American Society of Adaptation Professionals (ASAP)

POLICY BRIEF

Policy Perspectives on Financing Infrastructure for Climate Adaptation and Resilience

Summarizing the 2018 research and dialogue of
the ASAP Policy Committee's
Adaptation Finance Task Group

ASAP Policy Committee

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About the ASAP Policy Committee:

The American Society of Adaptation Professionals (ASAP) Policy Committee meets monthly and is open to all ASAP members. It informs and influences policy through member-driven topic-specific time-limited Task Groups that produce policy products and resources. It hosts forums and discussions on important policy issues and innovations, builds recognition of ASAP as a source of expertise on adaptation-related policy issues, connects with domestic and international organizations whose work intersects with Committee interests, an engages with subject matter experts invited to regular monthly Full Committee and Task Group meetings.

Introduction

The Adaptation Finance Task Group was established by the Policy Committee of the American Society of Adaptation Professionals (ASAP) because of member concerns about the challenges in securing finance for climate resilient infrastructure, and adaptations to infrastructure. Over a series of months, the Task Group assembled on the Policy Committee's online workspace, a set of materials, including case studies to facilitate consideration of the issues ASAP professionals face in financing adaptation, and offer up information, examples, and ideas that might overcome the adaptation finance challenges.

This brief considers the importance of understanding and developing policies to better mobilize climate resilient infrastructure capital. In particular, adaptation policy and planning professionals need to better understand why finance is challenging, and how they may overcome these by tapping the policy, planning, and financial instruments that already exist or may be developed to meet an array of different needs.

In this brief, we focus on one policy dimension of adaptation finance: identifying financing for climate-resilient public infrastructure and ensuring that planned infrastructure investments are made in beneficial ways. The American Society of Civil Engineers estimates that the United States' public infrastructure will require $10.8 trillion dollars in investment between 2016 and 2040.[1] Where the required funding will be raised and how it will be spent are the subject of on-going debate across levels of government, but there is little doubt that much of this spending will occur on climatically-exposed infrastructure. Adaptation professionals must work to ensure that these investments are made in "grey infrastructure" (roads and railroads, ports and airports, pipes and water treatment facilities, and other projects built of steel and concrete) designed to operate under future climate conditions and in "green infrastructure" (living shorelines, stormwater retention, reforestation for air and drinking water quality, and other essential ecosystem services) designed to mitigate future climate impacts.

This policy brief is written by policymakers and planners for policymakers and planners to use in tackling this challenge. Among other purposes, it can serve as a roadmap for practitioners to locate additional technical guidance on financing mechanisms and enabling policies.

We start by considering the problem adaptation professionals often face: not having, and not knowing how to find the money to support adaptation measures, or to integrate adaptation into on-going infrastructure investments. The brief then considers how to overcome this by exploring policymaking frameworks through which the resources could be secured. With the proper strategy of structuring and communicating, funds can be effectively deployed to communities and vulnerable populations and infrastructure investments can be effectively leveraged to support a climate resilient future. We conclude the brief with an action-oriented set of ideas for adaptation professionals to undertake and

[1] American Society of Civil Engineers (ASCE) (2017). "Failure to Act Report: Closing the Infrastructure Investment Gap for America's Economic Future." *2017 Infrastructure Report Card.* Retrieved from https://www.infrastructurereportcard.org/the-impact/failure-to-act-report/.

present to decision-makers, governmental and private, to support informed partnerships with financiers of adaptation, in their resilience and preparedness projects and initiatives.

The Appendix to this brief surveys many of the more significant finance mechanisms and related case studies so that policy practitioners can assess and provide decision makers—particularly those at the state and local level—with the information they need to identify, secure, and structure finance. We have prepared this material intending that it be posted on a dedicated webpage on the ASAP website. That approach will provide easy access for ASAP members, and create a member-driven online process for continually updating the adaptation finance information.

Our overall intent is to facilitate an informed two-way conversation between policymakers and planners on the one hand, and finance professionals on the other. This policy brief is a first attempt to address, from a policymaking perspective, climate resilient infrastructure and investment in adapting infrastructure to climate, in a manner that can guide the adaptation practitioner in securing infrastructure investment.

Adaptation finance for infrastructure: Challenges and opportunities

Policymakers and planners are aware of the evermore-evident impacts of climate change on our public infrastructure. Forest fires raging across California, storm surge inundating the Gulf Coast, unrelenting rain pounding the Carolinas, drought-depleting agricultural production across the West Coast, algae blooms poisoning water supplies in the Great Lakes - all these climate-related disruptions come at great cost not just to the social and environmental fabric of America, they also come at great economic cost.[2] Combined with an underinvestment in new and upgraded infrastructure to meet the growing populations, business activities, and needs of 21st Century America, the climate resilient investment is a daunting challenge. Policymakers and planners tasked to meet the challenge of climate adaptation are generally ill equipped to navigate the financing options necessary to fund proposed projects and initiatives.

Study after study shows that proactive adaptation approaches and newly-built climate resilient infrastructure not only protect the environment and society, they are very good investments. They are good investments because they prevent much greater costs from storm damage, crop loss, disease, and lost economic productivity.[3] Sometimes, but not always, these costs are directly financial, and thus the investor realizes good monetary returns.

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[2] 2017, the third warmest year on record, follows on a trend of ever growing economic loss and damage to households, businesses, and communities. NOAA estimated that in 2017, 16 severe weather and climate events cost the nation over $300 billion - a new record for the U.S. (NOAA National Centers for Environmental Information (NCEI), (2018). "U.S. Billion-Dollar Weather and Climate Disasters" Retrieved from https://www.ncdc.noaa.gov/billions/.

