Advancing Risk-Informed Investments for Social and Environmental Protection and Management

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

PARTNERS FOR RESILIENCE

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Abbreviations

ADB	Asian Development Bank
AfDB	African Development Bank
AIIB	Asian Infrastructure Investment Bank
CEDRIG	Climate, Environment and Disaster Risk Reduction Integration Guidance
DRR	Disaster Risk Reduction
GWP	Global Water Partnership
IDB	Inter-American Development Bank
IDS	Institute of Development Studies
IIED	Institute for Environment and Development
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contributions
IWRM	Integrated Water Resources Management
MDGs	Millenium Development Goals
OECD	Organisation for Economic Co-operation and Development
ORCHID	Opportunities and Risks for Climate Change and Disasters
SDGs	Sustainable Development Goals
SES	Socio-ecological System
UN	United Nations
UNFCCC	U.N. Framework Convention on Climate Change
WB	World Bank
WBSCD	World Business Council for Sustainable Development

A Reflection from Partners for Resilience

Partners for Resilience is pleased to have the London School of Economics (LSE) conduct a research on mitigating risks from investments to protect and manage both social and environmental interests of societies. The Partners for Resiliece is comprised of the Netherlands Red Cross Society, Cordaid, CARE Netherlands, the Red Cross Red Crescent Climate Centre, and Wetlands International and some 50-plus local organisations worldwide.

Partners for Resilience is an initiative funded by the Netherlands Ministry of Foreign Affairs and focuses its work on strengthening community resilience. The subject of responsible investments is crucial in the resilience discourse as most governments strive to increase economic development for the benefit of their citizens. Development is a welcome trajectory as it increases job opportunities, reduces poverty and consolidates people's livelihoods. However, development that is conducted irresponsibly can also aggravate poverty and vulnerabilities (destruction of ecosystems, displacement of people, heighten social tensions, etc.)

Partners for Resilience promotes key principles for building community resilience including:-

- Putting communities at the centre by empowering them to reduce their risks and to strengthen their livelihoods;
- Promoting coherence and the continuum between development, humanitarian and environmental sectors.
- Connecting disciplines by using the combined strength of organizations working in partnership (interdisciplinary collaboration and inter/sectoral solutions)
- Expanding focus by encompassing wider ecosystems and the use of climate information across timescales;
- Integrating local/community and landscape risk perspectives into disaster risk planning, related policies, regulations and investments.
- Emphasizing/reinforcing the long-term (cost) benefits of IRM approach versus responding to crisis and maladaptation

Partners for Resilience echoes the assertion that responsible investments have incentives for all involved- the governments, the investors and the communities who often at the frontline of dealing with disasters when they strike. This research will support existing positive dialogues with governments, the private sector, multilateral banks, communities and academia to promote investments that benefit all interested parties. This research will certainly strengthen our learning as well.

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Executive Summary

This report was commissioned by Partners for Resilience as a consultancy project for students of MSc Development Management at the London School of economics and Political Science (LSE). It seeks to answer the question of how to make investments robust and informed to social and environmental risks. This topic is of vital importance because responsible investments are fundamental for a consistent and sustainable process of development, and ultimately contribute to building/strengthening resilience of people and their societies. Hence, to ensure robustness and responsiveness in investments, risk minimization is a must. The report answers this question with a focus on investments in water infrastructure. The focus was deemed appropriate due to its high relevance to social and environmental protection and management, and because it has been confrontating new dynamics and uncertainty due to trends like climate change, intensifying competition for water, and incommensurate levels of water governance capacities.

Three universal trends that increase the vulnerability of projects to risk are identified: increasing competition for water, climate change, and poor governance. Nonetheless, the report acknowledges that challenges to investment in water management infrastructure embody a complex, multidimensional, and interdependent set of issues. The identified trends are therefore highly interlinked.

To further emphasize the importance of context in the emergence of risk, the report then identifies how patterns of risk vary across four different geographical regions: Africa, Latin America and the Caribbean, South Asia, and Southeast Asia. Some examples of best practice in particular regions are presented. They emphasize how risk patterns vary depending on the regional context.

Having identified common patterns of risk, the report moves on to discuss how to manage these risks. A lesson that emerges from the complexity of risk is that mitigating investment risk must involve a holistic outlook that looks beyond the confines of the investment project itself. This requires coordination and communication, without which the ability of any system to manage and mitigate occurrences of risk is impaired.

