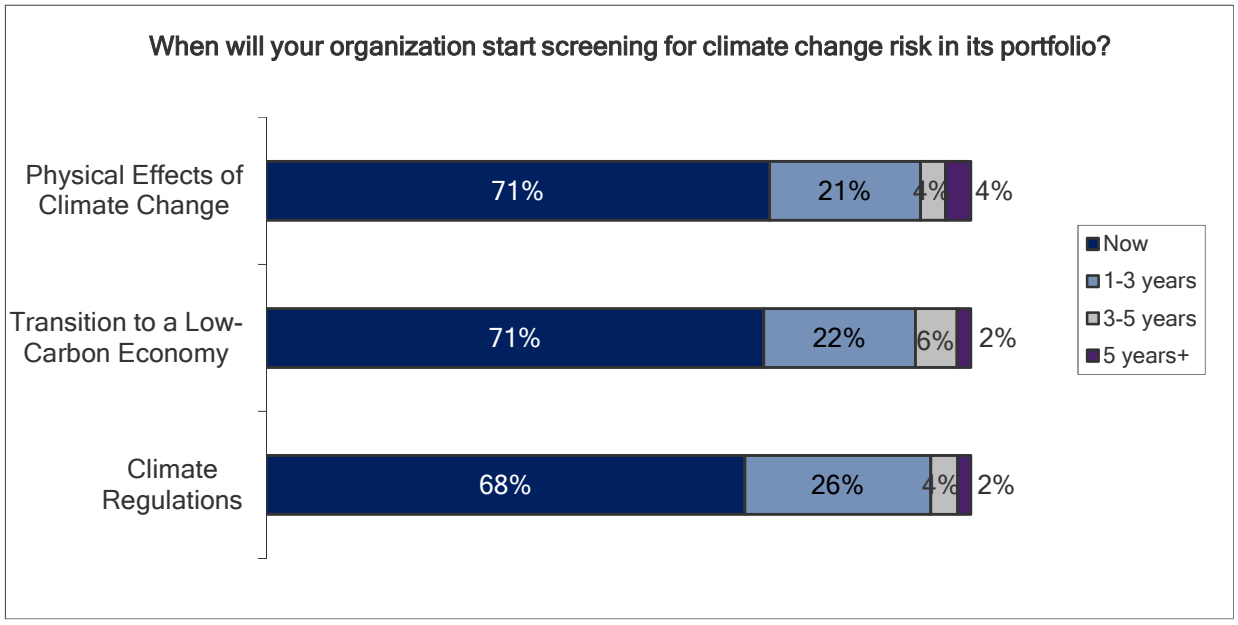
In the follow-up 2016 GARI Survey, respondents indicated that evaluating physical climate change risk was the most important of three possible risks and the risk most immediately being evaluated by their organizations[55]:

[50] See e.g., BlackRock, 2016; Mercer, 2015, Cambridge Associates, 2015; Ceres, 2015.
[51] S&P Global Ratings, 2016.
[52] BlackRock Investment Institute. Mercer. Cambridge Associates.
[53] PRI, French Energy Transition Law, 2016.
[54] See Task Force on Climate-Related Finance Disclosure, Phase I Report, 2016.
[55] GARI hastens to note that the presentation of the answers to the 2016 GARI Survey are not meant to suggest that they are necessarily representative of the broader private sector or investment industry. GARI recognizes that they capture the priorities and insights from a subset of organizations that have a stated interest in climate risk and resilience. GARI believes that these responses are relevant and provide context for discussion, but does not mean to suggest that necessarily they reflect the views of a more general investor or private sector population.

- Over 78% of respondents indicated that "Physical Effects of Climate Change" was "Very Important" to respondents' organizations versus around 69% for "Transition to a Low-Carbon Economy" and about 53% for "Climate Regulations."



Over 70% of respondents (with investment portfolios) indicated that their organizations were evaluating "Physical Effects of Climate Change" now – more than about 66-70% for both "Climate Regulations" and "Transition to a Low-Carbon Economy" – with an additional almost 23% of respondents expecting their organizations to do so within the next 1-3 years.



GARI participants agreed to focus discussion of approaches to measurement and metrics for climate risk on (A) identifying current examples and (B) providing feedback and suggestions.

B. Examples of Approaches to Measurement of Physical Climate Risk

To provide stakeholders with a starting point to help reduce the uncertainty and lack of clarity of the impact of climate change, GARI participants first focused on identifying existing approaches to measuring different aspects of physical climate change risk. Over the course of 2016, GARI participants identified a number of existing approaches to measuring aspects of physical climate change risk and the need for adaptation and resilience currently being used in the private and public sector. GARI members recognized that the list was not exhaustive and that many additional approaches could be added[56], but sought to develop an initial set of concrete examples of how aspects of physical climate risk were being currently analyzed.

The identified approaches to analyzing physical climate risk can be divided into several rough categories:

1) Government indices and rankings
2) Insurance risk ratings
3) Corporate use data
4) Project / Portfolio risk screening tools
5) Project scorecards
6) Engineering due diligence & design analysis

The working group then sought additional information regarding the underlying data source, duration, scope of application and investment implications of each of these approaches. Working group participants supplied additional information about several of these approaches and completed research on others. This paper describes 1-2 examples of each type of approach based on GARI participant submissions and research. Additional information about some of the approaches and metrics are attached as Appendix.

(1) Government indices and rankings – these approaches assess factors related to physical climate risk and vulnerability at different levels of analysis (e.g., countries (ND-GAIN), cities (100 Resilient Cities, CDP cities data))

Global Adaptation Country Index at Notre Dame Global Adaptation Initiative

- The index is currently applied to gauge investment potential for climate adaptation projects at country-level
- Measures the biophysical impacts of climate change using data from peer-reviewed sectoral climate impact models
- Measure social vulnerability and readiness using data from public, authoritative data sources with open access

[56] For example, OECD identified over 400 disclosure regimes for climate risk, though many are focused specifically on carbon disclosure rather than identifying, measuring or describing the physical risk of climate change. <https://www.oecd.org/daf/inv/mne/Report-on-Climate-change-disclosure-in-G20-countries.pdf>
TCFD was created in part to address the range of disclosure approaches and challenges.

Carbon Disclosure Project - Cities

- Developed CDP city reporting platform to disclose greenhouse gas emissions, climate change risks, and mitigation and adaptation strategies
- Extends to cities benefits of companies who have been reporting for 10 years to CDP
- Collected data from over 500 cities this year
- Currently focusing on identifying opportunities for investment

INFORM Index for Risk Management

- To understand and measure the risk of humanitarian crises and disasters, and how the conditions that lead to them affect sustainable development
- Available for 191 countries and creates a risk profile for every country

CADMUS EPA Urban Resilience Indicators Tool:

- Multi-sector, mixed-methods resilience assessment tool that uses both quantitative indicators of resilience and qualitative questions targeted at municipal sectors
- Focuses and measures adaptive capacity

(2) Insurance risk ratings – these approaches calculate risk for insurance/reinsurance against scenarios based on historical data to determine exposure to risks that manifest at specific frequencies (1:100 years, 1:50 years, 1:20 years) (e.g., Willis Re, AIR)

Capital, Science & Policy Practice, Willis Towers Watson

- Developed the 1-in-100 Initiative with other private and public sector partners to encourage improved understanding and management of disaster risk through a requirement to disclose risk exposure on the balance sheets
- Seeks to build resilience and encode natural disaster risk into the financial system through risk disclosure using standardized methodologies that the re/insurance industry has developed over the last 25 years
- Uses data and analytics to understand risk exposure and employs standardized metrics such as 1-in-100 or 1-in-200 year return periods to evaluate and report exposure
- Encourages the application of the methodologies used by the re/insurance industry to the wider community, to better educate the wider world about risk and to empower companies to make commercial decisions on how to manage and address risk exposure
- Encoding risk into accounting and regulatory norms will discount the value of assets and resilience will be rewarded; helping organizations to understand and manage their risks

AIR Worldwide

- Develops catastrophe models to help private and public entities anticipate likelihood and severity of potential future catastrophes to adequately prepare for financial impact
- Most commonly used in (re)insurance industry to estimate loss potential to books and enable risk management
- Models enable "What If" analyses that measure impact of risk mitigation strategies (e.g., storm shutters, cross-bracing)

- Models can estimate personal injuries and fatalities and number of insurance claims
- Formed global resilience practice to support risk reduction and resilience, assisting governments and NGOs to apply catastrophe modeling to identify, quantify, and mitigate risks to the public and inform disaster risk financing programs

(3) Corporate ESG data – these approaches identify specific measurements at the corporate level of uses of resources that could become scarcer (e.g., CERES water data, CDP water)

Carbon Disclosure Project - Water

- Developed CDP water disclosure program to guide companies, help investors and multinational organizations understand their portfolio companies and suppliers
- Focuses on whether company is a "good steward of its water assets and water resources"
- Currently receives disclosures from about 1,500 companies
- 5 years of available data, will be available through Bloomberg
- Migrating from absolute number reporting to sector-specific focus

(4) Risk screening tools – these approaches set out a series of factors designed to flag physical climate risk in specific projects (e.g., EBRD, IFC)

European Bank for Reconstruction and Development

- Systematic screening for climate change sensitivity at concept stage since 2011, with integration of resilience measures into investment design if applicable
- Developed sector-specific tools to integrate climate resilience measures into investments
- Applying joint MDB climate change finance tracking methodology; exploring developing of adaptation impact metrics
- 100 adaptation investments with total EUR 2.5 billion, of which dedicated adaptation investments of EUR 694 million
- Assessing climate risk over overall asset-life time frame (vs. narrower investment or loan repayment horizon)

International Finance Corporation

- Developing tools that analyzes, at sectoral level, climate risks, how they may impact investment projects' financial, environmental and social performance, and how these risks can be managed

Acclimatise' Aware for Investment

- Web based tools for users to screen companies or projects for climate change risk globally
- Designed to help investors identify potential risks to the companies they are investing in

Four Twenty Seven's FAST

- Hosted solution for supply chain and facility screening for physical impacts of climate change
- Quantifies and monetizes impacts of climate change on CapEx and OpEx
- Screens for socio-economic and policy vulnerability linked to climate impacts

(5) Scorecards – these approaches identify in many cases process and procedures and considerations in addressing resilience preparedness (e.g., AECOM)

AECOM & IBM - "Disaster Resilience Scorecard"

- Based upon the UN's Ten Essentials for Disaster Risk Reduction
- Applied to Cities as an initial activity to define gaps to be addressed, to then use this information to produce a "Resilience Plan" to address the gaps, to mitigate the risks and reduce the consequences from an acute shock
- Typically a Five year plan of capital improvements, process changes and procedure improvements

(6) Engineering due diligence & design analysis – these approaches evaluate per required regulation or according to internal policies the vulnerability of specific infrastructure components to specific perils (e.g., flood vulnerability, windstorm resistance)

WSP Parsons Brinckerhoff Engineering Services

- Analyzes climate change and extreme weather effects on infrastructure typically for owners of infrastructure assets, often as required by state or federal funding to consider resilience as part of planning and design
- Developed and applied methods to incorporate changing probability of weather events with climate change using Monte Carlo analyses to help determine NPV (net present value), BCR (benefit cost-ratio) of adaptive design options under different climate scenarios – typically high, medium and low GHG emissions
- Developed Adaptation Decision-making Assessment Process (ADAP) to guide and design infrastructure with climate change
- Performs Climate Preparedness work

International Organization for Standardization

- Technical Committee 207 with the Adaptation Task Force has been developing a roadmap for ISO climate adaptation standards; Technical Committee 268 and 292 also working on resilience and sustainability metrics and indicators at city, community levels.
- Guiding framework has four categories of standards: 1) pre-planning (includes vulnerability assessment and data collection), 2) planning, 3) implementation, and 4) monitoring and evaluation. Multiple standards anticipated as one size does not fit all
- New proposals developed on three topics: vulnerability assessment, planning (local governments), and monitoring and evaluation.

More detailed description of the above measurement approaches are listed in the Appendix.

C. Comments and Suggestions

Following the identification of different approaches to measuring physical climate change risk, GARI participants provided feedback and perspective on the examples of approaches and the broader challenge of measuring physical climate risk and the need for adaptation and resilience. The perspectives of the GARI members on the approaches to measuring physical climate change risk can be divided into two basic categories: comments on existing approaches and suggestions for improvement.

(1) Comments

In initial review of different approaches and their applicability to capture and assess changes in physical risk generated by climate change, the working group identified several challenges:

Historical Data

Consistency/Versioning: The underlying data on which these different approaches to assessing vulnerability or risk may not be consistent across different geographies, scales, or time. For example, analysts have estimated that 15% of FEMA flood maps have not been updated since 1970s/1980s[57]. The resolution of flood map data, for example, can also vary from highly specific topography mapping (drone-based LIDAR mapping of individual Florida home lots) to much lower resolution remote imagery (satellite data).