[3] For instance, a study found that public infrastructure in Alaska could expect to cost considerably less cumulatively from 2015 - 2099 with adaptation investment. (Melvin, A. M., P Larsen, et. al. (2017). "Climate

But climate resilient investment is not keeping pace with needs. The Climate Policy Initiative estimates the cost of adapting to climate change in developing countries could rise to between $280 and $500 billion *per year* by 2050.[4] These rates would accumulate financing needs to $3 – 5 trillion by 2025 (Figure 1).[5] Total global climate finance flows were $437 billion in 2015, before falling 12% to $383 billion in 2016. Only about 6% was used for adaptation activities (Figure 2).[6]

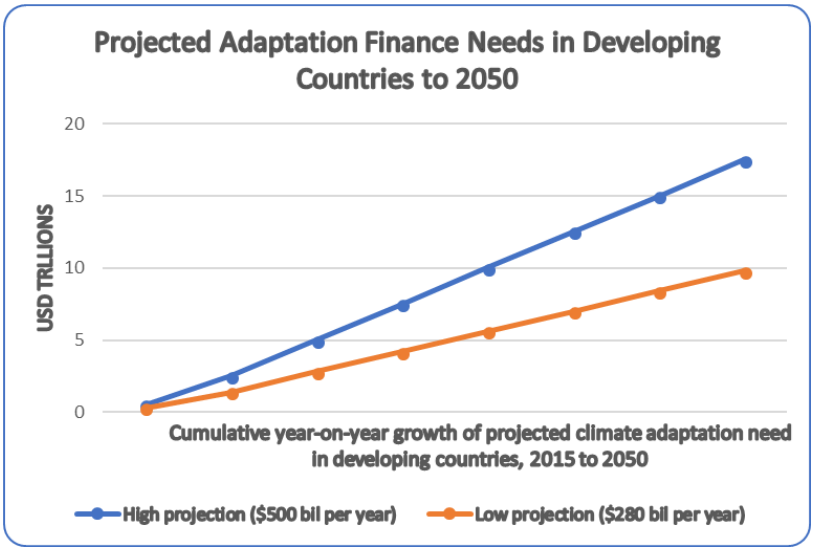

Figure 1: Projected Adaptation Finance Needs in Developing Countries to 2050

change damages to Alaska public infrastructure and the economics of proactive adaptation." *Proc Natl Acad Sci USA* 114 (2): E122-E131. https://doi.org/10.1073/pnas.1611056113.)

[4] Buchner, B, et al., (Oct. 2017). "Global Landscape of Climate Finance 2017." *Climate Policy Initiative*. Retrieved from https://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2017/.

[5] Buchner et al., 2017. Figures were extrapolated and presented as accumulating year-on-year for 2015 to 2050.

[6] Graph created for data from: United Nations Environment Programme (UNEP) (2016). "The Adaptation Finance Gap Report." Retrieved from http://www.unepdtu.org/-/media/Sites/Uneprisoe/News-Item-(pdfs)/UNEP-GAP-report-2016_web-6_6_2016.ashx?la=da&hash=10B5992B026DC85EBFF20B79E786D97C3DCCE516.

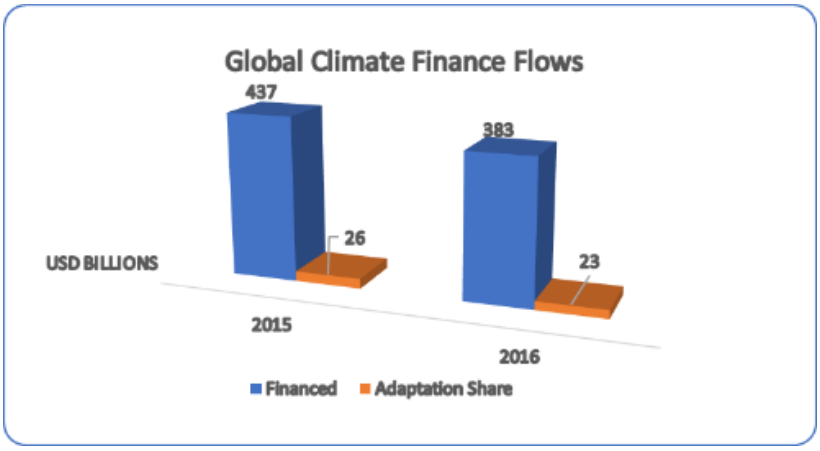

Figure 2: Total Global Climate Finance Flows in 2015 and 2016

The American Society of Civil Engineers reports that $4.6 trillion is needed over 10 years to fund America's failing infrastructures. The funding gap is $2 trillion ($206 billion per year) through 2025 (Figure 3).[7] A failure to act to fund infrastructure needs could cost the U.S. economy trillions in lost GDP, sales, and jobs by 2025 (Figure 4).[8]

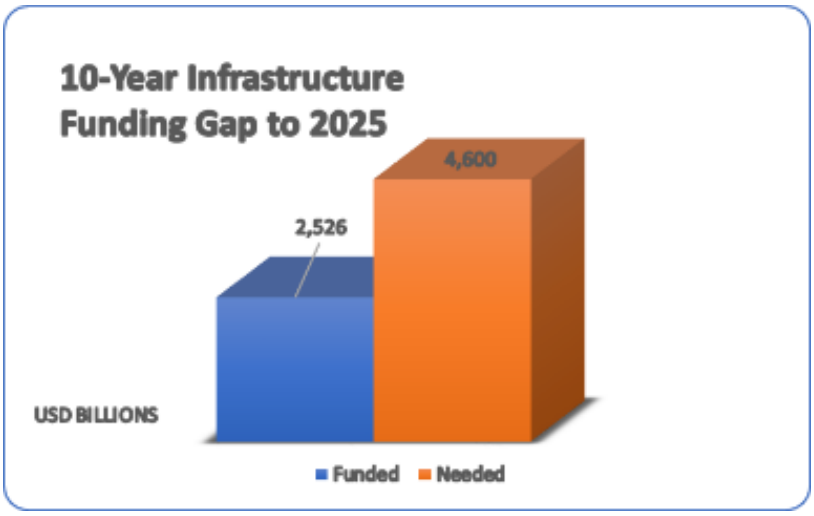

Figure 3: 10-Year Infrastructure Funding Gap

[7] Graph created for data from: American Society of Civil Engineers (ASCE) (2017). "Failure to Act Report: Closing the Infrastructure Investment Gap for America's Economic Future." *2017 Infrastructure Report Card.* Retrieved from https://www.infrastructurereportcard.org/the-impact/failure-to-act-report/.

[8] American Society of Civil Engineers (ASCE) (2017). "Economic Impact." *2017 Infrastructure Report Card.* Retrieved from https://www.infrastructurereportcard.org/the-impact/failure-to-act-report/.