Two approaches to risk and uncertainty are presented: Integrated Water Resources Management (IWRM) and Adaptive Water Management (AWM). IWRM takes an institutional perspective and highlights the importance of coordination for risk management. AWM zones in on the socio-cognitive issues involved in the project cycle itself, focusing on creating a common understanding between multiple actors, including local stakeholders. Both approaches are critical, in different capacities depending on the context, in order for investments in water infrastructural systems to be both robust to uncertainty and risk, and resilient in the long-run. Importantly, both are presented because they are complementary.

The report follows by discussing two existing risks management frameworks (DRR and climate proofing). The discussion draws on lessons inspired by IWRM and AWM to refine an understanding of how they can be used and how they operate within risk management frameworks. Six key lessons are presented:

1. a checklist alone is insufficient to adequately manage risk and uncertainty;
2. a holistic approach is necessary: risk management must involve multi-scale, multi-stakeholder, and multi-risk considerations;
3. community participation and collaboration that reflect social learning is vital;
4. livelihoods must be focused on, rather than simply the risks themselves;
5. in addition to acknowledging uncertainty in the project as a risk itself, strategic utilization of uncertainty in project preparation facilitates the robustness of project design;

6. trade-offs between different stakeholders and sectors are inevitable; therefore, some instruments to incentivize cooperation are desirable.

Cases of best practice in the management of social and environmental risks are presented. Since risk is context-specific, they are not meant to be translated into a blueprint. Nonetheless, they highlight important insights and ways in which the presented key lessons are accounted for when managing investment risk.

The report concludes by proposing recommendations to identified common limitations on managing investment risk. These recommendations emphasize that by refining the investment process itself, investment projects planners and operators can mitigate risks for the investors, the community, and the environment. The report advises the following:

- embrace a holistic and adaptive approach;
- apply social learning and iterative reflection (strengthening communication pathways and applying multi-looping learning);
- account for stakeholders and their vision for the future (applying backcasting in scenario building);
- accommodate risk management approaches in investment process according to results of uncertainty evaluation (impact-/vulnerability- driven or a mixture)
- integrate information-sharing platforms on and from various levels;
- create multi-criteria analyses, benefit-sharing mechanisms to enhance robustness of decisions; and compensation schemes to facilitate cooperation.

Introduction

The concept of ‘resilience’ has been widely taken up by the development community over the past years. It is being applied in both policy and practice (Brown, 2014). While the literature on resilience is vast and definitions of it innumerable, this report understands it in a broad sense as the capacity of socio-ecological systems to “adapt or transform in response to a broad spectrum of unfamiliar/unexpected shocks” (Carpenter et al., 2012:3249). In practice, this requires two things: identification of exposure and vulnerability to risk and subsequent adequate management of risk.

Responsible investments are necessarily resilient in order for them to be sustainable. Minimizing risk therefore refers to ensuring the investment is robust and responsive to uncertainty. Such an approach is in line with the growing emphasis in the development community on ‘no regrets’ planning and considerations of human vulnerability (Oates et al, 2014; Siegel and Jorgensen, 2011).

Of most interest to the development community are investments with the goal of maximizing sustainable development outcomes. Henceforth, it is this type of investment that ‘investment(s)’ shall refer to. Whilst investment occurs in all sectors, investments in infrastructure are arguably amongst the most fundamental and cross-sectoral. This report uses them as a lens through which to provide hints on how to make investments more robust and resilient to risks more generally. Two main reasons for focusing on infrastructure are identified.

First, the infrastructure sector is highly risky by nature. This is largely due to the long-term nature of many infrastructure projects. To a greater extent than many other types of development projects, infrastructure investments are particularly vulnerable to the (increasing) risks associated with climate change.

Second, infrastructure is a vital enabling factor for development. It helps societies meet their social needs and supports rapid economic growth. Infrastructure is a recurring and increasingly prominent theme in investments made by international organisations; it is hugely present in almost every sector. Moreover, global agreements such as Habitat III and the Paris Agreement emphatically underline the importance of developing infrastructure. For instance, Habitat III highlights the significance of the role of infrastructure in addressing the risks that arise from urbanization, climate change, and increasing population growth (Habitat 3 and UN Task Team, 2015).

