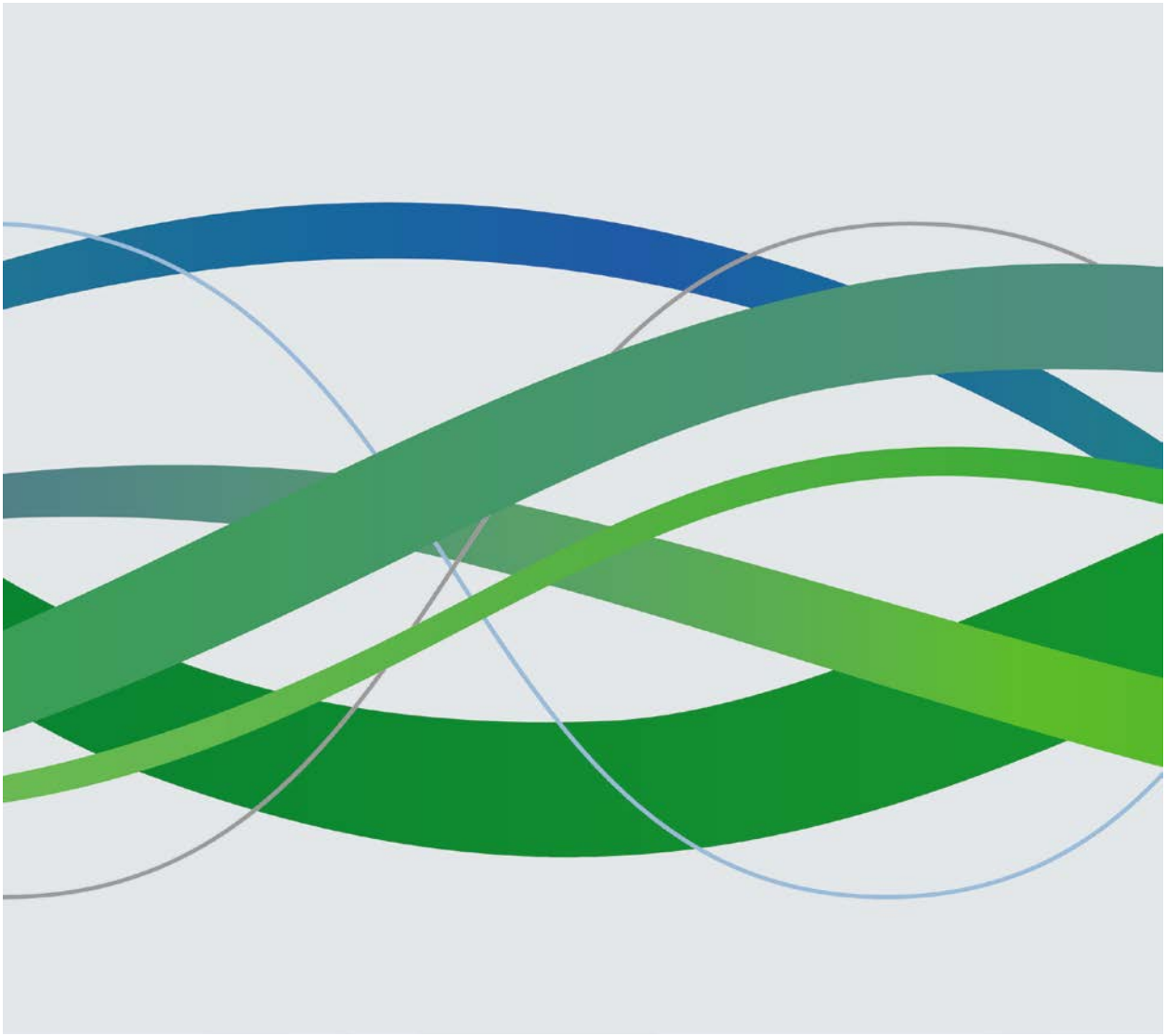
Private Investment, Market Mechanisms and Climate Change Adaptation:

Options for Closing the Adaptation Financing Gap



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Introduction

Development finance managers and policymakers widely recognize the need to fund projects enhancing low-income countries' climate resilience. Their advocacy for increased investment in climate change adaptation measures is driving action at international institutions.

Diplomats at the last UNFCCC Conference of the Parties in Durban, South Africa voiced strong support for advancing climate change resilience objectives. Not only did the Parties launch a Standing Committee on Finance, they also established a new Adaptation Committee to focus attention on adaptation issues in future negotiating sessions. Furthermore, they clarified the Green Climate Fund's (GCF) governance structure, providing it with financing windows for both mitigation and adaptation initiatives, and mechanisms to allow private sector entities access to funding.

The GCF is expected to facilitate investments worth US$100bn annually by 2020. A part of this sum should be directed to measures to reduce low-income countries' vulnerability to climate

hazards. As the mechanisms for channeling these funds crystalize, many critical questions need to be addressed, including - ***Where will the required capital come from? How should it best be invested? What is the role of the private sector and how can we facilitate its support?***

DNV KEMA covered related issues and mechanisms for addressing them during a roundtable discussion with leaders in the climate policy and development communities in October of 2012. Incorporating feedback to a similar discussion paper distributed prior to the roundtable and other comments from participants, DNV KEMA offers the following concept brief. In it we attempt to highlight key challenges to effective adaptation investment, and offer a short menu of solutions that might potentially play a part in raising required funds. Perspectives presented are those of the authors only.

Sincerely,

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With very special thanks to Edwin Aalders (DNV) and Leo Sommaripa (DNV KEMA) for their extensive feedback on report drafts and participants in the roundtable, listed below.

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1. Executive summary

Lower-income countries will incur heavy costs as they adapt to a changing climate. Various sources estimate total annual funding requirements for climate change adaptation to be in the range of US$50 – 100bn. (World Bank 2010a, UNDP 2007) This is in addition to the much larger sums countries in these regions must invest in infrastructure to support their baseline growth. Furthermore, actual expenses may be much higher than these estimates, particularly as infrastructure and populations in vulnerable zones are likely to grow at an accelerating pace (Hallegatte 2011). Lower-income countries are also particularly exposed to weather shocks, as many host fragile physical infrastructure and political institutions, or count agriculture as a large contributor to their domestic economies. European Commission researchers estimate that developing countries' export revenues typically fall by 22% following a natural disaster (Andrade and Cernat 2012), with this impact lingering for up to three years. As lower-income countries assume more extreme weather risk, with growth in vulnerable regions and exposure to shifting climate distributions, hazards to these nations' economies also become more severe.

Meanwhile a range of studies suggest that well-targeted investments in climate risk reduction may generate substantial long-term returns, often worth upwards of three times the value of the initial outlay (Hochrainer-Stigler et al 2012, Mechler 2005).