Figure 4: Economic Impact of the Infrastructure Funding Gap

The reasons for this finance gap are considerable, as are the barriers to sourcing and mobilizing finance:

- Sometimes the impacts of *not adapting* cannot be counted in a way so that the conventional investor may see the need to invest and realize a good monetary return. The costs may be real, but the ***avoided costs are not attributed to the potential financier***.
- Those who do face these costs: communities, governments, companies, may have a ***limited understanding of the adaptation need, and how proactive adaptation is a net benefit.***
- As ***vulnerable parties*** don't understand how adaptation helps them, they are ***not willing to reward those who could finance adaptation.*** Even if they do understand, they may not have the financing policies, structures, processes and mechanisms in place to reward financiers.
- Many individuals, communities and decision-makers are ***not receptive to accepting the phenomenon of climate change and its impacts***. If they are, it may be viewed as a geographically and temporally distant phenomenon of no immediate consequence.
- Perceived uncertainty about future climate conditions or the effectiveness of adaptive strategies such as green infrastructure may result in adaptive spending being perceived as a financial risk. As a result, resources are rarely earmarked for adaptation, and there is an ***additional burden-of-proof to secure the (often incremental) finance required for resilient investment.***
- Governments and their decision-makers are reluctant to tax and spend on what they don't see as immediate exposures to public wellbeing. They often have ***short-term perspectives on investment, and most adaptation brings about long-term benefits.***
- ***Knowledge of the financial instruments*** and sources that may be applied to adaptation, and how to apply it are ***not commonly understood***.
- Meanwhile, the ***approaches to integrate adaptation into investments are also not widely understood by the investment community.***
- There is thus a ***need for two-way street between,*** on the one hand, ***policymakers and planners, and*** on the other hand ***the investment community*** in communicating and raising awareness of respective needs and opportunities.

All is not despair.

While the adaptation finance challenges are great, the resources directed towards climatically-exposed infrastructure is tremendous. In the U.S., trillions of dollars are spent on infrastructure.[9] This investment can be an opportunity to make the country resilient to climate change, but decision makers need to understand the costs, benefits, and options for effective adaptation investment or this investment will be misspent by ignoring climate vulnerabilities and effective approaches to address these vulnerabilities.

And the private money on the table that could be steered towards climate resilience is perhaps greater than the public. Businesses in local communities and the private financial community are key ingredients in making up the adaptation finance gap.

There are a host of reasons that businesses would find investment in climate adaptation extremely attractive. Business exposure to climate change from supply chains and markets is considerable and is beginning to be recognized by many companies.

Owing to today's complex climate change policy environment in the U.S., this policy brief's focus, however, is on infrastructure investment to offer concrete policy solutions for adaptation policymakers and planners to successfully mobilize resources in the context of the infrastructure "challenge" that is, we believe, politically viable in today's challenging policy-making environment.

Public assets: from services (not our focus in this policy brief) to infrastructure (our focus here), are assets that business relies on to maintain and grow. Even a lower direct return on investment in some of these assets may have tremendous business benefits, from more secure sourcing, a healthier and more productive workforce, and a market that looks at business in a positive light.

Fortunately, there are a host of successful experiences, practices, and instruments that can help in the effective finance of climate resilient infrastructure, supported by increasing interest from the private sector in adaptive and "green" investments.[10]

As the Figure 5[11] below outlines, infrastructure finance can stem from a variety of sources, public and private. In the Appendix, we provide further information on the instruments that adaptation practitioners may deploy.

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[9] The American Society of Civil Engineers has noted that $4.6 trillion in infrastructure investment is needed by 2025 (ASCE, 2017).

[10] Hulac, B. (2018, January 31). "Green bonds almost doubled in 2017, to $155B." *Climate Wire*. Retrieved from https://www.eenews.net/climatewire/2018/01/31/stories/1060072437

[11] Figure 8 "Infrastructure Finance" by M. Klein, The Frankfurt School, p. 30 in United Nations Environmental Program (2016). "Demystifying Adaptation Finance for the Private Sector." Retrieved from http://www.unepfi.org/wordpress/wp-content/uploads/2016/11/Demystifying-Adaptation-Finance-for-the-Private-Sector-AW-Full-Rerpot.pdf.

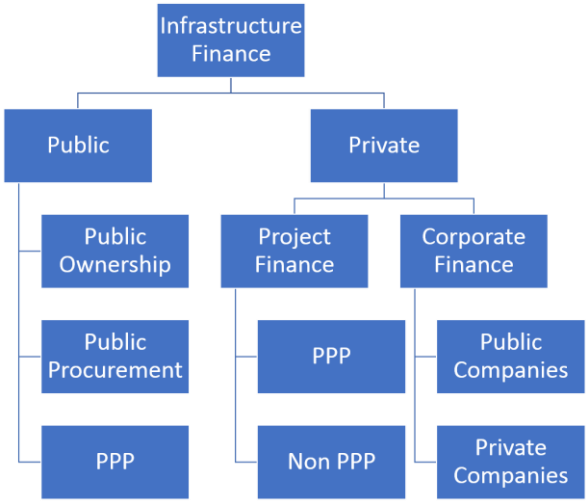

Figure 5. Public and Private Infrastructure Finance Sources

Case Study: Blended Finance Policy Learning from HafenCity

The success of HafenCity in Hamburg, Germany that began in 1997 is one of urban redevelopment that mainstreams sustainability, climate adaptation, and socioeconomic and ecologic resilience. It is a prime example of how innovative, "blended finance" and planning coalitions continue to yield returns on investment that fuel further economic growth and generate revenue for new public projects. Prioritization of quality-of-life features attracts firms and retains talent.

Investment volume: Private € 8.5 billion; Public € 2.4 billion (mostly financed from special assets fund sales of plots in HafenCity, about € 1.5 billion)

New above ground floor space: 2.4 million square meters (26 million square feet)

Firms: >730 total including 40 larger firms

Planning: Long-term (30 years), comprehensive (all sectors) that prioritize quality-of-life objectives.

Flood resilient: Permeable buildings and pavements, green infrastructure, and flood-accommodating plazas eliminate or reduce down-time for businesses, schools, transportation, and harbor activities.

HafenCity best practices and policy lessons for US practitioners:

- HafenCity is an example of **cross-sector development** and **blended financing. Long-term benefits to firms result in buy-in from private sector partners**. In HafenCity, private sector finance is three and a half times public expenditure.
- Strong outcomes and **sustained ROIs for public and private actors are found in comprehensive long-term planning.** City-wide resilient infrastructure ensures continuity of operations across sectors, relieves the uncertainty and instability of budget-busting crisis management of predictable natural events, and increases economic activity.
- **New opportunities exist in adaptation finance for policymakers and practitioners to help change the cultural landscape around comprehensive long-term planning** by encouraging consideration of instruments like resilience bonds and promoting coalitions that incentivize longer-term private investment.