Yet, in most developing countries there are enormous infrastructure deficits in both quantity and quality. Furthermore, the severity of supply-demand gaps has increased due to the intensification of development in the developing world. The AIIB, for example, has been established precisely for this reason.

The report will further zone in to focus on investments in water infrastructure for three major reasons. First, water is fundamental for life and development. To ensure human development, including human and ecosystem well-being, sufficient supply of good quality water is vital (WWAP, 2017). This links to the issue of *water security*: an emergent concept centering on the importance of equitability.

Water security has been increasingly incorporated into both global frameworks (as reflected in SDG Goal #6) (SDGs, 2015) and adopted by academics and practitioners as a foundational concept in sustainable development. The GWP, who first used the term, defines it as such: “water security, at any level from the household to the global, means that every person has access to enough safe water at affordable cost to lead a clean, healthy and productive life, while ensuring that the natural environment is protected and enhanced” (GWP 2000b:12). Bakker (2012) identifies four mechanisms through which water security interacts with human development:

1. threats to drinking water supply (due to pollution, diminishment and lack of access, etc.);
2. threats to human livelihoods and economic growth due to water-related hazards (e.g. floods, droughts);
3. threats to ecosystem services (e.g. loss of mangroves and wetlands);
4. increased variability and unpredictability of the water cycle owing to climate change.

These issues, embedded in and exacerbated by the dynamics and uncertainty brought about by climate change, are identified in our report as risks which the design of an investment project must seek to address.

Second, due to its fundamental importance to human development, water is a priority in the agenda and practice of both the private and public domain, at local, national and international levels. The international community continuously emphasizes water as a fundamental element. 85% of countries’ post-Paris INDCs mention water (AfDB, 2016). The UNFCCC details how water was seen as a key adaptation issue in the Paris Agreement (*ibid*). The Plan of Implementation of the World Summit on Sustainable Development (Johannesburg) underscores Integrated Water Resource Management (UN, 2002). Water is a key area of interest for the private sector as well. One of the priorities of WBCSD’s Action 2020 is water (WBSCD, n.d). In practice, national and international investment banks heavily invest in water. For example, the ADB, under the WFP, has planned to invest a total of over $20-25bn by 2020 (ADB, 2017).

Third, water is increasingly relevant for environmental and social protection and management under the new dynamics of climate change. It is predicted to be “the main challenge through which the impacts of climate change will be felt by people, ecosystems and economies” (Oates et al, 2014:iv).

This report is going to make a two-pronged argument. First, by strengthening the quality of the investment process itself, project planners and practitioners can facilitate a better enabling environment for water infrastructure investments. By ‘strengthening the quality of the investment process itself,’ this report refers to the betterment of the design and operation of the actual projects which reflect the best practices. This report focuses on strengthening the investment process by acknowledging and adapting to the uncertainty involved in the process instead of rigidly focusing on predetermined outcomes. Second, acknowledging a general inadequacy in communication and cooperation, both between different water-related sectors and amongst countries, this report argues for a holistic, integrated, and adaptive approach to investment that facilitates integration and cooperation beyond one single dimension itself (let it be a single sector, country, project, or risk).

In short, this report argues that investments can be made more responsive to social and environmental risks by refining the actual process of investment to reflect best practice in cooperation and adaptation. In the sections that follow, the report first identifies common sources of risks that affect water infrastructure investments, and briefly narrows in on how these commonalities vary across four different regions of importance to the international development community. Then, it sheds light on successful ways to manage and mitigate these risks by strengthening the investment process in the face of uncertainty and complexity. Concrete recommendations are offered at the end.

Risk patterns

Universal Trends

This section aims to identify the common dynamics that increase the vulnerability of investments to social and environmental risks.

Challenges to investment in water infrastructure embody a complex, multidimensional, and interdependent set of issues. Nevertheless, this report identifies 'Increasing Competition for Water,' 'Climate Change,' and 'Poor Governance' as universal trends in all four regions of interest. These trends pose challenges to water security and increase possibility of social and environmental risks in water infrastructure investments.