But current investment in climate adaptation currently falls well short of required investments for ensuring climate resilience, creating what may be described as an "adaption financing gap". Given the potential returns to adaptation investments and enthusiasm shown from international public institutions, are there specific tools we can use to help meet global financing needs? In the following sections we discuss three barriers contributing to this gap, and a set of potential instruments for addressing them.

This document focuses on the financing of climate resilience investments and is unfortunately fairly abstract. To add slightly more concrete shape to the types of investments included in the category, we offer an indicative list in the table below. We emphasize that it is not comprehensive. Examples are grouped according to the activity's "Temporal" nature – whether the investment 1) directly lowers an individual's or community's vulnerability to changing climate events or 2) enables less costly action by local entities to avoid event losses, and "Spatial" nature – whether the investment 1) helps lower vulnerability in aggregate or 2) distributes financial losses more widely over the global population.

Table 1: Indicative approaches to increasing climate resilience

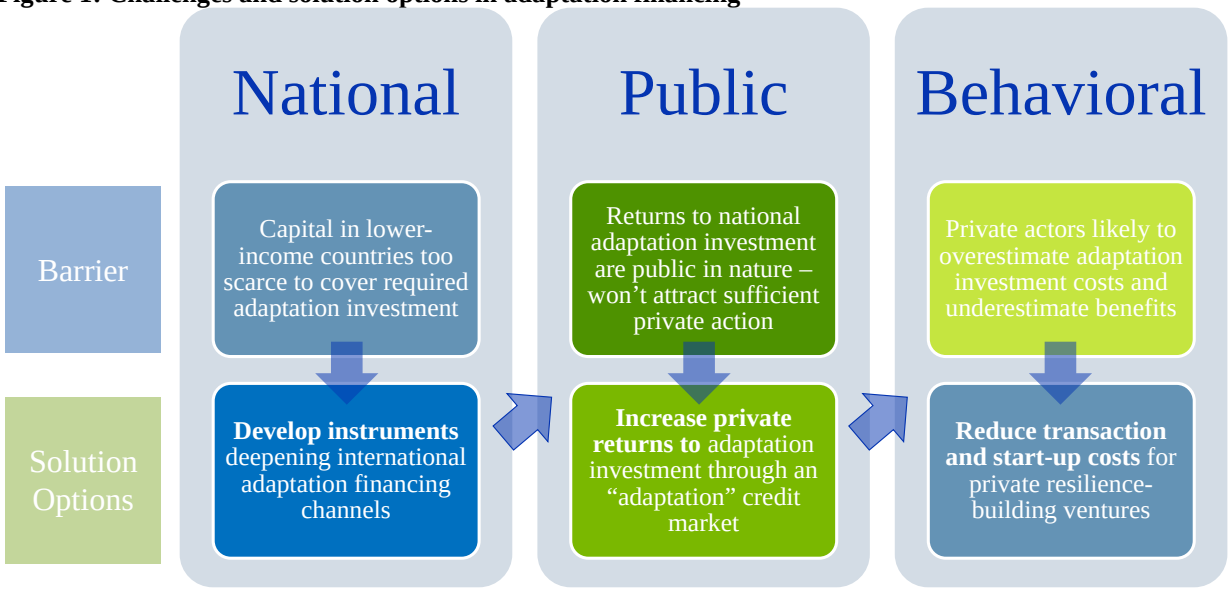
Approaches to reducing climate vulnerability		**"Temporal"**	
		Preventative	Responsive
"Spatial"	Mitigating	Less vulnerable infrastructure (roads, seawalls, ports, water systems, etc), development of climate-resilient agriculture, immunization of climate change-linked illnesses	Early flood warning systems, flexible supply chains, mobile infrastructure, disaster response institutions, information-sharing technology
	Distributing	Index insurance, risk-pools, catastrophe bonds	Post-event aid channels, technologies for private cash transfers, assistance agreements

While the approaches in the table have differing characteristics, we consider them all as potential targets for support from the financing mechanisms discussed in this report. Some of the mechanisms listed are more relevant to specific intervention options we offer later. For example, investments in more climate-proofed roads are likely to attract funding as a result of our "National" or "Public" solutions, due to their public nature. Other technologies for enhancing individual resilience, like micro-insurance platforms, may appropriately attract funding as a result of "Behavioral" interventions.

Additionally, while much of the discussion here regarding adaptation and resilience focuses on reducing vulnerability to dramatic, uncommon events like weather disasters, we suggest that the same principles should inform funding for adaptation to more gradual, but still costly, changes prompted by climate change.

We outline three barriers to adaptation investment and mechanisms the multilateral community may consider using to overcome these. A summary diagram of the barriers and interventions to address them is featured in Figure 1.

Figure 1: Challenges and solution options in adaptation financing



Three barriers to adaptation investment and options to address them

National funding barriers to private investment

Governments in lower-income countries will struggle to fund increasingly costly climate adaptation investments. Furthermore, low-income countries emphasize that they are largely not responsible for the greenhouse gas concentrations in the atmosphere. They will incur adaptation expenses which can be largely attributed to middle- and high- income nations' cumulative emissions, which account for about 94% (World Bank 2010b) of all human contributions to atmospheric CO_2. For reasons of necessity and equity, a large part of climate change adaptation investment may require international financing.

But funding for adaptation projects in foreign countries is unlikely to enjoy strong political support, nor be commercially viable. Foreign aid budgets are constrained in traditional donor countries and benefits of resilience investment abroad will not accrue to local stakeholders. Thus channeling funding across borders from cash-rich to vulnerable countries will be difficult. We call the task of raising required local adaptation funding "National" financing barriers.

Addressing national barriers:

The menu of international instruments for transferring capital and risk is growing, offering access to more middle- and lower-income countries. More prominent instruments include local currency bonds, catastrophe bonds and reinsurance products. We suggest a related hybrid instrument may potentially represent another useful addition to this list. **Climate Adaptation Securities (CAS)**, we might call them, would be issued by climate-vulnerable countries and purchased by long-term investors, potentially with some guarantees from the World Bank or GCF, and offering coupons potentially subsidized by the one of these institutions.

With funds from CAS issuance, governments could sponsor (for example) infrastructure, disaster management and agricultural projects with significant real economic returns under a very broad range of climate scenarios. In response, issuing Governments would repay CAS-holders with a coupon, which might potentially be linked to the country's major export earnings or other indicators of local economic activity, and be partially subsidized by contributions from the GCF.

CAS would have one other feature to help make the securities less risky for borrowers and potentially more palatable for the international community. CAS terms would specify that in the case the borrower experiences climatic conditions sufficiently abnormal and adverse during a given year, security coupon payments will be reduced or forgiven. Given the impact weather has on low-income countries' economies, avoiding debt service expenses in calamitous times would take substantial pressure off the borrowing government's treasury. This relief measure could form a concession to global interest groups urging softer terms for poor countries.