Coverage: The reinsurance industry reports that 70 percent of natural catastrophe losses globally are uninsured, the number rising to 80-100 percent in developing countries[58]. Limited insurance penetration provides one indication of the limited underlying data available to determine vulnerability. Privacy restrictions and data limitations also create challenges to mapping the value of assets against weather, climate, hazard, and topography data.

Limited/Inconsistent Disclosure: Many of these approaches do not explicitly identify the source or version of data that underlies their analysis nor do they recommend that identification or disclosure. As a result, applying the same approach to different assets may result in inconsistent outputs or incomparable conclusions. Comparing the results of different approaches is even more difficult if not impossible, because the underlying data or assumptions used as a starting point may be inconsistent.

[57] Childress, Sarah. "How Federal Flood Maps Ignore the Risks of Climate Change." PBS. May 26, 2016. <http://www.pbs.org/wgbh/frontline/article/how-federal-flood-maps-ignore-the-risks-of-climate-change>
[58] Swiss Re Sigma. "Underinsurance of property risks: closing the gap." Swiss Re. November 5, 2015. <http://media.swissre.com/documents/sigma5_2015_en.pdf>

Application/Future Scenario Planning

Lack of Standardized Forecasting/Scenario Assumptions: Many approaches to evaluating current risk are based on historical data (10-, 20-, 100-year historical information) and are only being updated for changed climate conditions as a result of each new year's addition of data. Where scenario planning is applied and assumptions are made about the changed set of future conditions (from the starting point of historical data), the assumptions used to account for climate change also may not be standardized or consistent basis. For example, it is unclear how localized evaluation of climate risk or vulnerability against specific forecasted local conditions corresponds to global scenario assumptions of climate changed conditions. And it may not be clear that the forecast assumptions used to evaluate the resilience of one infrastructure asset are the same as those used to evaluate a different infrastructure asset. Some GARI participants also reported that most consultants still rely solely on IPCC report data instead of additional sources such as modeled data.

Inconsistent Application of Duration/Short Duration: Different time horizons of different investors giving rise to different applications of measurement approaches. Some GARI participants noted that although multilateral development banks (MDBs) require clients to look at resilience and offer technical assistance, not all clients focus on the topic. Others commented that commercial entities typically have a shorter time frame for planning, operations and investment, and thus long term-models are not very relevant. This affects the choice of scenarios because in the short-term it is difficult to adopt a scenario as the climate will not change in a way that impacts the model in the short-term. However, focusing on the short-term ignores significant variability in impacts over the medium to long term. Moreover, some participants indicated that financiers outside of insurers, and also some insurers themselves, do not have to stress test against climate risk due to the shorter timeframe. They reasoned that if banks and other asset owners had to adopt the same stress test as insurers, drastic changes will be apparent. Finally, some GARI participants noted that most catastrophe models currently do not incorporate climate change due to 1) difficulty in attribution 2) difference in time horizon (what will happen next year vs. investor's long-term time frame).

Lack of Standardized Risk Measurement or Targeting: Moreover, even if the scenario assumptions are consistent, there appears to be a lack of agreement on the standard to which assets should be tested or designed – e.g., should an asset be elevated to a level of two feet above a FEMA flood map elevation, adjusted for a defined sea level rise under a specified scenario or three feet? GARI participants noted the lack of harmonized agreement on specific targets for resilience both within and across sectors, operations, and asset types.

Implications of Analysis

Lack of Connection to Financial, Regulatory, Disclosure or Other Systems: Most approaches to physical climate risk analysis have been developed for highly specific purposes (calculating insurance and reinsurance premiums; evaluating and encouraging capacity building; creating a baseline for shareholder engagement) but have not been used to inform other processes. A more robust approach from the point of view of investors and other private sector actors would connect the output of these approaches to financial and operational and other decision-making processes. For example:

- Does the resiliency metric have implications for financial performance? For example, a measurement of the availability of a service or asset might directly predict revenue generation; the resilience or quality of service of an asset might result in differential pricing for its use; the resilience of an asset

might relate directly to the financial resources set aside as reserves for recovery capital expenditures or for operational expenditures

- Does the resiliency metric have implications for financial cost? For example, is it a relevant data input to credit rating agencies in evaluating credit scores or to insurance companies in calculating insurance premiums?
- Does the resiliency metric satisfy regulatory, reporting or disclosure requirements? For example, would the output satisfy materiality disclosure requirements of the SEC, SASB reporting standard, Article 173 of France's Energy Transition Law requiring carbon and physical risk disclosure for institutional investors, the forthcoming guidance from the Task Force on Climate Disclosures?

Does resiliency metric inform investor or consumer or government preferences? For example, could the metric be incorporated into the Green Bonds or Green Buildings standards or aligned with Fair Trade or other certification standards?

Diversity of Users and of Physical Climate Risk Types

Different Users/Use Cases: GARI participants also recognized that there is a need for different tools for different users (e.g. engineering firms will have a different tool to assess than institutional/pension funds). Although standardized data sets and future roll-forward or "stress test" scenarios can be adopted across different methodologies and different approaches can be mapped to other financial and regulatory systems and approaches, different users will continue to need tools with different features, resulting in on-going challenges of complexity.

Complexity, Context, Quality of Physical Risk: GARI participants also noted that physical climate risk encompasses multiple hazards that can interact at a very contextual/localized level and at different levels of geographic or societal scope. Physical climate risk not only includes a range of different individual risks – e.g., flood risk versus heat risk versus disease vector risk – but different effects on different stakeholders (in some cases, both positive and negative) and over different time scales. GARI participants further noted the complexity of addressing slower moving or more chronic changes in climate conditions versus more acute extreme weather event severity or frequency and the difficulty in designing approaches that are flexible enough to address both general types of risk.

(2) Suggestions

After identifying, discussing and analyzing the set of metrics, measurement and data approaches described above, GARI participants also provided feedback on how physical climate change risk assessment and screening tools could address some of these challenges. Suggestions included the following:

- **Data:** Identify and base analysis on uniform data sets; and at least disclose the data set and modeling assumptions used in a climate risk analysis (FEMA maps of specific vintage, local flood maps of a specified type)
- **Scenario Planning:** Identify and stress test/scenario plan to a defined or identifiable sets of assumptions, linked to standardized and widely available references (specific IPCC forecasts, for example)

- **Targeting:** Identify and report specific level of resilience of asset based on assumptions
- **Implications:** Identify financial implications of resilience – link resilience metrics to concrete financial implications for operations, revenues, capital expenditures, reserves, credit ratings, disclosure, etc.

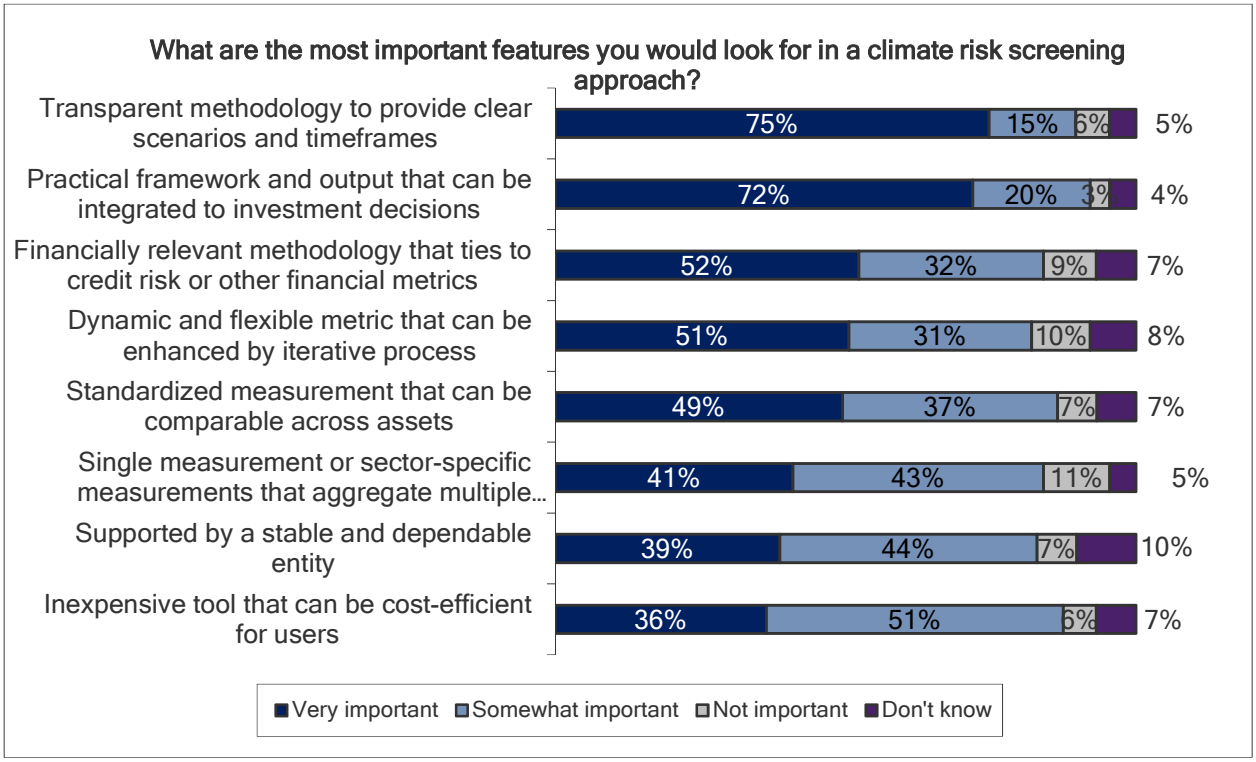
- **Diversity:** Identify specific physical climate risk vectors being evaluated with regard to specific stakeholders, acknowledge complexity of risk analysis and use cases and disclose the explicit risks (type, time frame, chronic versus acute) being assessed against specific stakeholders

GARI participants also commented on the metrics and measurement approaches discussed from the point of view of investors. Participants identified the following criteria for a set of metrics to be successful and widely adopted, and in the 2016 GARI survey, ranked them in order of importance

1. ***Transparent*** methodology to provide clear scenarios and timeframes
2. ***Practical*** framework and output that can be integrated to investment decisions
3. ***Dynamic*** and flexible metric that can be enhanced by iterative process
4. ***Financially relevant*** methodology that ties to credit risk or other financial metrics
5. ***Standardized*** measurement that can be comparable across assets
6. ***Single*** measurement or sector-specific measurements that aggregate multiple factors
7. ***Supported*** by a stable and dependable entity
8. ***Cost-efficient*** tool for the user

The two criteria of Transparency and Practicality received overwhelming support as the most important, receiving "Very Important" ratings from over 70% of respondents.

GARI participants and survey respondents also made a series of recommendations regarding approaches to measuring physical climate change risk that will be discussed in Chapter IV below.



D. Conclusion

As discussed above, discussions of the GARI working group and responses to the GARI survey revealed several important observations about the state of approaches to measurement of physical climate change risk:

- Measuring physical climate change risk is important to private sector investors and other stakeholders and is being evaluated now: Over 78% of 2016 GARI Survey respondents rated physical climate risk very important, more than low carbon transition risk and climate regulation, and of respondents with investment portfolios, 71% indicated that their organizations were beginning to evaluate physical climate risk now.
- Different approaches to measuring physical climate change risk already exist. At least six categories of current approaches to measuring aspects of physical climate risk have been identified by GARI participants: government indices and rankings, insurance risk ratings, corporate use data, project/portfolio risk screening tools, project scorecards, and engineering due diligence and design analysis.
- Current approaches have challenges, but there are suggestions for addressing them. At least four major categories of challenges can be identified with regard to current approaches to physical climate risk: historical data limitations, consistency of future scenario planning, implications of analysis, and diversity of uses and risks.

- Transparency and practicality are the key criteria for success of an approach to measurement. GARI participants and 2016 GARI Survey respondents identified eight criteria for a successful approach to measuring physical climate risk, the most important two of which are Transparency and Practicality. Others include: financial relevance, flexibility, standardization, single approach, stable support, and cost-effectiveness.

GARI participants and 2016 GARI Survey respondents also provided additional specific suggestions for a variety of actors and stakeholders which are discussed in Part IV below.

PART III

Examples of Investment in Climate Adaptation and Resilience

PART III: Examples of Investment in Climate Adaptation and Resilience

A. The Need for Investment in Climate Adaptation and Resilience

As described in the background section, despite the growing awareness of the scale and immediacy of the need for adaptation and the development of resilience to the physical impacts of climate change, investment flows in adaptation and resilience have been dramatically lower than in climate mitigation, both in the public and private sector. As noted, the Climate Policy Initiative (CPI) reports that less than seven percent of public sector climate finance can be identified with climate adaptation,[59] and that there is an extremely limited ability to identify and track private adaptation financial flows.[60] Other studies reveal a very limited amount of private sector engagement in those public sector investments[61]. And although there may be some private sector investment around adaptation and resilience challenges, it remains at an early stage, is not at the scale that experts project will be needed to address the challenge, and is not focused or coordinated at the same level of sophistication or scale as climate mitigation investments in renewable energy and energy efficiency, for example.