Understood through these universal trends, this subsection illustrates how population size and distribution, extreme weather events, and changing social and economic conditions result in social and economic uncertainties and risks in water infrastructure investments. Although presented separately, it is important to note that they are highly interlinked and can therefore exacerbate risks and impacts through each other. For example, rapid population growth increases both competition for water and the number of people exposed to projected impacts of climate change.

1. Increasing competition for water

Competition for water exists at all levels and is predicted to intensify due to population growth and urbanization. There is heightened competition for water not only within various sectors but also between upstream and downstream jurisdictions (Hassanzadeh, 2014). Competing user groups all try to influence water resource development and management processes, which may make the processes more political and less purely technical. Such challenges, in the context of increasing emphasis on multi-stakeholder participation and accountability in investment, make it increasingly difficult for a potential basket of common benefits and effective integration to occur (Engle et al., 2011:7).

a. Increasing Population

Population growth is a major contributor to water scarcity (Population Action International, 2012). It has led to a mounting demand for water in domestic, industrial, and municipal domains. With per capita water availability projected to fall by half by 2050, this situation might be dire in the coming years (WB, 2007). This may pose challenges in investments in various ways. First, it intensifies the complexity of stakeholder engagement and cooperation. Moreover, faster degradation of facilities might be caused by frequent utilization. Third, financial shortages may complicate maintenance.

b. Rapid Urbanization

While population growth leads directly to increase in overall water demand, demographic changes in population distribution and age structure resulting from rapid urbanization pose challenges to investors by modifying the patterns of demand. Urbanization has exacerbated the rural-urban gap of investment projects. This phenomenon reinforces disadvantages in access to and management of water. Also, rapid increases in the number and volume of investments can lead to land and water grabbing, causing displacement of indigenous communities. Constant changes in the investment environment heightens the level of uncertainty, making it more difficult for investments to be sustainable and resilient.

2. Climate Change

Climate change poses one of the greatest uncertainties to investments. Its impacts at the local level, particularly, are far from predictable (WWAP, 2012). Rising awareness and visibility of climate change-induced risks has led to an overall shrinkage in investment (McCarthy, 2001). Outdated data in the project preparation phase may lead to failed results.

a. Extreme-weather events

There is currently no evidence that climate change is directly responsible for increased losses created by water-related hazards (Bouwer, 2011). However it is expected to increase the frequency of certain natural hazards such as floods and droughts (IPCC, 2007). In the midst of such emergencies or natural disasters, competition for water increases since clean and potable water is needed for drinking and preventing the spread of disease. This can result in regional conflicts and displacements by complicating allocation of water resources. Also, extreme-weather events can severely damage or affect the infrastructure functioning. Examples of droughts complicating the functioning of hydroelectric dams can be found in many countries, including Brazil, Zambia, and Venezuela (Bardeen, 2016).

b. Rising sea levels

A rise in sea level of only 1.6 feet can put 150 million people globally and $35 trillion assets at risk in 20 of the world’s most vulnerable port communities (Azevedo de Almeida and Mostafavi, 2016). Rising sea levels are starting to affect continental coastal areas and river regimes, contributing to the deterioration in surface water quality, quantity, and availability. This is especially threatening in low-lying coastal areas and islands as it can accelerate degradation of infrastructure due to disruptive events and catastrophic salt contamination of water supplies.

C. Hydrometeorological variation

Climate change complicates trends in hydro-climatic variables such as temperature, rainfall, sunshine, humidity, and tidal water level. Such intensified hydrometeorological variation poses challenges to investments as it makes it difficult to keep data up-to-date, making the decision making process less robust. Unreliability of water sources can affect the long-term prospects of an investment.

3. Poor Governance

By poor governance, this report refers to weak or inadequate water management mechanisms including policies, laws, structural organization of the government, etc. Poor governance exacerbates the pressures on water security when coupled with increasing population, urbanization, and climate change. Developing regions are increasingly vulnerable to risks involved with investments with weak governance. This is especially due to the shift from single-purpose water resources development to multipurpose development objectives such as power generation and industrial purposes. Therefore, effective management and allocation of water resources is becoming increasingly important. The current water resources management practices in most of the developing world are not sustainable from both economic and environmental perspective (Gupta, 2001).