While the coupon forgiveness feature would decrease CAS expected returns, all else being equal, credit and cash enhancement on the securities from multilateral entities could make them sufficiently attractive to foreign funders. Furthermore, a weather-linked coupon would help make CAS uncorrelated with most other assets, a valuable characteristic in a large global investor's portfolio. Such instruments may sound far-fetched, but actually blend components of existing securities which are becoming relatively widespread and supported by current technology.

Incentive barriers to private investment

While investments in climate change adaptation contrast with mitigation investments as they generate local (as opposed to global) benefits, many or most project types are public in nature. Communities will benefit from the introduction of a higher sea wall, a climate-proofed bridge or an early flood warning system[1], and it is often difficult or impossible for a private entity to collect payments for the value provided to local residents.

[1] See Hallegatte 2012: *A Cost Effective Solution to Reduce Disaster Losses in Developing Countries*, with estimates for early warning and evacuation systems investment returns of **4x to 36x**

Raising and targeting resilience-focused public investment in developing countries could be difficult. Various constituencies in each country are likely to have strong and diverse preferences over potential government action. Constituents may not favor adaptation investments from government general funds, but may be willing to incentivize specific private funding for adaptation.

Addressing incentive barriers:

To address climate change adaptation investment needs at a national level, governments may consider channeling private investment according to an **Adaptation Investment Market Mechanism**. Such a mechanism would attribute value through "Adaptation Units" (AU) to be issued for actions providing demonstrable climate resilience benefits. AU issuance would be governed by strict, widely reviewed methodologies and would elaborate procedures for valuing project impacts in terms of

- Estimated project impact on human vulnerability, like DALYS (Disability-adjusted life years saved – as used in Michaelowa et al 2011)
- Estimated project impact on property value at risk, or
- Other vulnerability measures

With the AU project crediting and verification metrics set, the government could steer investment according to identified project AU values. Specific mechanisms to set AU market values include

- Compensation mechanisms required for commercial entities judged to be generating climate-forcing emissions (e.g. requiring corresponding adaptation investments from fossil fuels extractors, similar to "wetlands banking" requirements for US construction projects)
- Granting access rights to federal land or properties based on executed projects' AUs
- Contracting private infrastructure projects targeting specified AU levels via reverse project auctions

Behavioral barriers to private resilience investment

Some of the knottiest challenges to generating private interest are cognitive and organizational. Many studies indicate managers' tendencies to excessively discount uncertain future savings benefits, such as those likely to come from adaptation. Other evidence suggests that executives are typically not incentivized to address long-term opportunities with their firms. As a result, commercial entities may perceive climate risk-linked product development as excessively costly, instead focusing on more familiar services. Even if incentives for and understanding of future benefits from private investment were recognized by private decision-makers, data on resilience projects' costs and benefits are scarce, as is the capacity for their analysis. The enormous obstacles to adaptation investment created by limited local data and capacity were highlighted by multilateral managers doing pioneering work on catastrophe risk transfer and resilience initiatives during our October roundtable event.

Addressing behavioral barriers:

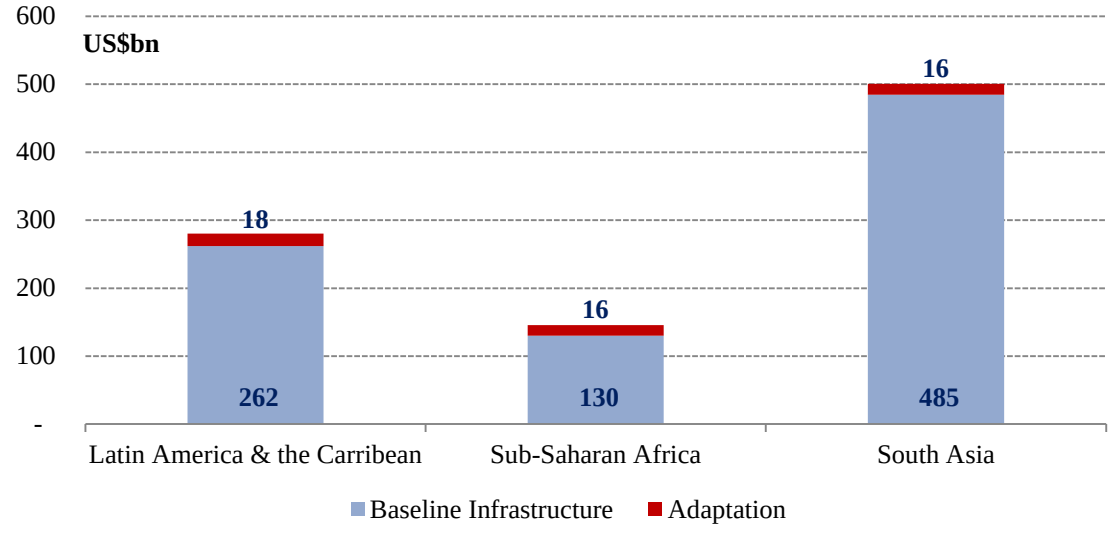
To help firms and individuals deliver adaptation measures with private benefits, multilateral actors should consider targeted technical advisory interventions and financial support. Interventions to promote energy savings can offer a useful guide, as can recent innovation in "micro" financing products. Some sample interventions may include:

- Support for the creation of climate risk and resilience service markets, with
    - Transaction enhancement, such as guarantees, partial risk insurance or direct subsidies for financing to adaptation projects
    - Technical assistance to providers of resilience-enhancing services (e.g. offering climate modeling data and risk frameworks for pricing insurance)
- Direct funding for resilience-enhancing technologies and institutions with network effects and large start-up costs

2. Background: why new tools are needed to finance climate change adaptation

CO_2 concentrations in the Earth's atmosphere have reached over 390 parts per million,[2] over 30% above the maximum values previously reached during the last 800,000 years and about 70% above average concentrations over this period (Luthi 2008). Researchers' findings overwhelmingly suggest the rapid atmospheric accumulation during the last 200 years has been driven by industrializing and industrialized nations' economic growth.

Figure 2: Regional average annual investment requirements 2010 - 2050



Source: World Bank 2010c The Costs of Adapting to Climate Change for Infrastructure

[2] US National Oceanic and Atmospheric Administration http://www.esrl.noaa.gov/gmd/ccgg/trends/

Growing greenhouse gas concentrations are altering the global climate. Average annual temperatures have steadily increased from historical observations during the last 100 years (Hansen 2012), and evidence is building to support the claims that extreme weather events are becoming more common (IPCC 2012).

Adapting to a changing and uncertain climate is particularly difficult for low-income countries already struggling to maintain and finance current growth. Adaptation investment requirements add an extra 3 – 12% to projected base infrastructure spending of US$130bn/yr in Sub-Saharan Africa to US$485bn/yr in South Asia for the period from 2010 to 2050. to these enormous sums.