Several key issues appear to contribute to the extremely limited amount of identifiable investment in climate adaptation and resilience. First, as described above, one critical issue both in identifying and driving private investment into climate adaptation and resilience has been the uncertainty, lack of data, complexity, questions about time-frame and issues with measurement that make shorter term, location-specific practical investments and related business decision-making much more challenging for businesses.[62] The uncertainty about how to evaluate or measure both existing and potential physical climate risk – and also the potential adaptation and resilience benefits of related investments – also make identifying successful investments and driving additional financial flows in this area very challenging. Second, as noted, sources of investment such as strategic and institutional investors report that the lack of concrete investible opportunities and the related uncertainty about the financial risk and return of those investments[63]. These two are distinct, but related issues.

GARI participants confirmed the importance of identifying examples of investment in climate adaptation and resilience. In the first GARI meeting, working group participants agreed to focus on examples of practical, concrete investments in climate adaptation and resilience as the second key topic for

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[59] Buchner et al. The Global Landscape of Climate Finance 2015. November 2015.<http://climatepolicyinitiative.org/wp-content/uploads/2015/11/Global-Landscape-of-Climate-Finance-2015.pdf>

[60] Brown et al. Estimating mobilized private finance for adaptation: exploring data and methods. November 2015. <http://climatepolicyinitiative.org/wp-content/uploads/2015/11/Estimating-mobilized-private-finance-for-adaptation-Exploring-data-and-methods.pdf>

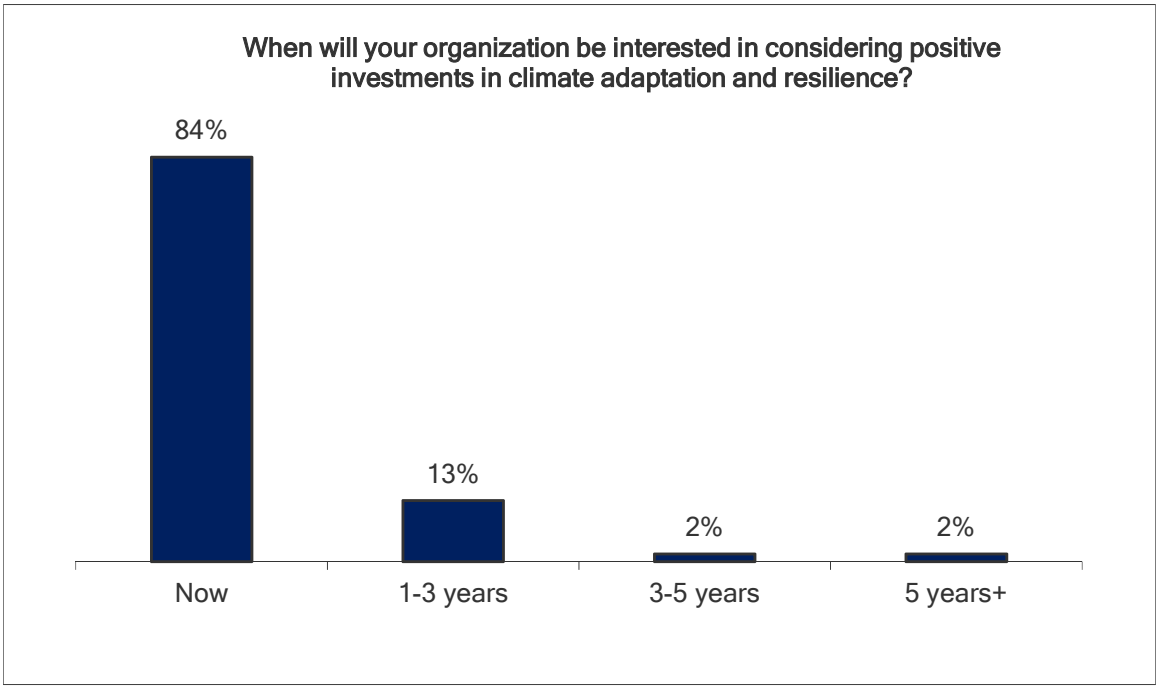
[61] A recent review of 14 projects under the Pilot Program for Climate Resilience (PPCR) from 8 countries found that none had yet moved to implementation, only 9.2% of all PPCR financing involved private sector actors, and that there was no leveraging of private sector finance for any of the projects. Tom Fry 2013. Working Paper: The Private Sector and Climate Change Adaptation: International Finance Corporation Investments Under the Pilot Program for Climate Resilience. Bretton Woods Project and CAFOD.

[62] Ibid.

[63] Ibid.

2016. As described above, some GARI participants (particularly from the institutional investment community) specifically called for prioritizing the assessment of physical climate change risk to existing investments ahead of new potential investments in adaptation and resilience, but the working group repeatedly stated the importance of identifying and discussing existing examples of investments and instruments for finance in adaptation and resilience.

In the follow-up 2016 GARI Survey, the set of respondents with current investment portfolios indicated that 83% of their organizations were interested in positive investments in climate adaptation and resilience now, with an additional 13% indicating that they would consider investments over the next 1-3 years[64]:



Based on the agenda agreed upon in the first GARI meeting, participants focused discussions on two aspects of examples of investments in climate adaptation and resilience: identifying examples of investment in climate adaptation and resilience and providing feedback and perspective.

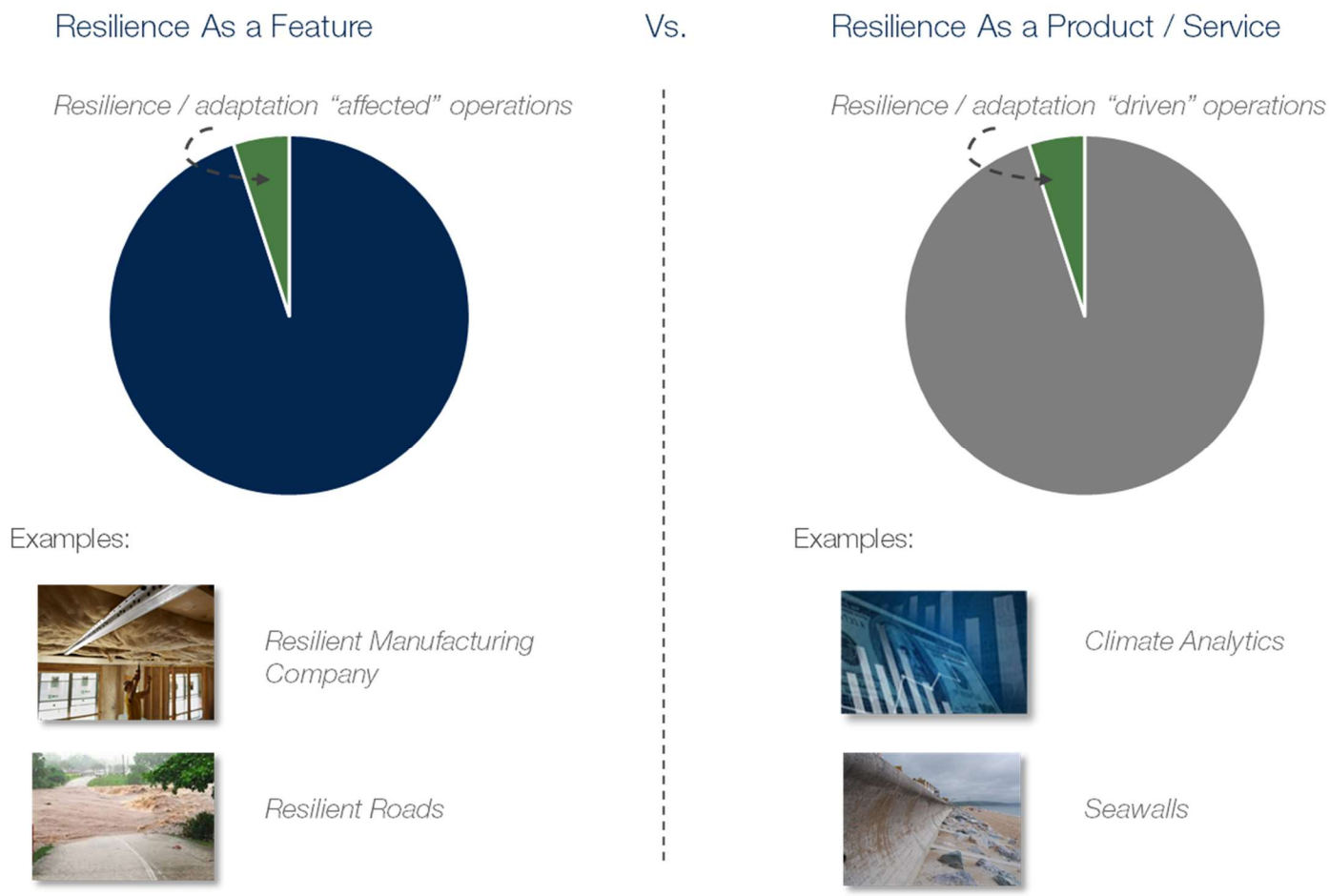
B. Examples of Investment in Climate Adaptation and Resilience

In framing the examples of climate adaptation and resilience investments, GARI participants discussed three concepts: (a) resilience as a feature of an investment vs. an investment that fosters resilience; (b) the

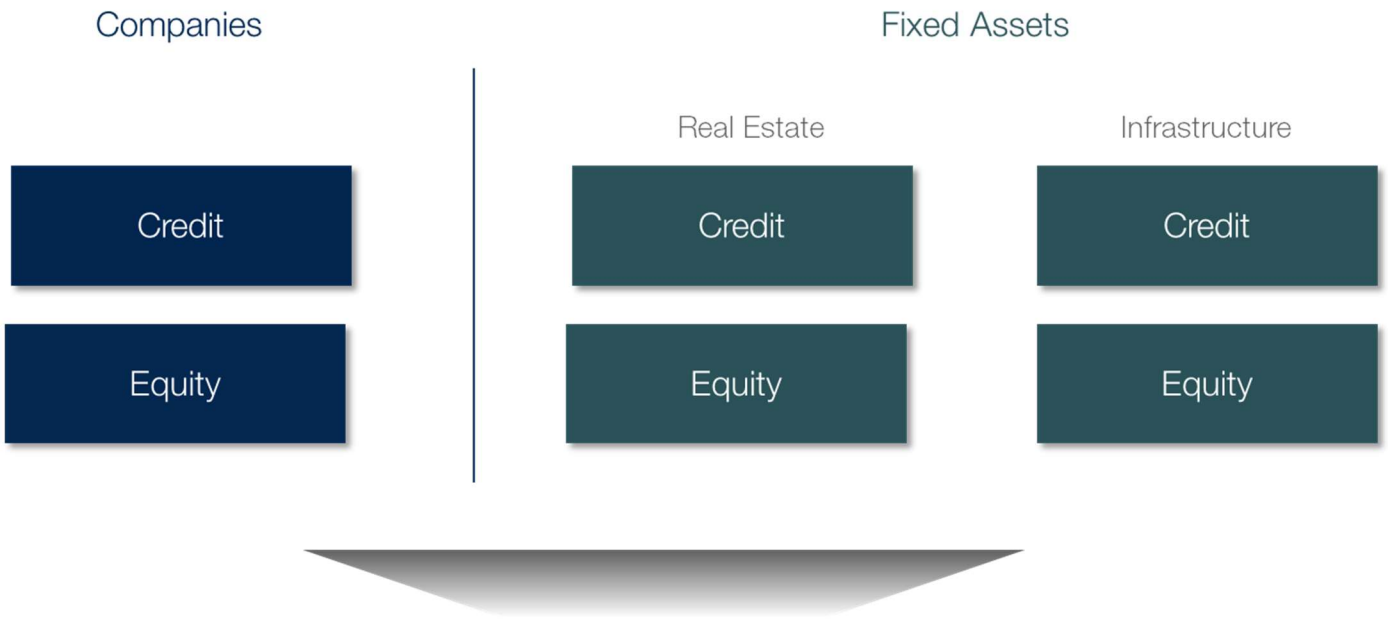
[64] As noted above, GARI notes that the presentation of the answers to the 2016 GARI Survey are not meant to suggest that they are necessarily representative of the broader private sector or investment industry. GARI recognizes that they capture the priorities and insights from a subset of organizations that have a stated interest in climate risk and resilience. GARI believes that these responses are relevant and provide context for discussion, but does not mean to suggest that necessarily they reflect the views of a more general investor or private sector population.

potential landscape of resilient investments and investments in resilience; (c) the potentially broad and evolving nature of investment in climate adaptation and resilience.