The following factors commonly observed in developing regions contribute to weaknesses in current management practices and make investments vulnerable to risks.

a. Poor or fragmented structures of organizations and over-centralization can lead to over-investment, uncoordinated management and disorganized communication among investors, government, and communities. This leads to incoherent, confusing decisions that can lead to detrimental effects such as overexploitation of groundwater, extreme competition, ineffective investment, and waste of invested funds.
b. Lack of clarity and transparency in government policy and budgeting leads to an imbalance of rights and opportunities for water stakeholders to take part in decision-making processes of the investment. Leaving out marginalized stakeholders in the process can result unexpected negative outcomes or even failure of the project.
c. Inadequate legal frameworks challenge investors through lack of protection for inventory, planning, use, quality, and protection of the infrastructure.
d. Insufficient data and information make it difficult to adopt control measures against undesirable implications and risks.
e. Lack of awareness of both the authority and community, has lead to a lack of support and cooperation when investments are being made.
f. Deficiencies in human resources development have contributed to inadequate expertise levels for achieving an efficient and effective management process.

Regional Risk Patterns

Having introduced common dynamics that affect incidences of social and environmental risk in water infrastructure investments, this subsection spells out various regional features which interplay differently with the common sources of risks and emphasizes the importance of context by highlighting the most significant features of each region.

Africa

Africa has high hydrological variability: rainfall patterns are various and unpredictable across the continent, both between and within years. Compounded with high seasonal variability, the chances of experiencing droughts and floods are much higher. Drought is the dominant climate hazard in sub-Saharan Africa. Floods are also destructive, as they may lead to casualties, infrastructure damage, disruption to the provision of goods and services, contamination of water supplies, and waterborne diseases (WWAP, 2012:8). All of these effects are further exacerbated by climate change.

Africa is characterized by a multiplicity of transboundary rivers. Among the more than 60 transboundary rivers, the Nile crosses 10 countries, the Niger 11, the Chad 8, and the Zambezi 9 (WWAP, 2012:122; Foster & Briceño-Garmendia,2010:272). This poses a challenge to the management of water infrastructure. Examples of impediments are divergent interests, political incoherence, and even armed conflicts (WB, 2016: 279; Foster & Briceño-Garmendia, 2010:v.iii). Challenges in transboundary river management result in higher chances of intercountry tensions and conflicts, and excessive competition over river ecosystem resources, exacerbated by rapid demographic growth in Africa. Since 1990s, sub-Saharan Africa has almost doubled (94%) in population (UNICEF and WHO, 2015).

Political situations are unstable and characterized by clientelism and patronage networks in Africa due to historical legacies of colonialist experiences, ethical division, and armed conflicts. Even economic reforms are instrumentalized by political leaders to expand their patronage networks and clout (Green, 2010). Such unstable and clientelist political systems might discourage investment in the region as well as heighten the risk of exclusiveness of resource allocation, which can be gender/age/ethnicity-blind.

Best practice case

The WB developed CIWA (Cooperation in International Waters in Africa) to assist riparian governments in Sub-Saharan Africa in using their transboundary water resources productively and equitably, protecting people and property from water-related shocks, and ensuring sustainability of the resource base (Tront et al.,2016:9). A Midterm Review is conducted to ensure flexibility and check compliance during the investment process (WB, 2015b).

The Niger Basin is an expansive region in West Africa. “Over 70% of the population lives in areas where food security depends on unreliable rainfall and highly variable inter-annual and intra-annual river flows” (WB, 2015a:1). Compounded with ongoing conflicts, it is the most vulnerable basin to climate change in the world. The Niger Basin Climate Resilience Investment Plan 2015 (Niger CRIP), inspired by CIWA, is a case of best practice reflecting how to make responsible water management investments in the African context.

Niger CRIP is aligned with existing policies of riparian countries. This ensures the feasibility of the plan does not contradict national projects, and considers the different interests of various countries. The two packages in the plan serve complementary purposes. The knowledge package aims to strengthen the capacity of institutions and update knowledge on climate. The sectoral investment package is designed to mobilize investments, including those in infrastructure, to solve different risks that appear in the basin (e.g. flooding, vulnerability to rising sea level, deterioration of water quality). It is a basin-level strategy that reflects multi-interest, multi-risk, and multi-mechanism considerations.