In response to climate change, many low-income countries have created National Adaptation Programmes of Action (NAPAs). These involve several main types of adaptation projects that countries expect will be needed in their particular circumstances. Drawing on earlier work from the OECD (Agrawala and Fankhauser 2008), the World Bank estimated specific adaptation investment requirements for specific sectors in low-income countries[3]. In Table 2 we note five key adaptation areas used by the World Bank, along with the exposure examples and corresponding investment types and estimated funding volumes.

Table 2: Risk exposures and required adaptation investments for Latin America, Africa and South Asia *

Sector	Example Exposures	Example Required Investments	Approx. Adaptation Cost, p.a. *(US$bn)*
Agriculture:	Irrigation availability, growing temperatures, transport channels	Agricultural research, expansion of irrigation, irrigation efficiency, road improvements	**5.5**
Freshwater access and flooding:	River flooding, municipal water supply access	Increasing reservoir storage capacity, implementing water-efficient technologies, creating precipitation storage, extracting from new groundwater sources; dams, dikes, diversion basins	**12.4**
Coastal zones:	Sea-level rise and flooding, enhanced storm impact as a result of higher water levels	Dike construction and maintenance, beach nourishment, port upgrades	**10.7**
Health:	Vector-borne and water-borne diseases, respiratory problems, deaths from extreme weather events	Treatment, prevention, immunization	**1.6****
Infrastructure:	Communication systems, electricity access, water treatment systems, transportation systems	Power and telephones, water and sewers, roads, other transport, health and schools	**14.0**

Source: World Bank 2010 Economics of Adaptation to Climate Change (sectorial papers) … *Sector expenses not equivalent to aggregate regional estimates due to varying approaches in World Bank estimation methodologies **Covers Malaria and Diarrhea impact of climate change.

[3] This bottom-up analysis used different methods than the top-down aggregate investment estimates produced by the World Bank and produced a slightly smaller number.

While developing countries are launching the previously mentioned adaptation initiatives and are in stronger fiscal position now than they have been during decades past (somewhat in contrast to their developed counterparts [IMF 2011]), they are still highly sensitive to economic shocks and less able to access capital markets to fund required projects. Lower-income countries forced to fully fund climate change adaptation projects through internal sources would face additional stress on their national budgets and efforts to achieve various stability and development objectives. Moreover, on the basis of historical fairness, we would suggest that the large adaptation spending requirements should not fall strictly or even largely to poor countries grappling with their changing climate.

Fast-track Financing, an interim conduit targeting Green Climate Fund objectives prior to the GCF's establishment, addresses both adaptation and mitigation objectives (Brown, et al 2011). US$2.9bn has been pledged by UNFCCC Parties for adaptation projects through Fast Track Financing.

Significant increases in commitments for adaptation investments are unlikely. European countries, the strongest supporters of UNFCCC binding mechanisms and climate financing vehicles, are currently weakened economically and will face fiscal difficulty in the next several years. They may be unable to offer increased climate funding and less apt to spend scarce resources on foreign projects given competing demands at home. The US is contending with similar political and economic constraints.

Traditional donor countries are not likely to find room in their budgets to match funding required for climate change adaptation projects. As a result, interventions to stimulate private investment by International Financial Institutions will be particularly critical to addressing requirements for climate resilient investment.

3. Addressing national barriers to climate adaptation investments: Climate Adaptation Securities and other options

By structuring securities to suit the appetite of cash-rich investors with long-term outlooks and enhancing them with support from the GCF and World Bank, lower-income countries highly exposed to climate risks may be able to raise capital for critical climate resilience projects.

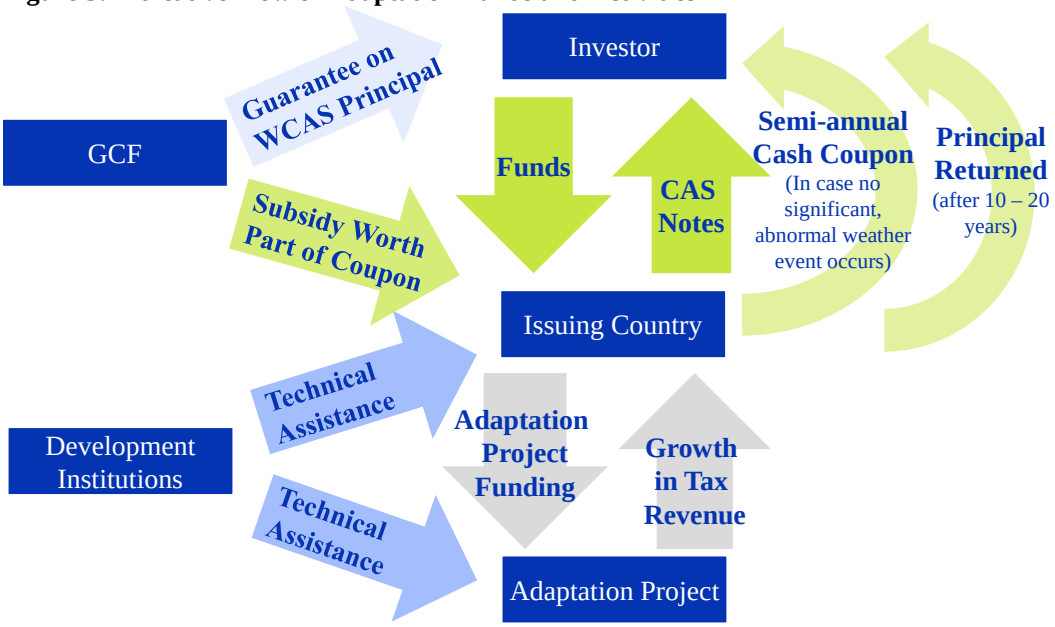
One such option we might call Climate Adaptation Securities (CAS). These CAS might have features similar to the following:

- Long maturity : 10 – 20 years
- Paying a cash coupon, semiannually (potentially indexed to the country's export earnings or GDP)
- Partially guaranteed by the GCF
- Coupon is forgone (partially or fully) in the event weather conditions (measured at an agreed site) differ remarkably from historical readings or projected trends

As noted in the figure below, the GCF would probably need to subsidize a portion of the CAS coupon payments in order to ensure securities are sufficiently attractive to the investor, while

limiting the strain on the issuer's budget. This implies an obligation on the part of the GCF, which would need to be capitalized by developed countries. But through this structure, GCF deployments would be limited and distributed into future periods, then leveraged several times over with upfront funding from investors. The structure would magnify donor concessional funding and make these outflows more palatable to domestic constituents.

Figure 3: Indicative Flow of Adaptation Funds and Activities



The weather event coupon adjustment is included as part of the security for two primary reasons. For one, this feature helps the issuing country manage significant risks, which may grow over time as a result of climate change. Secondly, this option can increase the incentives for an issuing country administration to effectively target adaptation project funds. After an adverse weather event, a portion of the cash saved from the coupon would be needed for addressing event impacts. In the case adaptation investments had been previously made by the government, lowering required post-weather shock outlays, the government Treasury would keep residual funds to use as needed. If government officials know ex-ante that they can reduce the impact of these weather events through proper planning and adaptation funding, with they will be motivated to use CAS funding for these projects in order to enhance their post-event financial standing.