The **US disaster management and adaptation professionals communities** can play a part in helping drive governance and investment toward public long-term comprehensive planning and funding

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[12] Sources for HafenCity Hamburg GmbH. (n.d.). "HafenCity - the genesis of an idea." Retrieved from http://www.hafencity.com/en/overview/hafencity-the-genesis-of-an-idea.html and HafenCity Hamburg

Mobilizing adaptation finance: Policy Action Items

In the Appendix to this policy brief, which we hope will find a permanent home on the ASAP website, we have identified a wide variety of financial instruments available to communities to implement climate change adaptation strategies and actions. When a community seeks to fund a major adaptation project it should be clear that there are two principal funding sources – the Federal government and the private sector.

There are indications that Federal funding will be limited at best in the coming years, thus our action recommendations are linked to that reality. At this time, there is growing interest in the private sector in funding adaptation and resilience actions and communities are advised to explore creating a public-private partnership with private sector partners that have the interest and capability to fund large projects. It must be noted that communities will likely be required to create a local funding source that provides a source of steady annual revenue in order to attract funding from the private sector.

ACTION ITEM 1:

Promote Blended Finance

There is growing interest in mobilizing private sector funding of adaptation and resilience actions, but communities are less familiar with private financing tools. This brief adopts the Blended Finance Taskforce's working definition of blended finance as, "the use of public/philanthropic funds to mobilize multiples of additional private capital." Blended finance instruments include direct investment into projects and funds through different types of equity and debt; indirect support through guarantees, insurance, hedging, swap, and derivative instruments; and finally, commercially oriented preparation support, which covers financial and technical support to mitigate early stage development risks in project preparation. Each of these instrument types addresses different risks and barriers.

Local governments are advised to explore creating public-private partnerships (PPPs) with private sector partners that have the interest and capability to fund large projects. Virginie Fayolle of Acclimatise has observed that blended finance can be an important way to direct money towards specific projects, locations, and sectors that might not otherwise see private sector interest.[13] Stephen Morel of OPIC has noted, however, that blended finance brings certain challenges, thus requiring

(March, 2017) "Facts and Figures on HafenCity Hamburg." Retrieved from http://www.hafencity.com/upload/files/artikel/HafenCity_Hamburg_Fact_Sheet_March_2017.pdf

[13] Mazzacurati, E, et al. (April 27, 2017). "The Role of Blended Finance in Promoting Climate Resilience," *Panel at April 2017 PROADAPT Conference*. Retrieved from http://427mt.com/2017/09/06/how-will-we-pay-for-climate-adaptation/. See also, Fayolle, V, and S. Odianose, (January 9th, 2017). "Using Blended Finance to Overcome Barriers to Climate Investments – Part 1," *Acclimatise blog*. Retrieved from http://www.acclimatise.uk.com/2017/01/09/using-blended-finance-to-overcome-barriers-to-climate-investments-part-1/

mechanisms to support private investor engagement in three broad categories: technical assistance, risk underwriting, and market incentives.[14]

At the international level, there is already a lengthy track record of blended finance through public and philanthropic institutions, including multilateral development banks such as the World Bank Group, multilateral climate funds such as the Global Environment Facility, bilateral development finance institutions such as the Netherlands' FMO, and bilateral aid agencies such as the UK's Department for International Development, which have long experimented with different approaches to mitigating or transferring risk to leverage private investment.[15] In the US market, the importance of blended finance has been recognized in climate adaptation circles, but to date, more from the financing perspective than the policymaking approach. A two-way dialogue must be established. (See Action Item 2 below.)

In developing policy incentives for blended finance-based initiatives, policymakers will need to understand the rationale for the blended finance and how it will catalyze private investment most effectively.

> *The first step towards deploying blended finance is to understand context-specific barriers to investment, identified through market analysis and discussions with private investors, and then to match appropriate instruments to these barriers. It's important to acknowledge that blended finance won't be the right solution to all problems, so a clear rationale for blending needs to be established upfront. Blended finance instruments need to be deployed in different combinations to address specific barriers, recognizing that some level of enabling environment—both generally conducive to private sector investment as well as specific to renewable energy—is a pre-requisite.* [16]

It must be noted that communities will likely be required to create a local funding source (through fees or taxes) that provides a source of steady annual revenue to attract funding from the private sector. If real estate investment can realize increases in land value this may be sufficient, however. As general guidance, CPI suggests that "all public and philanthropic funders should start with a focus on private investor needs and create structures and approaches that address these needs."[17]

Policymakers must be cautioned, however, that blended finance is not always the answer to meeting the adaptation finance gap and must be diligent to avoid potential pitfalls.

- Private sector entities will do what they are paid to do, and (typically) no more, so incentives for performance must be carefully set out in contracts.

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[14] Mazzacurati et al., 2017.

[15] Tonkonogy, B., Brown, J., et al., (January, 2018). "Blended Finance in Clean Energy: Experiences and Opportunities," page 31. *Report for the Business & Sustainable Development Commission and the Blended Finance Taskforce, Climate Policy Initiative*. Retrieved from https://climatepolicyinitiative.org/publication/blended-finance-clean-energy-experiences-opportunities/.

[16] Tonkonogy et al, 2018 at p. 31.

[17] *Id.*

- Costs of some blended finance instruments may be higher than wholly public provision of adaptation investments.
- Some adaptation priorities may benefit private sector parties more than others (such as transportation), leaving the option for investment in climate resilient infrastructure such as social housing more challenging.
- The needed revenue stream that the public sector must establish increases future public obligations and opportunity costs.

An informed and diligent public planning and management of climate resilient blended finance projects is thus critical to protect the public's interest. However, considering the current lack of Federal resources and the growing adaptation requirements for public infrastructure, blended finance is a viable option that must be considered to avert the considerable potential impacts and costs of climate change.

ACTION ITEM 2:

A two-way dialogue must be established.

This policy brief just scratches the surface of the adaptation finance challenge for practitioners and policymakers. The work of this Task Group has reinforced the perception that finance experts are not yet communicating effectively with other adaptation professionals reflected in the ASAP membership. The Policy Committee took some initial steps towards rectifying this state of play by inviting finance experts from the Global Adaptation and Resilience Investment Working Group (GARI) group to offer their perspectives on the Policy Committee calls.[18] Moreover, the Policy Committee co-chairs have proactively reached out to GARI leadership, including its chair, Jay Koh, to explore creating an ongoing liaison relationship between GARI and the Policy Committee. Such a continuing dialogue and information sharing process, if established in the near term, could dramatically move the needle in the US market.

ACTION ITEM 3:

Develop a research agenda for adaptation finance policy

In short, to become the leveraged force many believe it represents, blended finance must be demystified for practitioners and policymakers. Open questions for policymakers (adapted from UNEPFI):

- What are the adaptation needs of private sector actors?
- How are those needs typically financed?
- What are the barriers that inhibit private adaptation finance flows?