Latin America and the Caribbean (LAC)

LAC is rich in water, owning nearly 31% of the world's freshwater resources. However, due to its uneven distribution among and within countries, it is also home to large arid and semi-arid areas (UN, 2012). Existing patterns of production in the region are recognized to be unsustainable (UNEP, 2016); for example, agriculture is the main user of water, causing over 70% of withdrawals (AQUASTAT, 2016). These production patterns, with growing water usage, increase incidences of water pollution and waste of water, leading to water stress and foreseeable water scarcity.

The rapid pace of urbanization increases costs for investment and maintenance in infrastructure. In Mexico, rapid and unplanned urbanization will decrease the number of infrastructure investments and increase the cost of maintenance in certain parts, like Merida and Los Cabos, in contrast to "business as usual urbanization" (Kim and Zangerling, 2016; WB, 2017).

With regard to climate change, water supply in semi-arid zones and the Andes region can become more scarce due to retreat in glaciers, decreasing precipitation levels, and high evapotranspiration (ECLAC, 2017). Hydro-meteorological events cause frequent floods, droughts, or landslides in the region, impairing the functioning of water infrastructure.

Best practice case

Like many areas in LAC, Santo Domingo, the Dominican Republic, Port au Prince and Cap Haitien, Haiti, and Greater Georgetown, Guyana, suffer from hydro-meteorological hazards (Pelling, 2011). These include "flooding associated with storms and hurricanes and rainfall-triggered mass movements, e.g. landslides and rock falls", and "related processes such as risk of sea level rise" (Ibid:385).

Oxfam GB's work in these locations focused on tackling the risks derived from these hazards through a combination of urban governance and DRR. As explained by Pelling (2011), the most successful projects were built on strong pre-existing partnerships from local and municipal government, promoted longevity in physical and social infrastructure by including DRR in investments, and integrated local actors in project planning and coordination of disaster response. This participatory approach refined and strengthened the capability of project planners and operators to make better decisions. As such, it tackled issues of poor governance and DRR simultaneously.

South Asia

Acute climate change impacts in South Asia owe in large part to the region's overwhelming dependence on the Himalayan mountain belt for its supply of water; the annual monsoon, which contributes 70% of annual precipitation, is regulated by this behemoth landform, which also serves as the source of the myriad rivers and floodplains which support some 1.5 billion people. As such—as warming temperatures lead to higher glacial runoff, and as unpredictable changes in rainfall lead to disruptions in monsoon timing, floods (and, in particular, glacial lake outburst floods), will become more regular, more significant, and more disastrous. Flooding is also a major concern in coastal areas, where sea levels are steadily rising—and in parts of India and Pakistan especially, exposure to contaminated urban flood waters will intensify (Carabine et al., 2014). With mismanaged development and rapid urbanization, the number of those vulnerable to disaster in sub-optimal and hazardous urban areas is increasing.

Seasonal variations in the monsoon, when brought together with the effects of global warming and climate change, have led to a increasing number of intense floods in the region including the 2008 Kosi floods in Nepal, the 2010 Indus floods in Pakistan, and the 2011 Uttarakhand floods in India (The Asia Foundation, 2014). Extremely high sediment loads make the various transboundary rivers very difficult to manage, especially during floods, and create major challenges for hydropower due to both reservoir sedimentation and turbine damage. Changes in temperature, precipitation, and Himalayan glacier dynamics are likely to affect river flow regimes, impacting water, food, and energy security in the region. In addition, they pose challenges to water infrastructure maintenance (South Asia Water Initiative, 2017).

South Asia is home to around a quarter of the global population, but has less than 5% of the world's annual renewable water resources. Low per capita water availability, coupled with a very high relative level of water use (dominated by irrigation), makes South Asia one of the most water scarce regions of the world, with grave effects for economic development and challenges to expand water management and services.

Southeast Asia

The water crisis of the Southeast Asian region is more of a crisis of governance (ADB, 2007). Much of the water is being evaporated and lost during the process of delivery. Also, as result of poor governance many urban rivers in the region are highly polluted by domestic, industrial, and agricultural waste. In addition to the contamination of waterbodies through toxic industrial chemicals, lack of household sewerage systems has also contributed to the low quality of water in many parts of Southeast Asia. The weak management makes it difficult to coordinate stakeholders, data for a successful investment.