Returns to disaster risk mitigation programs are estimated to be very large for common measures in the US: 4 times initial investment, according a study by the Multihazard Mitigation Council (MMC)[4]. Given developing countries' relatively limited disaster response infrastructure, government risk reduction investment returns may be even larger. CAS-issuing countries able to limit the costs of unexpected weather will accrue correspondingly large payoffs.

The GCF, World Bank and/or other advisors could potentially help place the securities with large institutional investors. Ideally, they would target investors with objectives fitting the securities'

[4] Multihazard Mitigation Council, 2005 *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities*

benefits. One potentially suitable investor category includes Sovereign Wealth Funds. Managers at these groups have the following characteristics which make them likely to take interest in CAS: they have amassed enormous pools of investment capital - an estimated US$4 trillion at the end of 2011[5], maintain a long investment time horizon, have limited liquidity requirements, may possess wealth in assets which vary inversely with climate change intensity (fossil fuel exporters) and may attach strategic value in financing the development of issuing countries.

Other target groups may include Insurance Funds and Diaspora High Net Worth Individuals, who may have longer investment time horizons, see the value in the risk exposures provided by these securities, or have strategic interest in local development.

The CAS concept borrows from several other existing instruments currently used for financing investment and managing risk. These instruments can also be used on a "stand-alone" basis in viable strategies for raising adaptation-directed capital. They include:

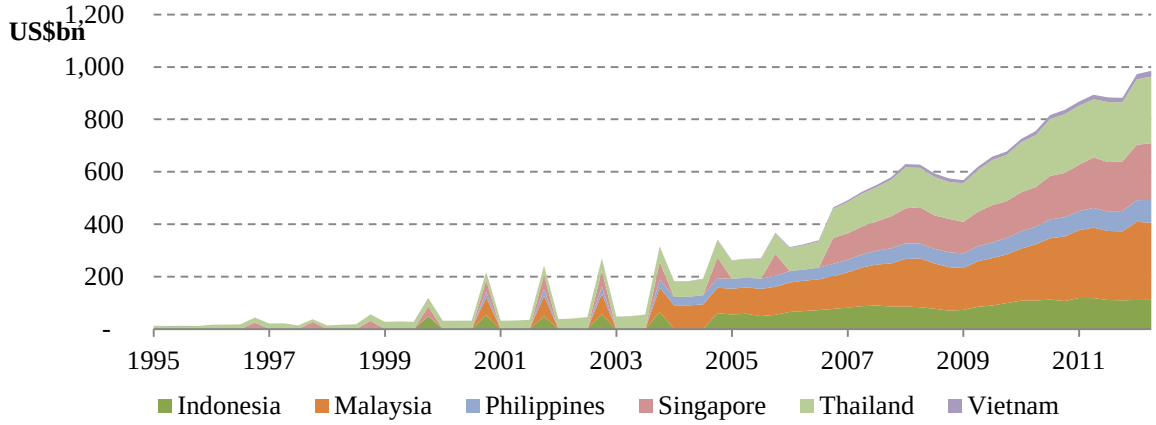
- Local currency bond issues
- Index-insurance schemes
- Catastrophe bonds

All of these approaches are feasible and used increasingly often. We highlight related global experience below.

Local currency bonds

Bond issues could play an important role in closing the gap between adaptation investment needs and capital supply. Cumulative local currency bond issues had grown to $9.2 trillion by March 2011, doubling in the previous five years[6]. While much of the growth can be attributed to China (which had issued over $3.5 trillion by 2011), many low-income countries have had recent success issuing local-currency debt, such as Ghana, Vietnam, and Peru.

Figure 4: Local currency bond value outstanding in Emerging Asia (excl. China)



Source: Asian Development Bank

[5] Prequin, 2011 *Sovereign Wealth Fund Review*
[6] Dombret 2011, *Speech to the 3rd international workshop on developing local currency bond markets.* State Street Global Advisors 2011 *A Case For Emerging Markets Local Currency Debt*

Local currency issues can help provide long-term capital for low-income countries' infrastructure needs while reducing their exposure to exchange rate risk.

(Re) insurance products

While insurance products don't reduce vulnerability to weather risks, they can help shift financial vulnerability from lower-income countries to parties better able to bear risk. Many development institutions have recognized the value of insurance in several of its support programs, as noted below in Table 3. Linnerooth-Bayer, et al 2008 and Munich Re 2005 suggest that asset losses from natural disasters per unit of gross national income in low-income countries are about **3.5x larger in low-income countries** than in high-income countries (12.9% vs 3.7%), and that only 1% of low-income country losses are insured versus about 30% of high-income countries'.

Reinsurance also can help national governments to sponsor insurance products for individuals and businesses at a local level ill-equipped to bear the consequences of severe weather events. If structured correctly, insurance may help low-income actors to productively manage otherwise inefficient investment patterns, prevent persistent "poverty traps", as well as prevent intrinsically tragic losses.

Table 3: Example insurance products for developing countries

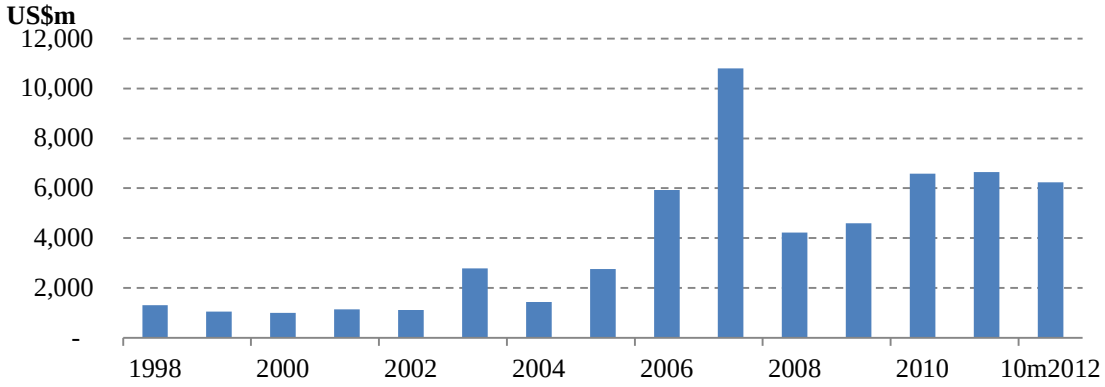
Insurance product	Description	Insurer	Insured
Caribbean Catastrophe Risk Insurance Facility (CCRIF)	Multi-country risk pool offering protection against the economic impacts of hurricanes, earthquakes, and excess rainfall with $100m maximum benefit; payouts triggered according to index measurements	Mutual insurance entity initially capitalized by participating countries; part of risk transferred to international reinsurers (Munich Re, Swiss Re, et al) and the World Bank	Participant countries covering the Caribbean, including Antigua & Barbuda, Belize, Cayman Islands, Haiti, Jamaica and Trinidad & Tobago
Turkish Catastrophe Insurance Pool	National risk pool protecting compensating building owners affected by earthquakes	Pool manager funded with compulsory payments from property owners in Turkey	Owners of officially registered property in Turkey
Malawi Weather Derivative Contracts	Put option on an index linked to maize production and rainfall, paying up to $4.4m if index falls more than 10% below historical average	Entities in financial markets wrote (sold) the put options, with the WB acting as intermediary. (UK DFID funded the upfront put purchase)	Malawian government, financing potential anti-drought measures
Horn of Africa Risk Transfer for Adaptation	Index-based weather insurance system for Ethiopian farmers, structured by Oxfam, WFP and other international organizations	Ethiopian government; reinsured by Swiss Re	Local farmers, with premiums "paid" through contributions to community infrastructure projects