[18] The website for the Global Adaptation and Resilience Investment Working Group (GARI) is available at https://garigroup.com.

- What is the appropriate role of public finance and policy to catalyze private financial flows towards adaptation?[19]

For example, under the "barriers" category, UNEPFI concluded that market imperfections are the main reason why the real world is currently not conducive towards levels of private adaptation finance flowing at socially-optimal levels. Research could be encouraged to analyze barriers to investment in adaptation-related activities that are defined as, "A friction that prevents socially optimal (adaptation-related) investments from being commercially attractive.[20] For such further study, market imperfections in adaptation-related activities are classified into:

- positive externalities
- imperfect capital markets
- asymmetric information
- and other potentially unjustified market imperfections[21]

Conclusion:

There is a major challenge here, but there are real incentives for doing climate resilient infrastructure finance in the US. Clearly, the instruments are available to help mobilize the private sector to provide finance that governments don't have or aren't willing to spend. Of course, care and caution are in order, so that socially beneficial involvement of private money is ensured, and that the public good and interests are preserved. There is a risk that public good can be diminished if private actors demand that public goods be transferred to private parties. To be clear, this is not strictly a technical financial discussion, it is a matter of public policy practitioners, planners, and decision makers – ASAP members -- have an important role to play in advancing adaptation finance opportunities for infrastructure in the U.S.

[19] This list is adapted from: Druce, L., et al. (November, 2016). "Demystifying Adaptation Finance for the Private Sector." *United Nations Environmental Program Finance Initiative.* Retrieved from http://www.unepfi.org/wordpress/wp-content/uploads/2016/11/DEMYSITIFYING-ADAPTATION-FINANCE-FOR-THE-PRIVATE-SECTOR-AW-FULL-REPORT.pdf.

[20] This narrower definition is suggested in Druce, et al., 2016.

[21] Druce, et al., 2016.

APPENDIX

Key instruments for financing climate adaptation

Below are examples of a variety of financing mechanisms and associated information resources that may be instrumental in adaptation finance complete with links to additional information, these include:

Financing Options, General:

The United States Environmental Protection Agency (EPA) has produced a report that identifies and analyzes potential funding sources for adaptation. Getting to Green: Paying for Green Infrastructure - Financing Options and Resources for Local Decision-Makers[22] includes a table on page 2 of the document identifying and defining potential funding sources with analysis concerning the advantages and disadvantage of each funding source identified.

Funds:

The Adaptation Fund[23] was established under the Kyoto Protocol of the UN Framework Convention on Climate Change and has committed US$438 million in 67 countries since 2010 to climate adaptation and resilience activities.

The Green Climate Fund[24] was established by 194 governments to limit or reduce greenhouse gas emissions in developing countries, and to help adapt vulnerable societies to the unavoidable impacts of climate change. This fund is applicable for developing countries, but may serve as an example that could be applied in the U.S.

State and federal grants:

Regional, State, and Local Opportunities for Funding Smart Growth Projects [25] ; Case Study: Washington, DC Flood Levee System Improvements – Federal Grants[26]

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[22] US Environmental Protection Agency (2014). "Getting to Green: Paying for Green Infrastructure: Financing Options and Resources for Local Decision-Makers." Retrieved from https://www.epa.gov/sites/production/files/2015-02/documents/gi_financing_options_12-2014_4.pdf.

[23] Adaptation Fund (n.d.). "About the Adaptation Fund." Retrieved from https://www.adaptation-fund.org/about/

[24] Green Climate Fund (n.d.). "Green Climate Fund." Retrieved from http://www.greenclimate.fund/home

[25] US Environmental Protection Agency (2018). "Regional, State, and Local Opportunities for Funding Smart Growth Projects." Retrieved from https://www.epa.gov/smartgrowth/regional-state-and-local-opportunities-funding-smart-growth-projects.

[26] U.S. Army Corps of Engineers. (2015). "Washington, DC Flood Levee System Improvements." Retrieved from https://www.fhwa.dot.gov/environment/sustainability/resilience/adaptation_framework/resources/dc_flood_levee_system/.

Taxes:

City of Berkeley, CA - The Transfer Tax Rebate Program[27] reduces the real estate transfer tax by one-third for homeowners who perform qualifying seismic safety work on their homes.

Napa County voters approved a half-cent sales tax - 'Living river' rejuvenates Napa, brings needed flood control.[28]

Fees:

Tulsa, OK Stormwater Fee[29] and Washington, DC[30] Stormwater Fees – Numerous jurisdictions have adopted stormwater fees to fund infrastructure maintenance and improvement, including green infrastructure.

Miami Beach's battle to stem rising tides - Beach commissioners raised stormwater rates by 84 percent last year to secure $90 million worth of bonds to start work in the fall of 2014, when pumps quickly went in along the southwestern shore of the barrier island. The cost to the typical resident rose from $9.06 to $16.67 per month.[31]

Bonds:

The availability of funds to rebuild infrastructure and communities, much less improve resilience of infrastructure of communities is limited. It is possible for communities to overcome this lack of funding from traditional resources of federal, state and local dollars, by looking toward newer, more innovative approaches to funding. Following is a discussion of three types of bond funding programs: green bonds, environmental impact bonds, and resilience bonds.

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[27]City of Berkley (October 21, 2013). "Section 3: Hazards Analysis." Retrieved from https://www.cityofberkeley.info/uploadedFiles/Fire/Level_3_-_General/Berkeley LHMP 102113 SECTION 3.pdf

[28] King, J. (April 30, 2017) "'Living River' rejuvenates Napa, brings much needed flood control." *San Francisco Chronicle.* Retrieved from http://www.sfchronicle.com/politics/article/Living-river-rejuvenates-Napa-brings-11109403.php

[29]City of Tulsa (n.d.). "Stormwater Fee and Funding." Retrieved from https://www.cityoftulsa.org/government/departments/engineering-services/flood-control/stormwater-fee-and-funding/.

[30] District of Columbia Department of Energy and Environment (n.d.). "Stormwater Fee Background." Retrieved from https://doee.dc.gov/service/stormwater-fee-background.

[31] Flechas, J and J Staletovich (October 31st, 2015). "Miami Beach's battle to suspend rising tides." *Miami Herald.* Retrieved from http://www.miamiherald.com/news/local/community/miami-dade/miami-beach/article41141856.html.