First, GARI participants discussed the potential distinction between resilient investments and investments in resilience (or similarly adapted investments vs. adaptation investments). Some participants explained that resilience could be considered to be an attribute of all investments, while an investment in resilience could be conceived of as one where the primary purpose of the investment was to create resilience. Others described this as the distinction between resilience as a feature and resilience as a product.



Although most GARI participants chose to discuss examples of investments in resilience or adaptation, some private investor participants noted the importance of the development of tools, technologies, products or services that disclose and address the resilience of all investment assets. In particular, some private institutional investor participants noted the need to incorporate climate adaptation/resilience risk analysis into ESG approaches and to financial risk approaches.



Second, GARI participants discussed the types of investments in adaptation and resilience. GARI participants noted the importance of identifying concrete examples of adaptation and resilience investments and describing and quantifying their risk and return for investors. GARI participants also discussed the landscape of available investments and identified investments in companies as one means of enabling a larger flow of public and private capital into the adaption space. Participants also identified other instruments for resilience investments such as company equities, fixed income and infrastructure.

(1) Resilient Investments

Resilient investments can be classified as projects that have a resilient feature attached to ensure that the project is protected from climate risks. Some examples of resilient investments are listed below.

- Smart grids that protect against extreme weather
- Green buildings that are resource-efficient
- Porous pavement parking lot expansion
- Resilient manufacturing company
- Road infrastructure projects that focus on increased protection from river erosion

(2) Investments in Resilience

Investments in resilience-focused products and services cover a more expansive universe ranging from company investments to infrastructures and fixed income products.

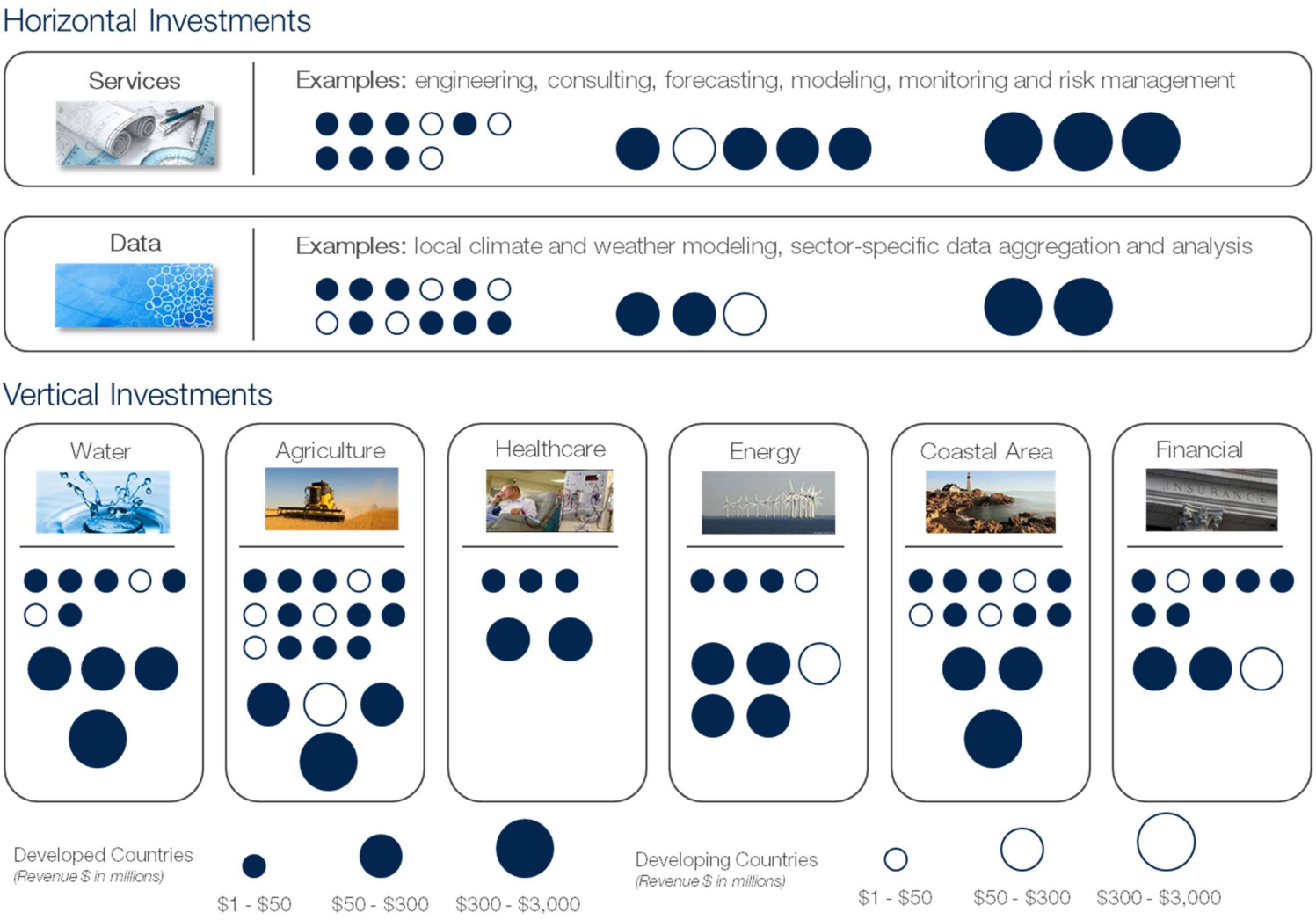
Company Investments

The range of investments in companies, in particular, was discussed as being grouped under two categories – horizontal investments and vertical investments.

- Horizontal investments include investments in companies who provide services (engineering, consulting, forecasting, modeling, monitoring and risk management), and data and technology development (climate and weather modeling, sector specific data aggregation and analysis). Horizontal investments in companies can result in creating services that "map" climate risk to -specific sectors and help address directly some of the the barriers / issues identified above (e.g., availability of screening tools for infrastructure investment).

- Vertical investments include investments in companies that provide products and solutions in sectors such as water, agriculture, healthcare, energy, coastal area and finance. Examples include:

    - Water: companies developing water efficiency software, meters; water infrastructure development; reuse and desalination technologies.
    - Food & Agriculture: companies developing drought resistant seeds, drip irrigation and precision agriculture.
    - Healthcare: companies in sub-segments such as vaccine and treatment pharmaceuticals and products addressing tropical disease vectors; extreme weather event-resilient facilities and management systems.
    - Energy: companies in sub-segments such as extreme weather-resilient generation and distributed energy.
    - Coastal Areas: companies in sub-segments such as early warning systems and climate resilient materials.
    - Financial Services: companies in sub-segments such as climate-related risk insurance, risk assessment and parametric insurance.



Examples of Investments

GARI participants then discussed a number of specific companies that were examples of the types identified above. Specifically, GARI participants discussed a mapping exercise completed by one participant that initially identified over 120 companies in the private sector – in both developed and developing countries – of various sizes that fit into the horizontal and vertical categories described. The GARI participant noted that this was an initial mapping exercise that suggested many more potential companies at different stages of growth and maturity. [See diagram above]. Other participants noted a range of investment examples.

<u>Horizontal (resilience services):</u>

- Catastrophe risk modeling software and consulting services company
- Climate resilience consulting company with economic modeling and climate science capabilities that help companies build awareness, mitigate risk and identify new opportunities

- Disaster warning systems and disaster recovery companies that prepare for climate-related perils and hazards
- Technology company that uses imagery and data to gain insights into global agriculture
- Advisory firm specializing in climate change risk management and adaptation
- Climate risk intelligence software startup that enables companies to prepare for extreme weather and climate change

Vertical (resilience products & solutions)

- Drought resistance seed company
- Weather analysis company that help assess and measure weather-driven impacts and manage the variability of climate
- Engineering consulting firm focused on built environment
- Engineering consulting firm focused in hydraulic and hydrological modeling software
- Design consulting firm focused on natural and built assets
- Wind and solar manufacturers
- Water metering and water efficiency companies
- Water treatment company
- Heat tolerant cattle company
- Autonomous tractor company
- Multi-level indoor agriculture
- Precision agriculture for orchards and vineyards
- Online marketplace for environmental technology and infrastructure solutions
- Teleworking company
- Consumer product company that develops cooling roofs and pavements

Infrastructure and Fixed Asset Investments

GARI participants also discussed examples of investments in infrastructure and fixed assets, particularly by development finance institutions, and approaches to determining the magnitude of current investment portfolios in adaptation and resilience. Resilient investments in developed countries are also a focus as infrastructure modernization is a priority. Participants highlighted the screening and identification of several billion dollars of investments in infrastructure by regional development finance institutions, for example.

- District heating and cooling projects

- Water framework and supply projects
- Water rehabilitation project
- Lake environment project
- Water systems such as rainfall storage, sustainable drainage and water treatment services
- Grain storage systems that manages fluctuations from harvest and variables in rainfall
- Forestry initiatives that change proportion of plant species in various locations to adapt for expected climate change
- Watershed projects that help preserve ecosystems and support natural cycles
- Coastal natural resource systems such as coral reefs and mangroves
- Natural Treatment and Habitat Wetland
- Algal Turf Scrubbing Technology
- GreenUp Green Roof Evaluations
- Algal Energy Production
- Flood protection structures such as dikes

Fixed Income and Financial Products Investments

In addition, participants outlined and described the current state of climate bonds and green bonds and their potential relationship to investments in adaptation and resilience, including screening existing green bond mitigation investments for resilience and opening the category of green bonds or climate bonds to investments designed to create adaptation and resilience.

- Climate bonds
- Catastrophe bonds
- Green bonds
- DC Water bonds
- Equity funds centered on climate resilience solutions
- Re-insurance products on coastal reefs
- Debt for adaptation swap
- Parametric insurance products

C. Comments and Suggestions

After characterizing and identifying different resilient investments and investments in resilience, GARI participants provided comments and suggestions.

(1) Comments

GARI participants then provided feedback and comments on the examples of investments that were identified. These comments can be organized into three broad categories:

Need for More Examples

More examples needed. GARI participants discussed the need for more concrete examples of types of transactions that were at the intersection of adaptation and resilience and investment. Other GARI participants indicated that the issue was a lack of investible products, projects and instruments. Some called for the development of new vehicles and instruments, while others suggested that existing projects and investments that support resilience even if they were not currently labeled that way could be identified, measured and relabeled to demonstrate the existing and potential scope of opportunities.

Investible products needed. GARI participants noted the importance of having investible products and potentially different vehicles such as funds or screening mechanisms for existing assets. Some participants noted that investors need adaptation and resilience investment to be structured similarly to existing financial instruments and vehicles such as investment funds, green bonds, screened asset pools or passive indices. GARI participants noted the released of reports from the investment advisory industry[65] as indicating growing awareness of considering adaptation and resilience as a risk to existing investments, but the limited awareness or understanding of how to affirmatively invest in climate adaptation and resilience and the need for vehicles or products to do so.

Screening for physical climate risk and making positive investments are both priorities and related opportunities. Some GARI participants noted a strong interest in both developing the capacity to screen and evaluate existing investments for climate risk and resilience as well as in making affirmative investment decisions that would benefit from or mitigate the effect of climate change impact. Other GARI participants noted the potential connection between affirmative investment in adaptation and resilience companies and the ability to screen existing assets and make new investment decisions.

Additional research and analysis on examples of investment is needed. GARI participants noted the early stage of analysis and research into examples of adaptation and resilience investment. Additional work was suggested by sector and with focus on performance, risk and return as well as across different asset classes, including insurance related assets, infrastructure, real estate, green bonds, private equity and venture capital. Other

[65] BlackRock Investment Institute, 2016. Mercer, 2015. Cambridge Associates, 2015.

GARI participants noted the importance of looking for examples more broadly geographically, particularly in emerging markets.

Definitions and Language/Labeling of Adaptation and Resilience Investments

Flexible, evolving definition of adaptation and resilience preferred. Some GARI participants noted the challenges of defining "adaptation investment" or "resilience investment" and referred to the current discussions in the development bank community regarding how to define and account financially for investment flow into adaptation projects or resilience. Participants also suggested engagement with the Green Bonds Principles Committee or other communities to begin to develop principles for adaptation or resilience investment.

Language/labeling differences exist between public and private sector. Other GARI participants noted that many private investors were less concerned with a narrow definition of adaptation and resilience for several reasons. First, they were simply not aware of "adaptation" as an investment area, but instead described aspects of adaptation as resilience, reliability, disaster recovery, business continuity, facilities and maintenance, or supply chain issues. Others commented that private sector investors were less concerned with definitions than the practical implications of an investment.

Risk and Return/ROI

Comparable risk and return required for investment. GARI participants emphasized the need for investment opportunities to meet comparable levels of risk and return. Acknowledging sources of mission-oriented, impact and concessional capital, some GARI participants stated that a key requirement for institutional investors is that investments in adaptation and resilience also meet commercial standards of risk and return. Other participants noted the potential for risk mitigation by concessional or blended finance providing first loss or junior equity to bring in commercial/institutional capital as has been done in the context of the early stages of mitigation investments such as renewable energy.