Sources: World Bank, USAID, SwissRe

Catastrophe Bonds

Another risk transfer instrument that has become more widespread over the last two decades is the catastrophe bond. With catastrophe bonds, issuers pay interest to bond holders and return bond principal by the bond's maturity date.

Figure 5: Value of annual catastrophe bond issuance, globally



Sources: Artemis.bm

However, as with CAS, catastrophe bond obligations are revised if a specified event (like an earthquake, flood or hurricane) occurs. In many cases, after such an event all principal and interest payments to the bondholder are forgone.

Catastrophe bond issuance volume grew significantly from the mid-1990s through 2007. Volumes have been lower than in the years just preceding the global financial crisis, but still reached over US$6bn annually since 2010.

And while several high profile events over the last few years have triggered catastrophe clauses in some issues, annual returns on catastrophe bond indices exceeded world equity market indices by 5-6% and government bond indices by 2-3% and exhibiting much lower volatility and very low correlation with these common asset classes for the period 2004 - 2011.[7] While historical performance may not be a valid predictor of future outcomes, this brief snapshot suggests that similar securities have uncommon and potentially attractive characteristics for investors capable of supporting the risks and liquidity profiles they offer.

4. Addressing incentive barriers to adaptation investments: Adaptation Investment Market Mechanisms

Infrastructure and public health and public evacuation mechanisms are all important parts of managing climate risk, and are not likely to be provided by private entities.

To address shortfalls in adaptation investment public entities could help place market values on certain types of adaptation projects. In one approach, a national government would set requirements for private entities to offer Adaptation Unit (AU) "credits" if undertaking specific activities, such as fossil fuel extraction. Covered entities would be required to either tender

[7] Lap Five Investments, GAM, Bloomberg, Thomson Reuters 2011

sufficient adaptation credits to meet its obligation, or to pay a duty to a fund for adaptation investments. If these credits are tradable, an "**Adaptation Investment Market**" emerges.

The process for generating Adaptation Units would be similar to those which are currently used for valuing carbon emissions offsets units:

1. A government or independent entity could draft a proposed AU valuation methodology, or solicit methodologies from qualified parties;
2. The methodology would be subject to technical and public review; and
3. Undergo revision until it satisfies stakeholder standards for determining adaptation benefits.

In particular, these projects would focus on reductions in the country's vulnerability over a robust set of potential weather outcomes. As part of the approved methodology, the designating entity may choose its potential climate scenario according to distributions estimated by research groups such as the National Center for Atmospheric Research (NCAR) or weighted averages of various centers' projections. Several researchers have promoted similar metrics for adaptation market-mechanisms. Michaelowa 2011 and Schultz 2011 both outline schemes under which governments facilitate private investments through compliance obligations related to adaptation.

An adaptation credit market might not be appropriately used for sponsoring investment in every project type. For example, initiatives to address climate change impact on public health might be more appropriately funded directly by the government. On the other hand, private sector firms might better manage infrastructure projects such as developing coastal zone protections, irrigation enhancements, flood protection, agricultural improvements, freshwater access and water treatment improvements.

We note that it will be important to emphasize distinctions between related climate change adaptation and emissions mitigation markets. Similarly, we do not suggest that one can substitute for the other. To the contrary, by making adaptation costs more explicit in the market, society will be more likely to consider mitigation actions, which are likely to be cheaper than efforts to adapt to climate change.

Countries may find it wise to assign responsibilities for mitigation and adaptation to different commercial actors: mitigation requirements might be imposed on companies that emit carbon, while adaptation requirements might be imposed on those that produce fossil fuels.

Roundtable participants also noted that resource firms potentially covered under adaptation credit regimes are particularly concerned about being "double-taxed" through emissions mitigation regulations and potential resilience-focused regulations. To be politically feasible, we note that a credit market would need to consider pre-existing regulations when implemented.

Table 4: Indicative Adaptation Credit Market Summary

In Brief: A Sample Adaptation Credit Market

Objective

To stimulate private sector investment in high priority, high quality adaptation projects through a market-based policy that incentivizes performance and promotes business-to-business collaboration between firms in developed and developing countries.

Principles

- Encourage **corporate responsibility and fairness** with a "polluter pays" principle.
- Promote **cost effectiveness** by channeling financial and technical resources where most needed.
- **Prioritize projects investments in most vulnerable** countries, regions and localities
- Ensure **administrative efficiency** with clear rules, pre-listing of projects and effective monitoring, reporting and verification.

Operational elements

Who Obligation established for bidders on rights to develop new fossil fuel fields in a developed country, with exemptions for entities subject to greenhouse gas emissions limits on the fuels produced.

What Bidders compete to commit to deliver a quantity of adaptation credits, and successful bidders form market demand for high-quality adaptation projects

When Annual deliveries of adaptation credits to meet credit promises; could also allow multi-year compliance periods.

Where Adaptation projects could be hosted by developing countries that enter bilateral agreements with interested developed countries

How Policy established by law in a developed country which has a bilateral agreement with a host jurisdiction targeting a set of pre-approved adaptation projects in need of partner investors. Available projects would be pre-listed by type, with the assumed adaptation credits available for a given investment with the developing country partner or consortia; types could include –

New or expanded irrigation systems	Agricultural technology improvements	New / improved water treatment or sewage facilities	Coastal zone protections and port improvements	New or improved power infrastructure

How Much Credits would be measured, verified and issued according to an index that assesses a set of pre-determined factors, such as:

Likelihood of extreme climate-related impact	Size of protected area	Size of human population impacted	Importance of area for protection of threatened animal/plant species

Why Climate change mitigation is not sufficient to prevent major impacts to developing countries – so a cooperative structure is needed to encourage private sector cooperation in adaptation projects.