Green Bonds[32] are like other infrastructure-related bonds except that they must demonstrate some type of environmental or climate benefit, i.e. a qualified green investment as defined by the Climate Bonds Standard Board.[33] They are typically issued as a use of proceeds bond, use of proceeds revenue bonds, project bond, securitized bond, etc.[34] The structure, risk, and return are identical to traditional bonds. Proceeds can be used for climate adaptation activity, which include information support systems and early-warning systems; watershed conservation projects; and flooding mitigation such as sustainable urban drainage systems.[35] To date, most of these bonds have been focused on renewable energy, low-carbon buildings and transportation. However, climate bonds have approved certification criteria for water infrastructure projects, and certification criteria is under review for a variety of green infrastructure like projects, such as coastal infrastructure.

The climate/green bond issuance activity has been done worldwide, with a handful in the US, including New York and San Francisco.[36] Relevant to Harvey efforts is the green water bond issued by the San Francisco Public Utility Commission to develop storm water management infrastructure. The PUC issued four bonds in 2016 and 2017 for a total of $1 billion.[37]

A good example of a green bond, South Burlington, Vermont's newly established stormwater water utility,[38] agricultural business model of Biological Capital,[39] and Quantified Ventures' first successful environmental impact bond[40] which is supporting Washington, DC's water[41] adaptation and resilience efforts,[42] plus the expected outcomes from the ongoing Environmental Impact Bond Challenge.[43]

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[32] Climate Bonds Initiative (n.d.). "Explaining green bonds." Retrieved from https://www.climatebonds.net/market/explaining-green-bonds

[33] Climate Bonds Initiative (2018). "Climate Bonds Standards and Certification." Retrieved from https://standard.climatebonds.net

[34] Climate Bonds Initiative (2018). "Eligible Debt Instruments." Retrieved from https://www.climatebonds.net/certification/types-of-bonds.

[35] ICMA Group (June 2, 2017). "The Green Bond Principals 2017." Retrieved from https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/GreenBondsBrochure-JUNE2017.pdf

[36] Climate Bonds Initiative, (2018).

[37] Climate Bonds Initiative, (2018). "San Francisco Public Utilities Commission." Retrieved from https://www.climatebonds.net/certification/sfpuc

[38] South Burlington, Vermont, Stormwater Services (2017). http://sburlstormwater.com/

[39] Biological CAPITAL (2018). https://www.biologicalcapital.com/

[40] Quantified Ventures (2017). "World's First Environmental Impact Bond to Reduce Stormwater Runoff and Combined Sewage Overflows in Washington, D.C." Retrieved from http://www.quantifiedventures.com/dc-water

[41] DC Water (July 10, 2014). "DC Water Announces Successful Sale of $350 Million Green Century Bonds." Retrieved from https://www.dcwater.com/whats-going-on/news/dc-water-announces-successful-sale-350-million-green-century-bonds

[42] Washington, D.C. Department of Energy and Environment, Climate Adaptation and Preparedness and the Climate Ready DC Plan (n.d.). Retrieved from https://doee.dc.gov/climateready

[43] Quantified Ventures, Environmental Impact Bond Challenge (2017). http://www.quantifiedventures.com/rockefeller-eib?mc_cid=1d1c98fb68&mc_eid=92ae6c6e8d

Resilience Bonds are bonds that allow issuers to build infrastructure to reduce loss or likelihood of loss during a natural disaster event; build new infrastructure with the expectation of reducing risk.

For a resilience bond, the issuer utilizes a catastrophe model [44] to determine baseline risk to infrastructure from natural disasters. This modeling establishes the size of the catastrophe bond that would be issued for this project. The issuer then calculates how the implementation of a more resilient system would reduce future loss in comparison to this baseline. A resilience rebate is set based on the value of the anticipated reduced loss. The reduced risk of principal to the investor and the reduced premium expense to the sponsor is captured and provided to the sponsor as a rebate. This rebate can be used for financing resilient infrastructure or risk reduction investment.

The insurance-linked securities (ILS) sector which is primarily made up of catastrophe bonds is a $25.5 billion market. There has been growing interest and efforts to better quantify risk and uncertainty regarding resilient projects that can be backed by these bonds.[45]

Figure 6 illustrates a resilience bond model.[46] The blue and grey components of the model demonstrate the flow of a traditional catastrophe bond. The orange lines and boxes represent the addition of the resilience bond component. The full report with the model is "A Guide for Public-Sector Resilience Bond Sponsorship."[47]

[44] Van Leer, K. (June 22nd, 2015). "What is Catastrophe Modeling?" *RMS Blog.* Retrieved from http://www.rms.com/blog/2015/06/22/what-is-catastrophe-modeling/

[45] Ruggeri, A (May 16, 2017). "Resilience Bonds: a secret weapon against catastrophe," *BBC Future Now.* Retrieved from http://www.bbc.com/future/story/20170515-resilience-bonds-a-secret-weapon-against-catastrophe

[46] Vajjhala, S. (December 16th, 2015). "Financing Infrastructure through Resilience Bonds," *Brookings Institute: The* Avenue. Retrieved from https://www.brookings.edu/blog/the-avenue/2015/12/16/financing-infrastructure-through-resilience-bonds/

[47] Vajjhala, S. and J. Rhodes (c. 2016). "A Guide for Public-Sector Resilience Bond Sponsorship," re:focus Partners & REbound. Retrieved from http://www.refocuspartners.com/wp-content/uploads/pdf/RE.bound-Program-Report-September-2017.pdf

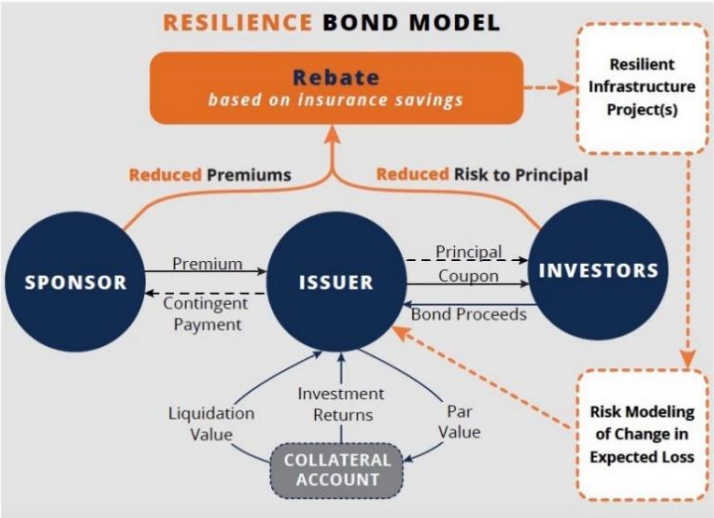

Figure 6. Resilience Bond Model Components

Environmental Impact Bonds (EIB) are options for green infrastructure for storm water management and other resilient infrastructure investments.[48] The EIB is a tax-exempt municipal bond that utilizes a pay for success approach to financing infrastructure. The bond provides upfront capital for innovative resilience-focused projects and shifts downside risk from government agencies to the private sector investors. The public sector repays investors based on the whether the agreed-upon environmental outcomes are achieved. If agreed upon performance is not achieved, the investor covers the loss.