Measuring return on resilience or amount of adaptation challenging and important. In addition, some GARI participants noted the importance of measuring or quantifying the resilience impact of an investment in the investment decision process. For example, while many 2016 GARI survey respondents expressed interest in investing in resilience, many GARI participants commented that no one has a robust or agreed approach to measuring resilience. Others noted that there have been calls for a "climate adaptation unit" that would measure the impact of adaptation and resilience investments or activities against a baseline.[66]

[66] Koh, Jay. "The Case for a Climate Adaptation Unit." LinkedIn. November 30, 2015. <https://www.linkedin.com/pulse/case-climate-adaptation-unit-jay-koh> See also Swann, Stacy. "Building Climate Resilience into Investment Choices: Time for a 'Koh'?" <http://climatefinanceadvisors.com/2015/12/building-climate-resilience-into-investment-choices-time-for-a-koh>

ROI and business case for adaptation/resilience investments must be demonstrated. Relatedly, participants noted theoretical and practical questions about measuring the financial and non-financial case for investments in resilience, including raising the following questions:

- How do you measure ROI of resilience investment? Should it be monetized or in a different unit ("impact" investment)? What should this unit be?
- How do you make money off a sea wall or other investment that generates resilience?
- Is there a need for new financing mechanisms (or repurposing of existing ones in other industries) to attract capital where needed where the ROI for resilience can be quantified or the financial performance of the instrument can be linked to resilience?

Investor biases pose a barrier to potential adaptation and resilience investments. GARI participants noted that several biases were shaping investor behavior in approaching adaptation and resilience investment that needed to be addressed. Specifically:

- Confirmation Bias – With confirmation bias, investors have preconceived views (eg. belief or disbelief about climate change and the need for adaptation and resilience). This can lead to rash decisions not to make investments or rash decisions to make unnecessary or unprofitable investments. In a new field such as adaptation and resilience, it is critically important that investors are aware of this bias and overcome this bias with data and rigorous analysis.
- Loss Aversion – Investors are often preoccupied by loss aversion which favors inaction rather than proactive action and the status quo over other alternatives. Even when presented with facts and data, investors frequently make bold forecasts but few and timid choices that could result in a loss. Excessive loss aversion may prevent wise planning and adequate investment.
- Recent Experience Bias – Investors tend to extrapolate recent events more strongly onto the present and into the future. Adaptation and resilience investment is an area where investors need to separate themselves from recent experience bias (e.g., Hurricane Sandy as a distinct event) and understand climate change and other related trends from an unemotional and statistical perspective.

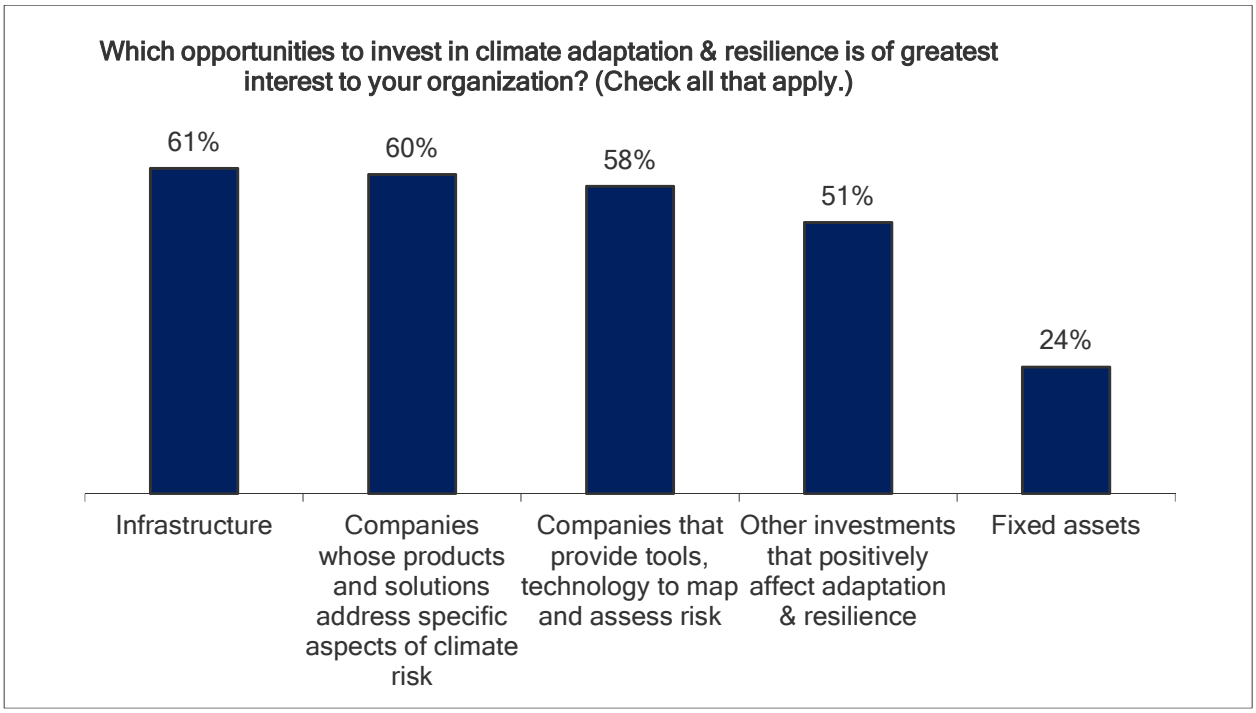
(2) Suggestions

GARI participants also discussed several suggestions about how to approach making decisions in investments as the investment landscape is being evaluated, including the following:

1. Recognize differences in language and definition in private sector investment in adaptation and resilience and that practical implications (risk, return) may be more important to private investors than strict or narrow definitions.
2. Both screening existing investments and making affirmative investment decisions in adaptation and resilience should be priorities for most institutional investors.
3. Be aware of the potential for indirect physical risks to disrupt business continuity and its implications for investments, considering both risk mitigation within portfolios as well as opportunities for collaborations, investing "outside the fenceline" to decrease risks to specific assets or activities.
4. Risk and return for adaptation and resilience investments need to be comparable to other investments. Consider blended finance to structure appropriate risk and return.

5. Support the integration of resilience consideration in existing products and standards to provide concrete comparable investible products
6. Additional research should be done to identify other examples of investments, by sector, by geography, by asset class, and on performance and risk/return.

In the follow-up 2016 GARI survey, respondents also indicated that the investment opportunities that were of greatest interest to their organizations were Infrastructure (61%), followed by Companies whose products and solutions address specific aspects of climate risk (60%).



D. Conclusion

As discussed above, discussions of the the GARI working group and responses to the GARI survey revealed several important observations about examples of investment in adaptation and resilience:

- Investments in adaptation and resilience are important today. 84% of 2016 GARI Survey respondents that have current investment portfolios indicated that their organizations were considering investments in adaptation and resilience now, with an additional 13% considering investment over the next 1-3 years.
- Opportunities can be divided into resilient investments vs. investments in resilience.
- Examples of investment in adaptation and resilience are diverse, including investments in companies, infrastructure and fixed assets, fixed income and financial products.
- GARI participants identified numerous types of existing investments, including providing a conceptual map of over 120 companies in data, analytics, technology and climate intelligence and in climate resilience products and solutions in specific sectors.
- Key feedback from private investors and stakeholders includes the need for more examples of investment, challenges of definition and language, and a focus on issues of risk and return.

- Infrastructure and companies whose products and services address the impact of climate change are of most interest to investors. GARI participants and 2016 GARI Survey respondents identified five types of investments in adaptation and resilience; of most interest are Infrastructure (61%) and Companies whose products and solutions address specific aspects of climate risk (60%). Others include: companies whose products assess risk, other investments, and fixed assets.

GARI participants and 2016 GARI Survey respondents also provided additional specific suggestions for a variety of actors and stakeholders which are discussed in Part IV below.

PART IV

Next Steps and Conclusions

PART IV: Recommendations & Next Steps

A. Recommendations

In the course of the five working group meetings, GARI participants identified and raised a number of suggestions for different stakeholder groups regarding approaches to measuring physical climate change risk, examples of investment in adaptation and resilience, and broader issues in the area of climate adaptation and resilience. In the final GARI working group meeting for 2016, participants called for the 2016 GARI Survey to include a series of identified recommendations and for respondents to provide stakeholders with specific weighted feedback and views from the working group participants and related stakeholders.

As noted in above, GARI does not mean to suggest that the answers to the 2016 GARI Survey are necessarily representative of the broader private sector or investment industry. GARI recognizes that they capture impressions from a subset of organizations with an explicit interest in climate risk and resilience. However, GARI believes that these responses provide different stakeholders with some feedback and context for on-going discussion.

(1) Government Stakeholders

During the GARI working group meetings, participants discussed suggestions for government stakeholders. GARI participants noted that it was very helpful to obtain views from different facets of the government. Some participants recommended specific helpful examples of government engagement:

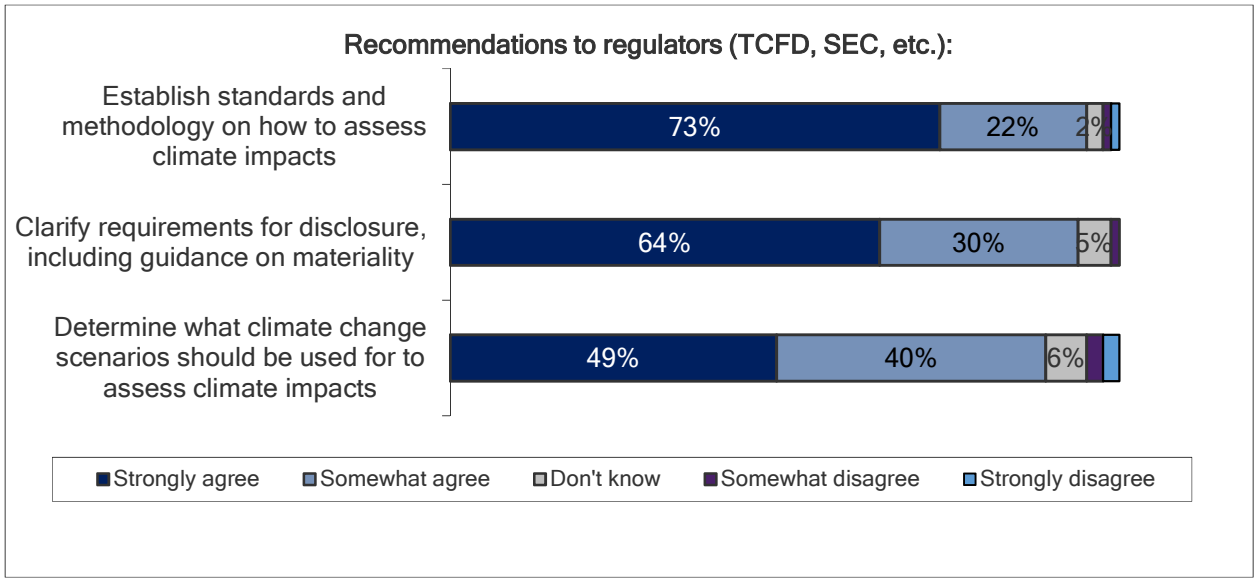
- Create enabling conditions to incentivize private sector and de-risk investments in adaptation and resilience and provide clear guidelines and data on climate scenarios and models
- Coordinate multiple stakeholder groups such as companies, governments and community to solve collective problems. (e.g., regionalized insurance pools, conditioning infrastructure spending)
- Bridge the timeline between private sector (short-term focused) and public sector (long-term focus) through various instruments (e.g., forward contracts)
- Roadmap creation for the next government and efforts from the private sector will be crucial; it can be galvanizing for the community to engage and participate in what the community can do to help the government
- There is significant value at the sector-specific agency level where meaningful partnerships can be established. The discussion will be timely, and the private sector can become possible advisors to the agencies.
- Identify adaptation projects "outside the fenceline" of corporate assets but with direct impacts, especially in the case of failure. (Transportation such as roads, ports, bridges and public transit; health assets such as hospitals or clinics; ICT such as telephone and internet lines; and energy infrastructure such as electricity and heat).