Notes on implementation

Any potential proponents of market-like adaptation investment mechanisms should also recognize key lessons from the implementation of carbon markets. As noted by project and methodology developers closely involved with Clean Development Mechanism, these include the following:

1. *Create structures that reward private firms for implementing projects with the greatest benefit for a given investment*

   The creation of the CDM spurred private developers to locate projects that could deliver emissions reductions cost-effectively. Incentivized by potential profits from CER sales, investors deployed $190bn to CDM projects which were documented to have mitigation benefits up to April 2012[8], even though actual direct carbon funding was no greater than $2bn p.a. for this period (Buchner 2011). During the process, private sector management skills and technology expertise were shared across borders while relatively small numbers of government employees were needed to oversee projects during implementation.

2. *Target early investment by pre-selecting project types to accelerate investment*

   The scaling of CDM was impaired by excessive delays in methodology assessments for project types which were widely recognized to yield elevated mitigation benefits. Many critics asserted that participating countries should have established a list of desired project types (a "positive list") that were eligible for crediting as a matter of policy, rather than requiring a case-by-case project determination.

3. *Incorporate third-party monitoring and verification mechanisms to ensure impact*

   The process of qualifying and designating third party experts to assess and verify performance has reduced government overhead requirements while helping ensure that projects credibly demonstrated mitigation impacts. A competitive certification service market accelerated projects' development and implementation and helped to ensure that regulatory bottlenecks were kept to a minimum.

4. *Accompany new market mechanisms with extensive education and capacity-building*

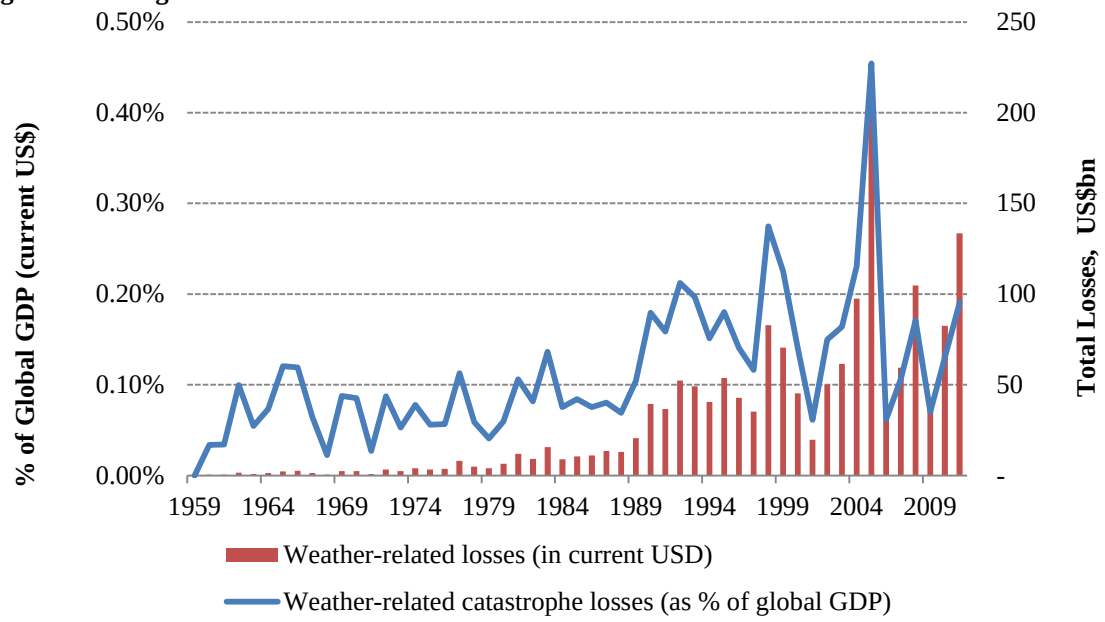
   In the CDM's early years, the project development process was poorly understood and rules were unclear for participants. Lack of clarity inhibited project participants and contributed to project delays and setbacks. From 2004 to 2009, average project registration time spanned 567 days per project. From 2010 on, average registration time fell to 215 days[9], as UN agencies introduced more CDM-related knowledge-sharing activities, developers produced better project design documents and the UN streamlined the registration process. Future efforts to sponsor climate projects through activity crediting mechanisms should seek to flatten the learning curve for potential market entrants and encourage greater initial participation.

[8] CDM Pipeline Jørgen Fenhann, UNEP Risø Centre, 1st April 2012
[9] *CDM Pipeline*

5. Addressing behavioral barriers to adaptation investments: supporting resilience-building private ventures

Private sector institutions in developing countries will play a critical role in financing climate change investment and providing cushion against potential weather shocks. According to The Climate Policy Institute, about 60% of funding for climate-related investments originates from the private sector (Buchner 2011). Concerns related to climate change impacts on business are expressed in a raft of recent publications from private consultancies, NGOs and trade associations.

Figure 6: Total global losses from weather-related disasters



Source: CRED EM-DAT International Disaster Database, World Bank World Development Indicators

Targeting climate change adaptation initiatives requires technical knowledge. Acquisition of this knowledge may be very costly, and managers may be averse to making these investments, particularly as resilience-linked products are likely to have few precedents. Temporary support from international institutions may help managers overcome aversions to exploring the adaptation product space.

Supporting growth of related service markets

In other contexts, public entities have been successful in spurring private investment with similar public benefits and behavioral obstacles. One useful example is the energy efficiency sector. Research has highlighted underinvestment in energy efficiency upgrades as a result of psychological biases, firm incentives and knowledge acquisition costs (Austin 2012). All of these factors also play roles in hampering private adaptation investment. We outline examples of efforts to overcome investment frictions in sectors with similar characteristics.

Under regulatory obligation, utilities across the US have sponsored programs creating markets for Energy Service Company (ESCO) and other efficiency-enhancing services. Through programs' effects on public awareness, service provider training and initial demand creation,

energy efficiency markets have moved sustainably beyond public programs to serve commercial clients (Satchwell et al 2010). Energy efficiency service markets have further been supported by mechanisms such as Property Assessed Clean Energy (PACE) financing in the United States, which provides owners loans for clean energy measures from bond issues, paid back through local property taxes.

Multilateral institutions have also been active in promoting Energy Efficiency upgrade financing. One example is the China Utility-Based Energy Efficiency Finance Program. Under it, the International Finance Corporation (IFC) advised Chinese banks on the roll-out of loans for energy efficiency projects and provided partial guarantees on their repayment. Within 3 years, related technical assistance to participating banks had ended, but participating banks continued to disburse energy efficiency products. Both the private and social returns generated through IFC's investment were judged to be significant by the World Bank's Independent Evaluation Group (IEG 2010).

Drawing on similar experience, multilateral organizations may seek to prime adaptation initiative markets through credit enhancement of innovative private financing products, technical assistance to adaptation service providers and awareness campaigns targeting service buyers.

Providing direct investments in critical industries

Multilateral organizations can also support the growth of resilience-enhancing industries through direct investments, grants and loans. Innovative new businesses providing financial services to the poor and historically unbanked may warrant this subsidized funding.