The first EIB was closed in September 2016 with the DC Water and Sewer Authority.[49] This is a 30-year, $25 million bond with a mandatory tender after five years.[50] With this bond, DC Water is looking to implement green infrastructure to mitigate storm water risk but lacked capital. The utility was attempting to implement a new more innovative approach to storm water mitigation and was concerned about performance risk. The EIB investors took on this risk and will pay DC Water if the infrastructure under-performs. The investors in this project are Goldman Sachs and Calvert Foundation. At the five-year mark an additional payment of $3.3 million will be made, either by DC Water or the investors. Who pays will be dependent on actual storm water runoff reductions.[51]

[48] Diez, E. (August 21, 2017). *Environmental Impact Bonds: Could They Help Save Americas Aging Infrastructure?* Environmental and Energy Study Institute. Retrieved from http://www.eesi.org/articles/view/environmental-impact-bonds-could-they-help-save-americas-aging-infrastructure

[49] Quantified Ventures (n.d.). "Worlds First Environmental Impact Bond to Reduce Stormwater Sewage Overflows in Washington, D.C." Retrieved from http://www.quantifiedventures.com/dc-water

[50] The interest rate is set at 3.43 percent. (Diez, 2017).

[51] An independent evaluator set the performance metrics for the project. If reductions in storm water runoff are greater than 41.3% then DC Water will bay an outcome payment. If the runoff is reduced less than 18.6%, Goldman and Calvert will pay a one-time risk share payment to DC Water (Quantified Ventures, n.d.).

Credits:

Risks avoided, or vulnerabilities reduced by an adaptation project can be measured and monetized as credits. These can be used as certification instruments and incentives in project financing and prioritization, insurance valuation, and measuring project effectiveness. For examples of how these credits can work, see The Higher Ground Foundation's framework for vulnerability reduction credits (VRCs) designed to stimulate accountable sustainable climate adaptation projects.[52]

Blended Finance:

Blended Finance channels private investment to sectors of high-development impact while at the same time delivering risk-adjusted returns. Blended finance leverages development and philanthropic funds to attract private capital into deals. High impact projects are best-suited where investments drive social, environmental and economic progress. Financial returns for private investors should be in line with market expectations, based on real and perceived risks.[53]

One type of Blended Finance is **Public-Private Partnerships** (PPP or P3). P3s are typically created for a publicly-owned infrastructure project where some aspects of the project, like operations, are contracted out to the private entity. Partnerships vary in level of participation, investment, risk and responsibility.

Figure 7 illustrates the spectrum of PPP agreements.[54]

[52] "What are VRCs?" https://www.thehighergroundfoundation.org/concept

[53] World Economic Forum, & OECD. (2015). *Blended Finance Vol. 1: A Primer for Development Finance and Philanthropic Funders*. Retrieved from http://www3.weforum.org/docs/WEF_Blended_Finance_A_Primer_Development_Finance_Philanthropic_Funders_report_2015.pdf

[54] Public-Private-Partnership in Infrastructure Resource Center, World Bank Group (2016). "PPP Arrangements: Types of Public-Private Partnership Agreements." Retrieved from https://ppp.worldbank.org/public-private-partnership/agreements. Referenced in Coffee, J (May 16, 2018). "Innovation in Municipal Finance for Resilient Infrastructure." *Innovations in Climate Solutions: Second Webinar in the Resilience Leadership Series*. Retrieved from https://www.dropbox.com/s/pk1n88ulfcwvgee/ASAP%20Webinar%20II%20_final.pdf?dl=0.

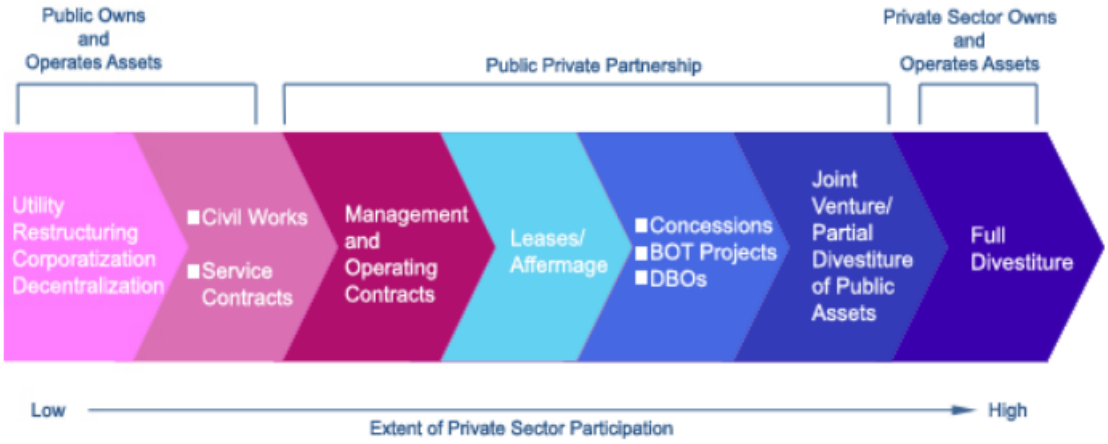

Figure 7. Spectrum of Public Private Partnership Agreements

Resources on Blended Finance:

The OECD and the World Economic Forum's guide: Blended Finance Vol. 1: A Primer for Development Finance and Philanthropic Funders; A How-To Guide for Blended Finance. [55] Invest4Climate is an initiative of the World Bank's Connect4Climate platform that "provides an opportunity to mobilize, coordinate and deliver the finance needed to help make the transition to a low-carbon resilient future, while creating jobs and building prosperity." [56] The Invest4Climate homepage includes the video "Unlocking Financing for Climate Action."[57] The press announcement has a good overview of the program.[58]

The UNFCCC's 2007 report, Investment and Financial Flows to Address Climate Change, contains a section on financing infrastructure adaptation.[59]