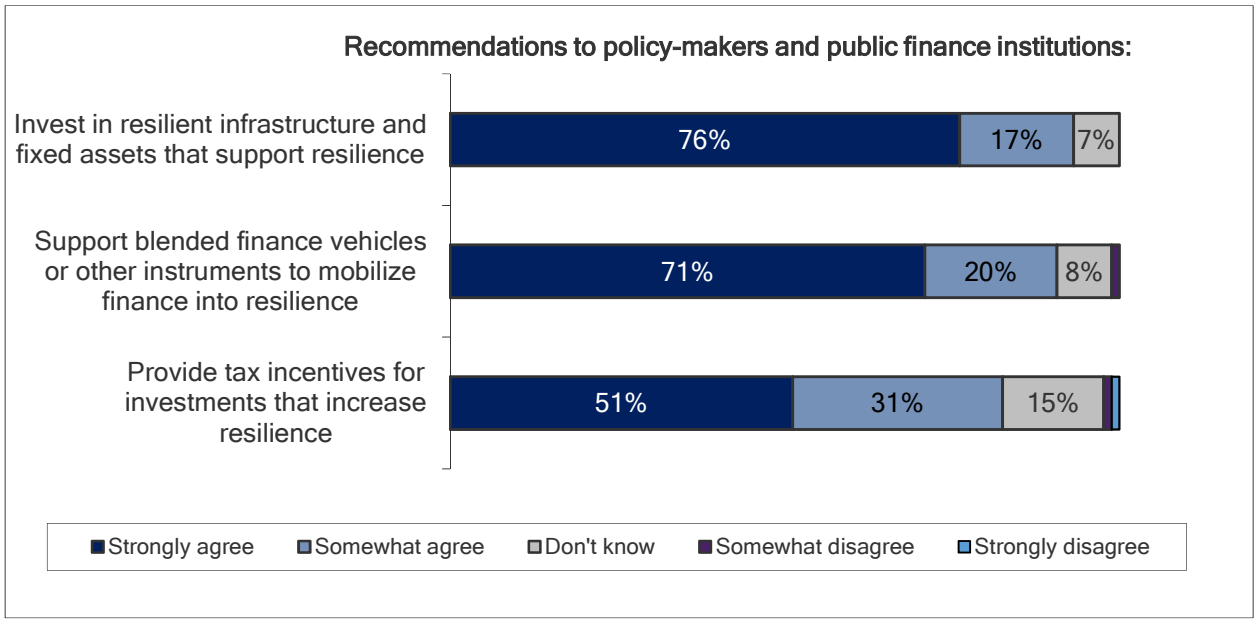
Respondents to the 2016 GARI Survey echoed some of these sentiments. They had specific feedback for Regulators as well as Policy-Makers and Public Finance Institutions. They included the following:

- Regulators: Establishing standards and methodology on how to assess climate impacts most important (73% strongly agree). Respondents also strongly agreed with recommending that

regulators clarify requirements for disclosure (64%). Guidance on climate change scenarios garnered fewer strong agreement responses (49%).

- Policy-Makers & Public Finance Institutions: Invest in infrastructure most important (77%), and support blended finance vehicle to mobilize finance (70%). Tax incentives were not rated as highly (50%).





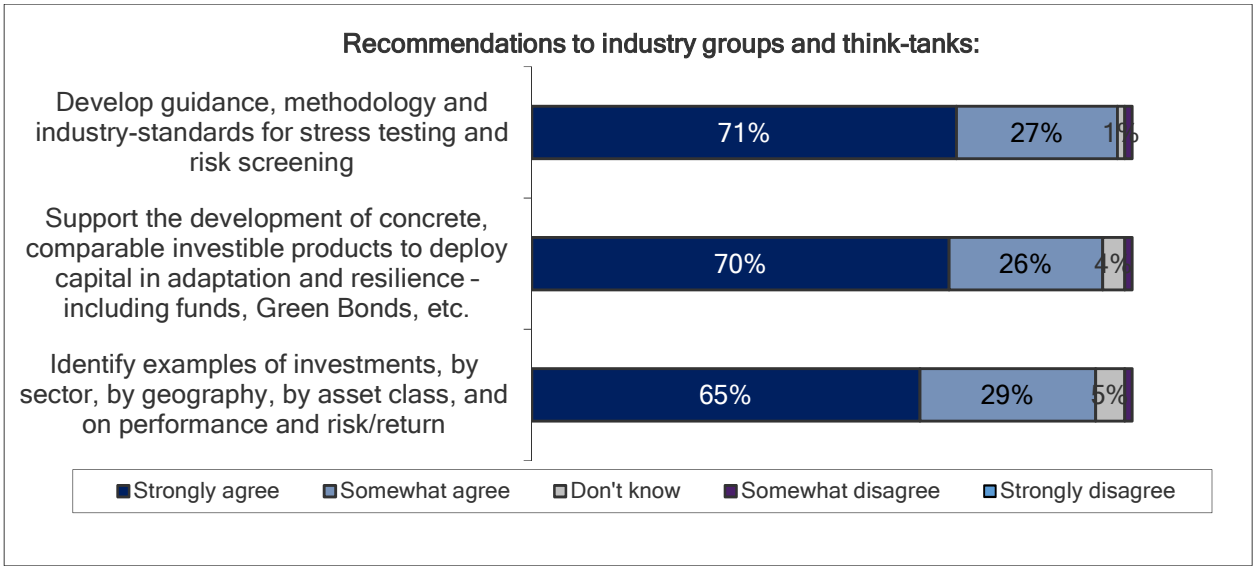
(2) Industry Groups & Think Tanks

During the GARI working group meetings, participants discussed suggestions for industry groups, think tanks and related stakeholders. GARI participants noted that the background materials generated by many of these institutions were very helpful in providing context and language for the GARI discussions. Some participants recommended specific helpful next steps for additional engagement with industry groups and think tanks:

- Identify additional examples of investments in adaptation and resilience and examples that may not be explicitly labeled as adaptation and resilience, recognizing the language differences between public and private sector entities.
- Focus on developing more consistent measurement approaches, metrics and data so that the private sector investor and related stakeholder community can have a richer, more consistent basis for investment decisions.
- Consider development of new investment instruments, particularly looking to prior structures, securities, vehicles to provide policy-makers, governments, and private investors with mechanisms for investing in adaptation and resilience.
- Continue to be flexible in the definition of adaptation and resilience and investment at the early stage of the development of this market.
- Support efforts like GARI that bring together multiple communities of interest rather than research and discussions in separate silos of academia, industry, government, and private investor communities.

Respondents to the 2016 GARI Survey provided additional feedback on some of these suggestions, specifically recommending the following for Industry Groups and Think Tanks:

- The highest percentage of respondents strongly agreed with recommending the development of guidance, methodology and industry standards for stress testing and risk screening (71%).
- Supporting development of investible products, including funds, Green Bonds, etc. was a close second with 70% of respondents strongly agreeing.



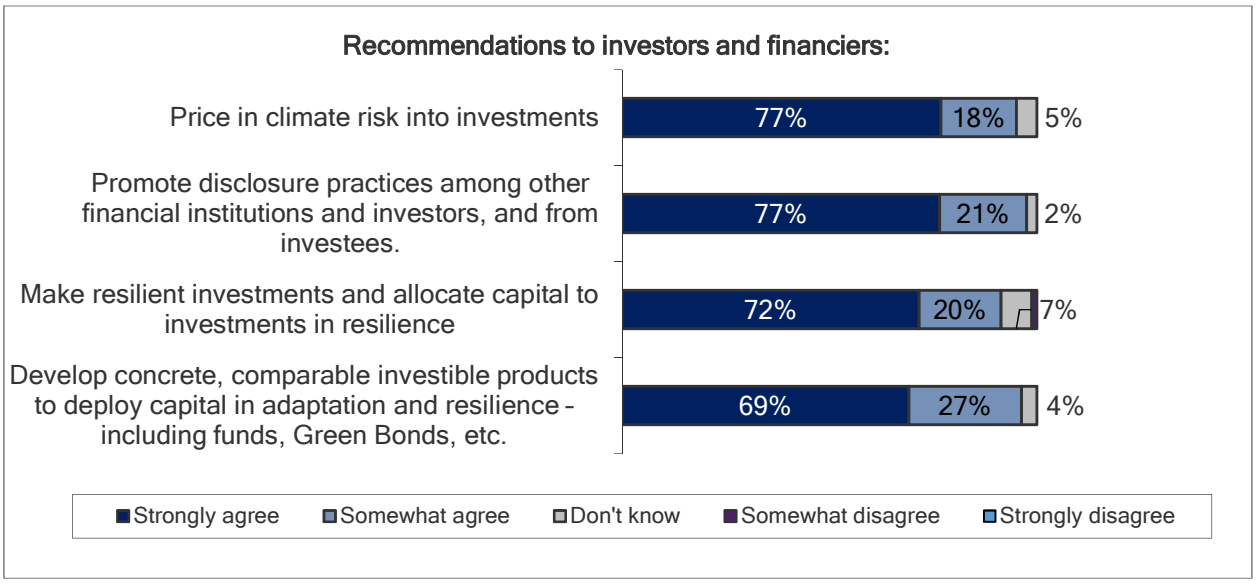
(3) Investors and Financiers

Finally, GARI participants also discussed suggestions for investors and financiers. As discussed above, many suggestions included prioritizing measuring physical climate risk to existing investments before focusing on positive investments in adaptation and resilience. However, both areas were considered of substantial importance and immediacy and their linkages were recognized. GARI participant recommendations for investors and financiers included the following:

- Move to identify and assess physical climate change risk in existing investments beyond looking at transition risk or liability risk.
- Consider both the resilient investments and investments in resilience and adaptation.
- Focus on identifying returns on investment, recognizing differences in duration and the complexity of risk.
- Recognize challenges of labeling and language in understanding the implications and opportunities for investment in adaptation and resilience – this may be labeled disaster recovery, business continuity, aspects of sustainability, reliability or diversification.
- Recognize the interrelation between company and financial investments and government and community resilience.

Respondents to the 2016 GARI Survey provided additional feedback on some of these suggestions, specifically recommending the following for Investors and Financiers:

- Most important were pricing climate risk into investments and promoting disclosure practices (77% strongly agree).
- Making resilient investments and allocating capital to resilience also received very strong support (72% of respondents strongly agreed) as did developing concrete investible products (69%).



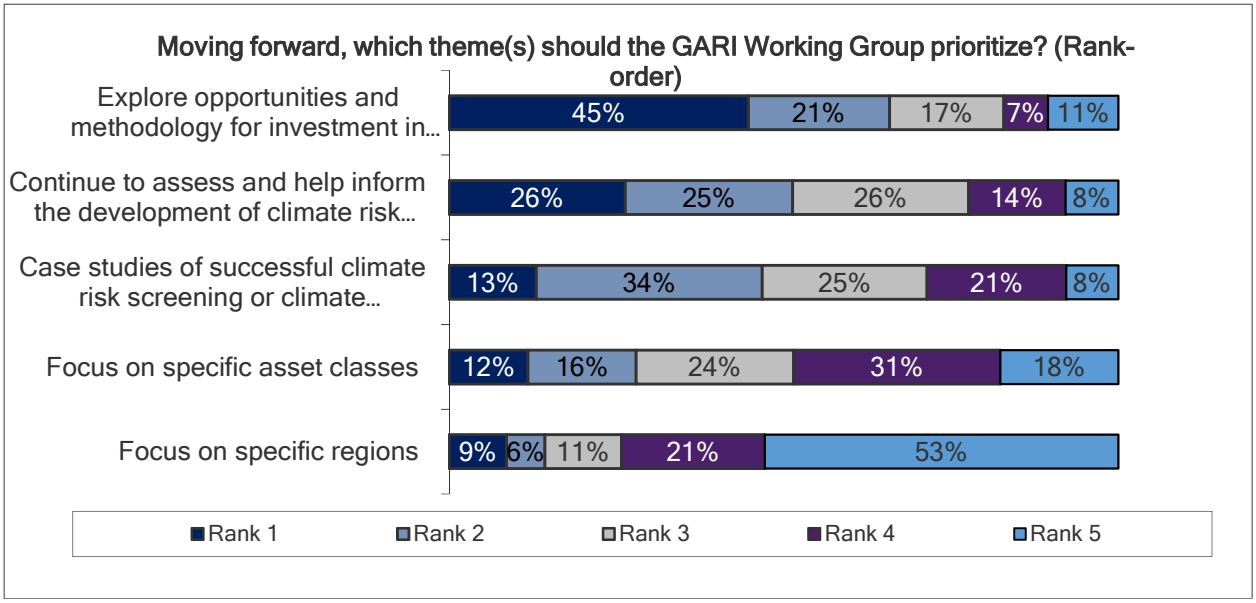
Overall, GARI participants and 2016 GARI Survey respondents strongly recommended support for measurement standards and disclosure across the different stakeholder groups as well as additional strong support for development and investment in adaptation and resilience instruments and products.