Through technology and retail infrastructure "micro" financial institutions are creating new ways to help low-income clients manage their risks. Micro-insurers have created options allowing poor people to avoid excessively expensive self-insurance practices, asset liquidations and informal risk-sharing arrangements. Likewise, through weather-insurance products small-time entrepreneurs and farmers are better positioned to make valuable long-term investments (Karlan et al 2012).

New private cashless payment systems in Africa have enabled low-income users to remain resilient to shocks which might have otherwise led to deprivation. Such technology holds promise for protecting individuals from shocks related to climate change. Recent studies have shown that households in Kenya with access to the M-Pesa "mobile money" product from 2008 to 2010 were not forced to reduce consumption after large income losses, while having access to transfers from other regions. Comparable households suffering similar hardships without M-Pesa suffered 7% reductions in consumption on average (Jack and Suri 2011).

Another potential product for addressing climate change may be possible using new techniques for monitoring weather and structuring contracts. One idea offered is a weather-indexed deposit account. Like indexed insurance, such products could be specified to alter contract terms in response to weather events like rainfall levels, monthly average temperatures or hurricane force wind. The product would offer clients the opportunity to deposit funds in a restricted account (limiting withdrawals within 1 or 2 years for example) at initially low interest rates. But with the occurrence of some agreed severe weather event, contract terms offer the depositor greater access to her funds at no penalty, much higher deposit yields for a specified period of time, or other benefits. Such a product would help protect depositors against catastrophic losses and may

also allow banks to mobilize capital for adaptation projects that prevent weather emergency withdrawals in the future. Also, while this product has many of the same risk-reduction features of weather insurance, its framing (as "owned" deposit versus premium payments to 3rd party with insurance) may make it more attractive for clients not familiar with formal insurance policies.

The development of resilience-enhancing products like micro-insurance or mobile payments platforms can be very risky and capital-intensive. International Financial Institutions are well placed to help entrepreneurs overcome these obstacles, particularly as social benefits to these enterprises' growth could be massive. By allocating capital to growing businesses offering risk management services, they can help protect the poor and vulnerable while promoting broader economic productivity.

6. Case Study: Ethiopia's Millennium Renaissance Dam – can we improve resilience impact in lower-income countries' investments?

To illustrate how some of the tools described above could be used to better support investments in climate change mitigation activities, we present the following mini-case study.

Ethiopia is a low income country. Its per capita Gross National Income is US$390 p.a. and only 26% of its rural population has access (as of 2008) to an improved water source, well below the Sub-Saharan average of 49%[10]. It is also highly vulnerable to risks from climate change.

According to the World Bank, Ethiopia's GDP is likely to be reduced by 2 -10% from baseline projections over the next 20 years as the country copes with its changing climate. Three sectors requiring the largest investments in order to reduce the country's vulnerability to this change are Agriculture, Road Infrastructure and Energy. All three areas can potentially be made more resilient through selective establishment of hydroelectric dams. Dams can help distribute water more efficiently and predictably for agriculture, they prevent damage to road networks in flood-prone areas and will continue to generate much needed power generation under a robust set of future climate scenarios. For related reasons, the World Bank recommends hydropower project expansion as a critical short-term investment priority for the Government of Ethiopia, to "increase near-term economic growth and make the energy system more climate resilient…provide more reliability and protection from regional droughts"[11]

The Government of Ethiopia is now in the process of constructing the largest hydropower plant in Africa. The ambitious project, called the Grand Ethiopian Renaissance Dam, is located in the Northwest of the country, on the Blue Nile, and will have a generating capacity of over 5 Gigawatts. Construction of the dam will cost the around US$4.8bn, or 16% of Ethiopia's 2010 GDP. This Ethiopian government is financing the project from its own resources and through the Commercial Bank of Ethiopia's issuance of "Millennium Bonds" to domestic banks, local businesses and members of the Ethiopian diaspora. Some sources claim Chinese banks are financing dam components[12], but Ethiopian officials do not confirm this.

[10] World Bank Data
[11] World Bank 2010 *Economics of Adaptation to Climate Change - Ethiopia*
[12] The Economist, April 20th, 2011 "A dam nuisance" http://www.economist.com/node/18587195

While the total environmental and social impacts of the dam are debatable (no environmental impact report was produced before construction began), for the reasons discussed above, this dam is likely to have a number of features through which it cushions the impact of climate change-induced extreme weather events on the local population.

How might the use of options outlined in the preceding paper sections have shaped the financing and execution of the project?

Table 5: Indicative scenario comparison

	Current scenario	**Hypothetical scenario with proposed options**
Project targeting	Seemingly selected on national energy and development priorities. (*will increase current national generative capacity by up over 150%*)	Potentially similar, though accompanied by environmental impact and climate resilience feasibility studies. Project tailored accordingly, with government sponsoring high adaptation-value features.
Project execution	Italian construction company with experience in Africa is building dam-contracted through no-bid process. Local company to provide electromechanical parts. No environmental impact study completed prior to construction.	Private financiers incorporate adaptation credit market returns into funding decisions, driving operating consideration of adaptation benefits. Selection process could likely open tender, with proposed adaptation benefits earning bidders government pricing improvement.
Private sector contributions	Local commercial banks compelled to fund project by Ethiopian central bank. Private companies with connections to Ethiopian diaspora also purchasing. Yields to be 5% in US$ terms on 10-year bond.	Some private sector banks, able to appropriate project benefits (e.g. realize lower credit risk in local agri-lending as result of project) or receive additional profits through adaptation-market activity, could increase their funding of dam bonds reducing the government's cost of capital
International fundraising	Government officially not receiving international funding (apart from diaspora bonds). World Bank reluctant to fund absent longer-term agreements with neighbors over water rights and electricity sales.	GCF enhancements could attract more international investors to finance project. Clarification of adaptation impact through adaptation crediting mechanisms may help attract more concessional multilateral funding.
Impact on government	Dam financing presents enormous burden for government- project cost around **2 -3x** annual national tax revenues.	Government could potentially ease its financing challenges with risk-reducing features of CAS or domestic currency bonds, borrowing at lower rates through GCF credit support

In summary, the project "*as is*" will likely generate benefits for some project stakeholders, mitigating risk from climate change and supporting a more resilient economy. However, it does so at great cost to the government, local commercial entities and Ethiopian citizens. It also may not be ideally executed to maximize long-term value under future climate scenarios. The options offered in this paper could help reduce the burdens facing countries trying to implement similar projects, and ensure these projects incorporate their potentially extensive benefits for climate change adaptation.

The Millennium Renaissance dam project demonstrates that climate-vulnerable countries are aggressively moving to reduce the long-term risks faced by their citizens. It also suggests that they are using creative financing strategies for attracting private sector and international funding to finance related initiatives. Building on this interest, we suggest that International Financial Institutions have an ideal opportunity to support similar efforts. Through the use of options like those presented in this paper, the international community may increase global wealth and welfare, particularly where people are most exposed to climate outcomes.

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