Aside from the Pacific Islands, Southeast Asia ranks as the world's most vulnerable region to natural disasters (ESCAP, 2015) as much economic growth is generated in coastal and flood-prone areas which are highly vulnerable to disasters such as typhoons and rainstorms. Also coastal and near-inland water sources are increasingly contaminated by seawater. Aside from the contamination problem, uneven distribution of water supply across time is another challenge. Heavy seasonal rain and frequent cyclones have led to massive flooding across Southeast Asia and pushed over 8 million people to urgent need for clean and potable water expecting to intensify competition for water (UNICEF, 2011).

Urbanization and population growth is another important phenomenon of the reason as more than half of the Asian population—close to 3 billion—will be living in towns and cities, particularly in secondary cities by 2050 (ADB, 2015). However, there exists imbalance in allocation of water with immense gap to access of clean water and sanitation between rural-urban areas and among countries (ADB, 2010). While the number of people without sanitation in rural areas of the region is more than three times that of urban dwellers (UN Water, 2012), the investments promoting accessibility to sanitation services are disproportionately concentrated in urban areas.

Conceptual approaches to risk and uncertainty

There are inherent shortcomings and *specific* risks that investments in water infrastructure entail. Engineering-based “hard” infrastructure has traditionally been the dominant approach to managing water resources. Indeed, investing in water infrastructure can have positive implications for economic development and poverty reduction (UNEP, 2011). While it still has an important role to play in these pursuits, however, increasing recognition of its limitations has given rise to “softer” approaches to water governance that focus more on building operational capacity, reforming institutions, and incentivizing changes in behavior (WWAP, 2012).

Many of the difficulties of hard infrastructure in water management owe to the fact that long-term contingencies must be accounted for in the initial processes due to their fixed physical nature. On the one hand, water infrastructural systems must be heavily maintained over time to prevent degradation. Water facilities degradation may pose serious hazards and exacerbate disaster risk—e.g. toxic urban flood waters, crumbling infrastructure—especially to the socially excluded or marginalized. On the other hand, they must also be regularly updated to account for changes in urban or population make-up, or, significantly, changes in climate and the impacts arising therefrom.

With the future impacts of climate change remaining highly uncertain, infrastructure faces the unique challenge of needing to be flexible and adaptive to unpredictable change despite its fixed physical nature. Academics and practitioners have increasingly come to acknowledge the falsehood of the assumption of *stationarity* (that future conditions will reflect past conditions (Varady et al., 2016), which is common in conventional engineering-based approaches. Consequently, one of the major current challenges becomes, as described in the 2012 UN World Water Development Report, “determining the capacities of new infrastructural components for a water resource system whose future inputs or design flows can no longer be predicted or calculated from the historical record” (WWAP, 2012:140). In order to account for uncertainty and be more equipped to manage the eventuality of risk, an investment must look toward bolstering the investment process itself.

One of the things that this bolstering must involve is a holistic outlook that looks beyond the confines of the investment itself. *Any investment should be cognizant of other management approaches and seek to collaborate with and integrate them, where possible.* Infrastructure investments, particularly, should be working in harmony with other “green” infrastructure or non-engineering approaches (e.g. Ecosystem-based Adaptation), rather than compromising them or replacing them where it is less viable in a cost-benefit analysis. In other words, investments in water infrastructure must seek to be *complementary* in interactions with other management and adaptation approaches in order to spread the risk and avoid *maladaptation* (Lukasiewicz et al., 2016). In some circumstances, coordinating ecosystem-based approaches *in tandem* with hard infrastructure can help ensure water security by delivering a whole package of required ecosystem services, reducing overall system risks in the process (WWAP, 2012).

Furthermore, investments in infrastructure need to account for and include material specifications, dimension and capacity standards, maintenance planning, training and information systems, and operations and management of local land, water, infrastructure, or systems (ADB, 2012), all of which must necessarily entail coordination and collaboration with a wide spectrum of actors and institutions.

In the planning process, practitioners should be aiming to create multi-disciplinary and multi-agency partnerships and linkages. As Varady et al (2016) explain, "types of knowledge and practices that are isolated from other applications and disciplines actively shape institutions, particularly in the water-governance sector. This sort of 'stovepipe' approach inhibits interaction between engineers, scientists, policy-makers, and other members of agencies, organizations, and institutions, impedes communication between information-providers and decision-makers" (*ibid*:75). This lack of coordination and communication significantly impairs the ability of any system to manage and mitigate occurrences of risk.