B. Next Steps

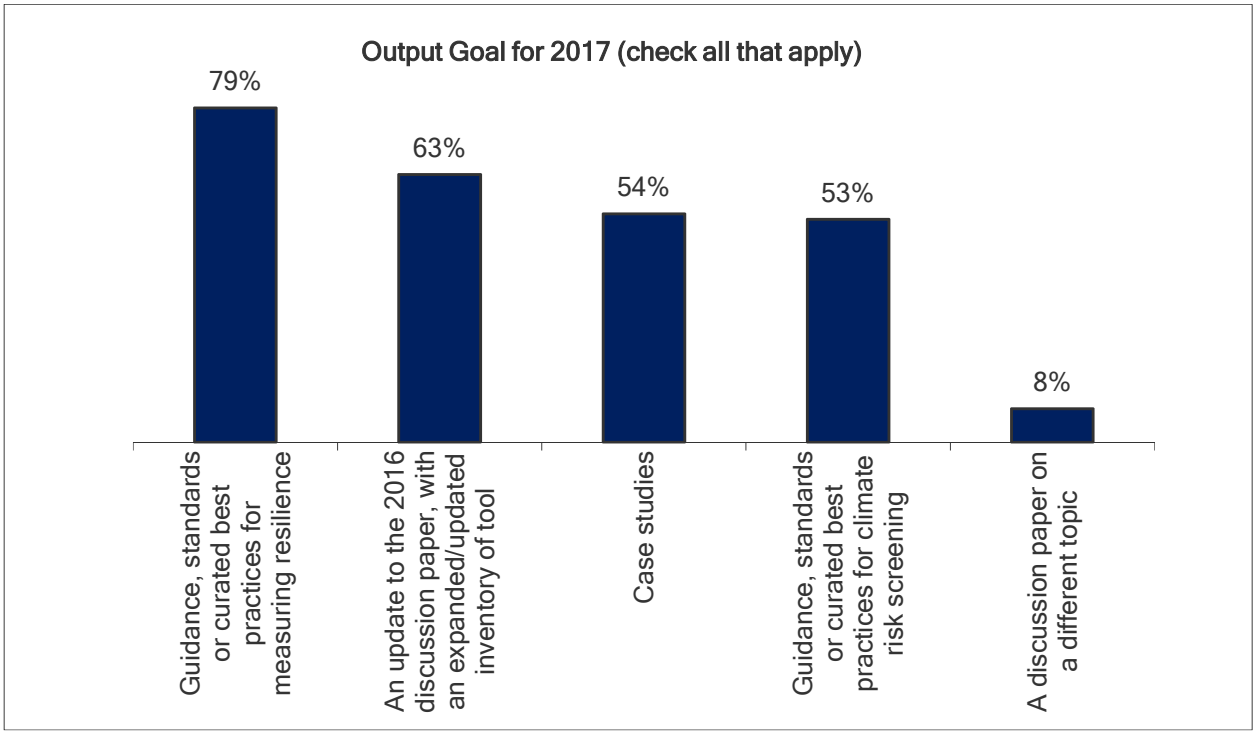
GARI participants and 2016 GARI Survey respondents also provided feedback regarding the operations of GARI and plans for 2017 and beyond. GARI participants agreed that the working group should take the following set of next steps in further developing the areas of measurement and investment in climate adaptation and resilience.

1. Release the discussion paper on activities of the working group to the public.
2. Consider the institutionalization of GARI moving forward.
3. Evaluate further potential areas of discussion in 2017 including a focus on a) regional or b) sectoral investments in adaptation and resilience while continuing to track c) approaches to measurement and metrics and d) examples of investments in adaptation and resilience.
4. Extend invitation to participate in the GARI working group to additional stakeholders and thought leaders in the adaptation and resilience space.
5. Encourage investors and stakeholders to invest in concrete examples in adaptation and resilience and lay the groundwork for developing investible opportunities for practical deployment of capital.
6. Encourage the development of instruments and vehicles for adaptation and resilience investment
7. Create a pool of online resources and documents for GARI members and the public.

Presented with a force-ranking of priorities for GARI, the largest percentage of 2016 GARI Survey respondents indicated that the #1 priority should be exploring opportunities for investment in resilience (45%), followed by continuing to develop a climate risk screening methodology (26%). Many GARI participants also strongly prioritized a focus on case studies, at 13% of #1 priority rankings.



In terms of preferred output for GARI for 2017, guidance, standards and practices for measuring resilience received the most votes at 79% of respondents, with an update to this discussion paper receiving 63%. Case studies and best practices for screening also received over 50%.



C. Conclusion

Climate adaptation and resilience are critical challenges facing the world today. Although there is substantial and growing interest in both screening existing investments for physical climate change risk and for making resilient investments and investments in adaptation and resilience, substantial barriers remain. Two major challenges are uncertainty and a perceived lack of investible opportunity.

The Global Adaptation & Resilience Investment Working Group (GARI) was launched to help address these challenges by bringing together private investors and other stakeholders to focus on the intersection of investment and climate adaptation and resilience. Launched at Paris COP21 in conjunction with the UN Secretary General's A2R Climate Resilience Initiative, GARI has brought together over 150 participants who dedicated time and energy to focus on approaches to measuring physical climate change risk and identifying examples of investment in adaptation and resilience. GARI also received feedback from 101 working group participants and other stakeholders through the 2016 GARI Survey that supplement these discussions.

This discussion paper represents the thoughts and ideas reflected in the meetings of the working group and the feedback of survey respondents. It is not designed to be a definitive and exhaustive list of examples and methodologies or a representation of a broad population, but rather as a starting point of approach.

However, the GARI discussions and the 2016 GARI Survey demonstrate that although measuring physical climate risk and identifying examples of investment in adaptation and resilience are challenging, there are many practical existing starting points to address these challenges. Private investors and other stakeholders are beginning to evaluate physical climate risk and consider investments in resilience now. Data and examples exist. And private investors and other stakeholders are beginning to understand the complexity and have specific, practical suggestions for a range of stakeholders on how to address the challenge.

The private sector has a substantial role to play in climate adaptation and resilience. GARI hopes that the working group meetings, the survey and this discussion paper demonstrate the willingness of private investors and other stakeholders to start.

Comments can be sent to: chair@garigroup.com

APPENDIX

Appendix

Current Approach Overview:

Affiliation / Approach	Overview	Duration, Geographic Scope and Investment Implication
European Bank for Reconstruction & Development (EBRD)	**Description:** Since 2011, EBRD has systematically screened investments at the concept stage for sensitivity to climate change impacts. **Application:** EBRD screens all concept-stage projects to identify those that are sensitive to climate change impacts. This means that screening is just the first step. The aforementioned methodology is then applied at appropriate stages in the project cycle, e.g. feasibility study, climate audit, environmental and social assessment etc. However the guiding principle is that climate change assessment and the introduction of adaptation measures into project design should be done as early as possible in the project cycle in order to avoid 'end-of-pipe' or bolted-on approaches. **Source of Data:** This will depend upon the project in question, but will typically entail the use of authoritative and preferably peer-reviewed analyses or reports such as the IPCC AR5, National Adaptation Strategies and/or Action Plans (NAS/NAPs), National Adaptation Programmes of Action (NAPAs), Nationally Determined Contributions (NDCs), Strategic Programmes for Climate Resilience (SPCRs), and other relevant adaptation strategies and Robust and authoritative climate change information sources should always be used.	An appropriate timescale over which climate change impacts are assessed should be established. This should match the intended lifespan of the assets, systems or institutions being financed under the project. Project design is adjusted where possible and as appropriate to include appropriate climate resilience measures that address the project-specific climate vulnerability context as identified. The results of the climate risk assessment may be used to inform project planning and design, in order to identify and appraise a range of adaptation options for tangible improvements in the climate resilience of the systems, assets and infrastructure being financed under the project with different values in terms of cost, risk or impact. This requires the use of robust climate change information to inform better decisions in the design and appraisal of such investments, for example through technology selection (e.g. wet process vs. dry process; water cooling vs. air cooling), or modifications to infrastructure design specifications (e.g. altered spillway capacity or quayside height), or by implementing a flexible design that can be adapted at a low or moderate cost.
Global Adaptation Country Index at	**Description:** A country's index score is composed of a vulnerability score and a readiness score. Vulnerability and readiness are based on	The index covers time spans up to the mid-to-end of the 21st century.

Notre Dame Global Adaptation Initiative (ND-GAIN)	compiled indicators. 36 indicators contribute to the measure of vulnerability. 9 indicators contribute to the measure of readiness. Each indicator comes from a public data source. **Application:** The index is currently applied to gauge investment potential for climate adaptation projects, at country-level **Source of Data:** To measure the biophysical impacts of climate change: using data from peer-reviewed sectoral climate impact models (e.g. crop production model, hydrology models, infectious disease model, marine and terrestrial biodiversity models, etc.) To measure social vulnerability and readiness: using data from public, authoritative data sources with open access (e.g. The UN databases at FAO, ITU; The World Bank database including the World Development Indicators, Doing Business index; and other databases that are freely accessible to the public)	It is a global index covering 180 UN countries. The index has been used by a number of global stakeholders to prioritize adaptation actions and be used as a climate risk-screening tool. The users include Climate Investment Funds, Green Climate Fund, Standard & Poor's, etc.
AIR Worldwide Corporation The format of the catastrophe model output offers users the ability to measure catastrophe risk in a number of ways. The most commonly used measurement approach is the **modeled loss exceedance probability distribution and average annual modeled loss.**	**Description:** Modeled loss exceedance probability (EP) distributions quantify the risk profile for whole portfolios or individual risks and can be used to inform a variety of risk management decisions. A stochastic catalog for a given peril, developed by AIR scientists, uses information on historical events from a comprehensive range of sources. To generate the modeled loss exceedance probability distributions, first an AIR catalog is run against the risk or portfolio of risks. Next, the loss for each event in each simulation of a calendar year of potential events is calculated. Then modeled years are ranked from highest loss to lowest loss. Finally, exceedance probabilities corresponding to each single year simulation are calculated by dividing the rank of the simulation by the number of simulations in the catalog. Average annual losses (AALs) can be calculated by averaging all event losses across all simulations.	The model outputs 10,000 to 500,000 simulations, depending upon model, of what loss potential could be experienced **next year** for a given risk or portfolio of risks. Thus, the time frame for AIR methodology is a **one year** view. It is commonly extrapolated out to analyze 1 – 5 year (re)insurance policies/contracts. The model does not explicitly project or forecast in its current form. AIR's model output can help assess the loss potential of a particular investment due to a wide array of natural, and man-made, catastrophes. This view of loss potential is commonplace in the broader (re)insurance industry.

	Application: Insurance, reinsurance, regulatory bodies, capital markets (via catastrophe bond risk analysis), government entities, and corporate risk managers. **Source of Data:** Utilizes hundreds to thousands of data sources. Examples include historical event databases, peril-specific scientific research and measurement data sets, engineering assessments of building and infrastructure vulnerability, building codes, historical loss data for validation, census data, land use/land cover data, etc. This does not constitute the full array of data sets used for the development, validation, or usage of AIR models.	
AECOM& IBM collaborated to produce the "**Disaster Resilience Scorecard"(2014)**	**Description:** The "Scorecard" is based upon the UN's Ten Essentials for Disaster Risk Reduction. Each Essential has Key Performance Indicators, scored on a basis of "0" (low) to 5 (high). There are a total of 94 KPI's. The Ten Essentials are: 1. Organize for resilience| 2. Identify/Understand risk scenarios | 3. Strengthen financial capacity for resilience | 4. Pursue resilient urban development & design |5. Safeguard natural buffers to enhance protective functions offered by ecosystems| 6. Strengthen institutional capacity for resilience |7. Understand Strengthen societal capacity for resilience | 8. Increase Infrastructure resilience | 9. Ensure effective disaster response | 10. Expedite recovery & build back better **Application:** The Disaster Resilience Scorecard has been applied to Cities as an initial activity to define gaps to be addressed, to then use this information to produce a "Resilience Plan" to address the gaps, to mitigate the risks and reduce the consequences from an acute shock (natural disaster. The Resilience Plan is typically a Five year plan of capital improvements, process changes and procedure improvements. This includes updating building codes and better enforcement of those codes. From the original Scorecard, a Survey Tool for Small Business was developed and applied to 208 businesses in New Orleans ten years after Katrina. **Source of Data:** Data is used from a variety of sources to define the acute shocks for which resilience is considered. City policy, plans and capital expenditures as well as procedures in place are assembled, reviewed and evaluated in terms of evaluating preparedness to plan for, respond to, recover from acute shocks	The Scorecard is a tool to conduct the gap analysis & develop a Community Resilience Plan. An aspect of the Scorecard is to define the disaster scenarios which are regarded as most probable – most severe. The implementation of the plan is defined in annual periods with some resilience plans taking five to ten years to fully implement. The Scorecard was placed in the Public Domain by AECOM & IBM via a UN Press Release in March, 2014, hence it is difficult to know of all the cities and countries that have applied the Scorecard. AECOM & IBM have used the Scorecard in 17 countries with numerous cities in North America, South America, Nordic, Africa, Europe, India, Asia, New Zealand, Australia The methodology drives investment decisions to highest risk elements to use the leverage of reducing risk and exposure per dollar spent. The output from the Scorecard are the essential factors for developing the Resilience Plan which drives investment.