[55] World Economic Forum, & OECD, 2015.
[56] World Bank Group. (2018). Invest4Climate Initiative. Retrieved from https://www.connect4climate.org/content/invest4climate
[57] World Bank Group. (2017). *Unlocking Financing for Climate Action*. Retrieved from https://cdnapisec.kaltura.com/index.php/extwidget/preview/partner_id/619672/uiconf_id/40617731/entry_id/1_6tsualou/embed/dynamic
[58] World Bank. (2017). Mobilizing Finance for Climate Action Through the Invest4Climate Platform. Retrieved from http://www.worldbank.org/en/topic/climatechange/brief/mobilizing-finance-for-climate-action-through-the-invest4climate-platform
[59] UNFCCC. (2007). *Investment and Financial Flows to Address Climate Change*. Chapter 5.4.6: Infrastructure. Retrieved from https://unfccc.int/resource/docs/publications/financial_flows.pdf

Case Studies:

Climate Adaptation: The State of Practice in U.S. Communities [60] is a series of 17 case studies written by ABT Associates and Missy Stults[61] with funding from The Kresge Foundation. Case studies describe strategies and practices vital to encouraging project financing including interactions with municipal leaders, public education and engagement efforts, communicating across government levels, building private sector partnerships (Boston), neighborhood climate action funds (Cleveland), and addressing near-term financially feasible strategies (El Paso).

[60] ABT Associates, and Missy Stults. (2016) "Climate Adaptation Case Studies: The State of Practice in U.S. Communities." https://kresge.org/sites/default/files/library/climate-adaptation-the-state-of-practice-in-us-communities-case-studies.pdf.

[61] Missy Stults is a member of the Board of Directors of the American Society of Adaptation Professionals. https://adaptationprofessionals.org/people/

Glossary

Blended finance

"Blending can be broadly defined as the combination of public concessional official development assistance (ODA) with private or public resources, generally with the aim of 'mobilizing' or 'leveraging' development finance from other actors." (Definition credit: Oxfam America at https://www.oxfamamerica.org/static/media/files/blended-finance-130217-en.pdf) "Blended finance is the strategic use of development finance for the mobilisation of additional commercial finance towards the Sustainable Development Goals (SDGs) in developing countries." (Definition credit: OECD at http://www.oecd.org/dac/financing-sustainable-development/development-finance-topics/blended-finance.htm)

Catastrophe Bond (CAT)

"A catastrophe bond (CAT) is a high-yield debt instrument that is usually insurance-linked and meant to raise money in case of a catastrophe such as a hurricane or earthquake. It has a special condition that states if the issuer, such as the insurance or reinsurance company, suffers a loss from a particular predefined catastrophe, then its obligation to pay interest and/or repay the principal is either deferred or completely forgiven." (Definition credit: http://www.investopedia.com/terms/c/catastrophebond.asp#ixzz4wKxK7EF7)

Environmental Impact Bonds (EIB)

Another option for green infrastructure for storm water management and other resilient infrastructure investment, is environmental impact bonds (EIB)[6]. The EIB is a tax-exempt municipal bond that utilizes a pay for success approach to financing infrastructure. The bond provides upfront capital for innovative resilience-focused projects and shifts downside risk from government agencies to the private sector investors. The public sector repays investors based on the whether the agreed-upon environmental outcomes are achieved. If agreed upon performance is not achieved, the investor covers the loss.

Fees

Funds raised by states and municipalities through charges for services such as inspections and permits that are used for adaptation and resilience projects. Funds raised through developer impact fees are one-time charges linked with new development.

Forecast-based Financing (FbF)

In disaster management, forecast-based financing (FbF) recognizes that there are often forecasts available, but no humanitarian organization resourced to act before disaster, especially when there is no certainty and a risk of acting in vain. NGOs secure flexible preparedness funds, often from governments, for specific actions before or when a forecast disaster strikes. (Definition credit: Red Cross

Red Crescent Climate Centre at http://www.climatecentre.org/programmes-engagement/forecast-based-financing)

Green Bonds

Green bonds are similar to other infrastructure related bonds except that they must demonstrate some type of environmental or climate benefit, i.e. a qualified green investment as defined by the Climate Bonds Standard Board.[62] They are typically issued as a use of proceeds bond, use of proceeds revenue bonds, project bond, securitized bond, etc.[63] The structure, risk, and return are identical to traditional bonds.

Insurance-linked Securities (ILS)

"Insurance-linked securities (ILS) are products of the rapid development of financial innovation and the process of convergence between the insurance industry and the capital markets. The securitization model has been employed by insurers eager to transfer risk and tap new sources of capital market funding. Insurance-linked securities—both from the life and property/casualty sectors—hold great appeal for investors. While CAT bonds remain the dominant type of outstanding ILS, there are also other non-cat-bond ILS in existence, such as those based on mortality rates, longevity, and medical-claim costs."
(Definition credit: National Association of Insurance Commissioners at http://www.naic.org/cipr_topics/topic_insurance_linked_securities.html)

Public Private Partnership (PPP or P3)

Contractual agreement between a public agency and a private sector entity that allows for the private sector participation in the financing, planning, design, construction, and maintenance of a project or facility.

Resilience Bonds

Bonds that allow issuers to build infrastructure to reduce loss or likelihood of loss during a natural disaster event; build new infrastructure with the expectation of reducing risk. These can be used for coastal protection, sea walls, storm water mitigating green infrastructure, wind events, etc. Issuer would utilize a catastrophe model to determine baseline risk to infrastructure from natural disasters. This modeling would establish the size of the catastrophe bond that would be issued for this project. The issuer would then calculate how the implementation of a more resilient system would reduce future loss in comparison to this baseline. A resilience rebate is set based on the value of the anticipated

[62] Climate Bonds Initiative (n.d.). "Climate Bonds Standards and Certification." Retrieved from https://standard.climatebonds.net

[63] Climate Bonds Initiative (n.d.) "Types of Bonds." Retrieved from https://www.climatebonds.net/resources/understanding/types-of-bonds

reduced loss. The reduced risk of principal to the investor and the reduced premium expense to the sponsor is captured and provided to the sponsor as a rebate. This rebate can be used for financing resilient infrastructure or risk reduction investment.[64]

Vulnerability Reduction Credits (VRCs)

"A measure of the monetized cost of the estimated impact of climate change, as adjusted for the income level of the Community, to be avoided as a result of the project. Vulnerability reduction credits stimulate accountable, sustainable climate adaptation projects."
VRC is an unregistered trademark owned by Climate Mitigation Works Ltd., a limited company in England and Wales." (Definition credit: The Higher Ground Foundation at https://docs.wixstatic.com/ugd/d5a514_1f88fe029ba84197a58b6d2ee46bc32f.pdf)

[64] Vajjhala, S. (December 16th, 2015).