	from natural disasters. Preparedness to address chronic stresses may also be considered (IE drought, etc.	
Geosyntec-CAT/ Decoupled Net Present Value (DNPV) Method: The Separation of Risk and Time Value of Money	**Description:** Using DNPV, risk (technical, financial, legal, etc.) is viewed as a self-insurance cost designed to protect cash flows from a shortfall below expected values. These costs are subtracted from the expected cash flows. The resulting cash flows are thus considered risk free and can be discounted using the risk-free rate. **Application:** DNPV is a method that applies to any project sector, including energy (renewables, fossil, nuclear), transportation (e.g., toll roads), solid waste, wastewater treatment, oil & gas, mining, agriculture, etc. It allows users to allocate risk to the rightful owners and structure contracts in a consistent and transparent manner. **Source of Data:** All of the above. Once specific project risks are identified, available data (e.g., market data for commodities, weather data/models for climate risk, seismic hazard maps for earthquake risks, temporary and permanent shutdown risks, etc.) are used to price self-insurance.	DNPV works for all time frames (short-, mid- long-, very long-term, perpetuity); however, its unique strength is in quantifying risk over very long term frame frames. For example, DNPV can be applied to evaluate climate change resilience features of infrastructure projects in emerging economies, where long-term risks are more uncertain. The use of discounted cash flow (DCF) models has for many years resulted in severe economic distortions, particularly with regard to valuing liabilities, as the value of the present is overemphasized and the value of the future is downplayed. This leads to a widespread bias favoring short term investment decisions, a phenomenon known as the Tragedy of the Horizon.
Four Twenty Seven, Inc.	**Description:** Evaluates economic impacts of climate change on asset, corporate value chains, and industry sectors. **Application:** Four Twenty Seven's corporate climate risk methodology has been used for CDP climate risk disclosure, supply chain and market risk assessments, and threshold modeling for individual assets **Source of Data:** The methodology utilizes IPCC models, both global and downscaled; local observational datasets; socioeconomic and socioecological datasets; land use; natural resource consumption, and self-reported company data.	The methodology examines seasonal and decadal shifts at various intervals out to mid-century. The methodology has been applied to assets and value chains in the US and globally. The methodology identifies climate risk hotspots and quantifies monetary costs from these impacts, to help risk management, long-range business planning and financial disclosures.
Risky Business/America's Climate Prospectus	**Description:** Econometric/probabilistic approach to sector specific economic costs of climate change	20-80 years; North America

	Application: National-level economic assessments (US first, others countries and a global assessment in progress) **Source of Data:** IPCC models, sector- and region-specific economic analyses to generate impact functions	
New York City Panel on climate change	**Description:** Climate model assessment and storm surge modeling to calculate changes in physical climate changes **Application:** New York City climate assessments, FEMA maps and evaluation of floodplains **Source of Data:** IPCC models, storm surge/hydrodynamic models, scientific literature	20-80 years; New York City; Indirect; stakeholders in the community (utilities/etc) will use for planning purposes
Structures of Coastal Resilience	**Description:** Sea level and storm surge flood return period calculation **Application:** Informed urban design and planning **Source of Data:** IPCC models, storm surge/hydrodynamic models, scientific literature	2050; US East Coast; Future risk considerations
AER/AIR study "An Estimate of Increases in Storm Surge Risk to Property from Sea Level Rise in the First Half of the Twenty-First Century" AER study "Joint projections of US East Coast sea level and storm surge"	**Description:** Sea level and storm surge flood return period and loss calculation **Application:** National economic assessments **Source of Data:** Historical sea level observations, IPCC models, statistical tropical storm and storm surge models	2030-2100; US East and Gulf Coasts; Future risk considerations

Climate Risk Layers for Maplecroft Mapping Utility and Country Risk Analysis	**Description:** Climate model daily mean temperature outputs downscaled to a common grid and converted to degree days. Two time periods examine across fourteen climate models and 25-year climatologies developed for each time period (1981-2005 and 2036-2060). The future time period is subtracted from the historic base period for the individual models and the resulting deltas added to the reanalysis base to get a future state. **Application:** Provide a synthetic future climatology of degree days in raster format maps **Source of Data:** IPCC Model and NCEP Climate Forecast System Reanalysis (CFSR) data	1981-present and 2036-2060; Global coverage; Understand future energy use and heat stress
Climate Risk Layers for Maplecroft Mapping Utility and Country Risk Analysis	**Description:** Produce sea level rise projections **Application:** Provide raster maps of expected sea level rise **Source of Data:** IPCC models, storm surge/hydrodynamic models, scientific literature	2036-2060; Global coverage; Understand future sea level rise risk

AIR Worldwide

Overview: AIR develops catastrophe models to help companies and public entities anticipate the likelihood and severity of potential future catastrophes before occurrence to adequately prepare for the financial impacts.

Description: Catastrophe models can be used to address a number of questions, including the location, size, and frequency of potential future catastrophic events. By combining mathematical representations of the natural occurrence patterns and characteristics of hurricanes, tornadoes, earthquakes, severe winter storms and other catastrophes, with information on asset values, construction characteristics, and occupancy classes, these simulation models provide information concerning the potential for large losses.

Capital, Science & Policy Practice, Willis Towers Watson

Overview: The 1-in-100 Initiative seeks to build resilience and encode natural disaster risk into the financial system through risk disclosure using standardized methodologies that the re/insurance industry has developed over the last 25 years.

Description: Every year, millions of people are impacted by earthquakes, droughts, floods, storms and other natural catastrophes. Moreover, a growing share of the world's population live in regions considered highly exposed to extreme weather and natural disasters.

While natural disasters have taken their toll on lives throughout history, the economic cost of natural catastrophes affecting livelihoods has increased markedly. In the 1980s, the inflation-adjusted cost of natural catastrophes averaged about USD 30 billion per year. In the 1990s this increased to USD 104 billion per year. Over the last decade, economic damage grew to an annual inflation-adjusted average of USD 182 billion, and as a percentage of GDP economic losses from natural catastrophes have actually increased.

Willis Towers Watson, along with other private and public sector partners, developed the 1-in-100 Initiative to encourage improved understanding and management of disaster risk through a requirement to disclose risk exposure on their balance sheets.

The Initiative, based upon the methodologies that the re/insurance industry has developed over the last 25 years, uses data and analytics to understand risk exposure and employs standardized metrics such as 1-in-100 or 1-in-200 year return periods to evaluate and report exposure. It demonstrates that the tools used by the re/insurance industry have global applicability to encode natural disaster risk and resilience into the global financial system.

The aim of the 1-in-100 Initiative is to encourage the application of the methodologies used by the re/insurance industry to the wider community, to better educate the wider world about risk and to empower companies to make commercial decisions on how to manage and address risk exposure.

Encoding risk into accounting and regulatory norms will discount the value of assets and resilience will be rewarded; helping organizations to truly understand and manage their risks. This will make physical and financial resilience, (including insurance), a true business asset.

Resources:
The 1-in-100 Initiative Action Statement (Link)
Willis Towers Watson's Blog on the 1-in-100 Initiative (Link)

Carbon Disclosure Project - Water

Overview: CDP's water program is designed to guide companies though the challenges posed by worsening water security. It also helps investors and multinational organizations with large supply chains

better understand how their portfolio companies and suppliers are addressing water impacts and associated risks and opportunities.

Description: The water disclosure's main focus is to allow investors to answer the question of "is certain company being a good steward of its water assets and water resources". CDP currently has about 1,500 companies disclosing on water use, water stewardship on their operations. Water disclosure is integrated into the supply chain program and the current focus is to build a more investor-friendly view of the information.

The platform contains five years' worth of CDP water data and will be available through Bloomberg. At the moment, the data is absolute numbers for each company. The approach is migrating towards more sector-specific orientation to enable comparability.

CDP's guidance document provides an overview of question pathways, as well as details as to what information to provide, the format required and where to find tools or further information to construct the answer.

Resource: 2016 CDP Water Guidance Document (Link)

Carbon Disclosure Project - Cities

Overview: CDP offers a voluntary climate change reporting platform for city governments. The program provides the world's first global platform for municipal governments to disclose greenhouse gas emissions, climate change risks, and mitigation and adaptation strategies.

Description: CDP collects and delivers materially relevant data for cities, the private sector, and other stakeholders. CDP has developed the cities program to extend to cities some of the same benefits that companies have experienced over the last ten years of participating in CDP. This year, CDP has collected data from more than 500 cities around the world, with much of the data relating to climate risk and opportunities.

Currently, there is a particular focus on having cities to provide opportunities for investment. CDP has developed a program that help sustainability professionals within a city to bridge their finance teams to communicate and match-make with investors globally.

Resource: 2016 CDP Cities Guidance Document (Link)

European Bank for Reconstruction and Development

Overview: Since 2011, EBRD has systematically screened investments at the concept stage for sensitivity to climate change impacts.

Description: Climate-sensitive projects are analyzed to identify specific climate vulnerabilities, leading to the integration of climate resilience measures (both structural and non-structural, as appropriate) into investment design and delivery. In many cases, this is supported by dedicated technical advice and policy dialogue (e.g., building the technical capacities of the clients to assess and manage climate risks to their operations). There is a development and continuous improvement of a range of sector-specific tools for integrating climate resilience measures into investments.

Adaptation finance is tracked using the joint MDB climate change adaptation finance tracking methodology, and EBRD is now exploring the development of adaptation impact metrics that can be used towards the climate resilience impact of each investment. To date, EBRD has signed 100 adaptation investments with a total business volume of EUR 2.5 billion, which includes dedicated adaptation finance (MDB methodology) of EUR 694 million. These investments have been made in a wide range of climate-sensitive sectors such as water infrastructure, power & energy, transport, urban infrastructure, property & tourism, agribusiness, manufacturing, natural resources and financial services. There is an importance of robust systems for recording and tracking adaptation activities and financing amounts

The time frame for assessing the climate sensitivity of the investment is the overall asset life, not just the narrower time horizon of the investment and loan repayment horizon. EBRD made this decision as it is an intergovernmental entity and wants to ensure best practices and highest standard are spread to its investments.

Credit analysis is also affected but only pertaining to certain sectors such as hydropower where there is a direct link between climatic variability, revenue flow and credit risk. Run-of-river hydropower, for example, has a direct correlation between weather conditions, amount of runoff, amount of water going through turbines, amount of electricity generated and amount of resulting revenue.

Resource:
EBRD's Approach to Climate Change Adaptation (Link)
Integrating Climate Change Adaptation into Project Development: Emerging Experience (Link)
Climate Resilience and Hydropower in Tajikistan (Link)

International Finance Corporation

Overview: The IFC is developing tools that analyzes, at the sectoral level, relevant climate risks, how they may impact investment projects' financial, environmental and social performance, and how these risks can be managed.

Resource:
IFC's Approach to Climate Change Adaptation (Link)
Joint Report on Multilateral Development Banks' Climate Finance (Link)
Climate Risk and Financial Institutions (Link)
Climate Risk and Business (Link)

Parsons Brinckerhoff Engineering Services

Overview: WSP | Parsons Brinckerhoff conducts analyses for its clients on the effects of climate change and extreme weather on their infrastructure. Its clients (typically owners of infrastructure assets) are often required as part of federal or state funding to consider resilience as part of the planning and design process.

Description: WSP | Parsons Brinckerhoff performs resilience, vulnerability, and adaptation studies for specific pieces of infrastructure (such as a bridge, highway, power plant, storm water system, office development) or for a range of facilities, often related to an asset management study for all the properties within the client's jurisdiction. The company uses a range of climate and other data to assess resiliency against events such as flooding, extreme weather, drought, earthquakes, tsunami, hurricanes, fires, storm surge, sea level rise, heat waves and other temperature change, and other future conditions.

As part of the work for the Federal Highway Administration (FHWA), WSP | Parsons Brinckerhoff has developed and applied a method to incorporate the changing probability of weather events with climate change into Monte Carlo analyses. These analyses allow them to determine the key decision metrics (normally net present value (NPV) and benefit cost-ratio (BCR)) of various adaptive design options under different climate scenarios.

Typically, three scenarios are chosen for analysis: high, medium, and low GHG emissions. Economic analyses of climate hazards require engineering knowledge on how and when certain asset components will fail when subjected to different levels of a climate stressor. WSP | Parsons Brinckerhoff also has an

Adaptation Decision-making Assessment Process (ADAP) which covers the steps required to guide and design infrastructure in the context of climate change.

WSP | Parsons Brinckerhoff also performs Climate Preparedness work for clients in the commercial space and typically combine a top-down quantitative tool for establishing hot spots, with bottoms-up qualitative analysis of those hot spots.

The source of data generally begin at the highest level (IPCC scenarios) and downscaled to the local level to be site-specific. FEMA flood data are used to observe individual sites, in addition to public data on infrastructures. The time scales for most quantitative tools, however, are usually too long (2050 or 2100) to be actionable for commercial entities.

Resource:
WSP | Parsons Brinckerhoff's Journals on Resilience (Link)
A Systems Approach to Climate Change Adaptation (Link)
FHWA Bulletin on Building Climate Resilient Transportation (Link)