Two approaches emerge with different ways of addressing this common problem. One is **Integrated Water Resources Management (IWRM)**, involving the coordination of "policies, operations, maintenance and design standards of numerous agencies and departments responsible for one or more aspects of water and related natural resources management" (Stakhiv and Pietrowsky, 2009:4-5). The other, **Adaptive Water Management (AWM)**, includes concepts such as *social learning* which aims to engender platforms of common *understanding* between multiple actors—including, importantly, scientists, engineers, project designers, and local stakeholders of various groupings.

Whereas IWRM takes a somewhat more macro, institutional perspective, AWM zones in closer on the socio-cognitive issues involved in the project cycle itself. Both are critical, in different capacities depending on the context, in order for investments in water infrastructural systems to be both robust to uncertainty and risk, and resilient in the long-run.

IWRM

IWRM is *"a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."* (GWP, 2000a:22).

Water management should take a holistic approach. Coordination between various actors, policies, institutions, and frameworks is critical (WWAP, 2012). IWRM provides a common language in water management which enables decision-makers to set clear targets and smoothens monitoring processes across borders (Hassing et al, 2009). This awareness of coordination, generated through information flow among different actors, is essential for high quality management and investments (UNEP, 2016).

Furthermore, with its interdisciplinary approach, IWRM is recognized as a possible palliative to issues of miscoordination in water resource management (UNEP, 2012). It acknowledges that all forms of water usage are intertwined, meaning different production and consumption cycles taking place affect water resources and can have disruptive effects on them. This highlights the importance of co-management of various sectors.

Acknowledging the importance of water infrastructure to different sectors like agriculture and energy, IWRM prioritizes a joint approach for infrastructure and institutional investments which has been widely applied by many investments in water management nowadays. The particular equilibrium to be struck between these investments depends heavily on context, and can only be achieved through iterative adaptive processes of evaluation, feedback, and learning over time.

An integrated long-term approach enables planning investments in water infrastructure to coordinate with investments in other sectors to produce wider social and economic advantages. Any investment—infrastructural or otherwise—must be integrative and holistic in this way.

Limitations of IWRM

While IWRM was conceived primarily as a corrective to the technical, top-down, "stovepipe" tendencies of conventional water management, a wide corpus of literature has subsequently emerged to address its own shortcomings. As Varady et al (2016) outline, IWRM by itself falls short of taking into consideration issues of uncertainty in decision-making and having a clear objective or goal. Furthermore, since water resources consumption involves various sectors and institutions with different interests and priorities, the degree of integration that can be obtained among them is questionable (Hassing et al, 2009). Others also argue that IWRM does not have adequate instruments for realization and operation, and therefore has not been able to achieve striking results (Rahaman & Varis, 2005; Biswas, 2008; Medema et al 2008; Lubell & Edelenbos, 2013; Giordano & Shah, 2014). Therefore, preparing IWRM plans and putting them into action effectively are highly challenging, and should be open to experimentation (WWAP, 2012).

Adaptive management

The concepts of *adaptive management* and *water security* consequently materialized to deal with some of the aforementioned shortcomings of IWRM (Varady et al 2016). One can find traces of these ideas in the development of the SDG framework, which, by contrast to the preceding MDGs, began to integrate some principles underlying adaptive management frameworks (e.g. continuous and cyclical evaluation of and reflection on outcomes, greater stakeholder participation) and the principle of equity underlying the concept of water security. This idea has been reflected in SDG Goal #6 in the 2030 Agenda: "to ensure availability and sustainable management of water and sanitation for all" (UN, 2015b).

In detailing a case study of long-term adaptive water resource management in the Southern Indian state of Tamil Nadu, Lannerstad and Molden (2009) identify three basic kinds of uncertainty: lack of knowledge related to availability and variability of data; uncertainty in our understanding of water systems; and uncertainty related to potential shocks (including those arising from climate variability). Similarly, Fisher et al (2016) list four main challenges arising from increasing climate uncertainty: "the uncertain nature of evidence, the multi-sectoral nature of climate effects, long cause and effect timeframes, and differential impacts on marginalized groups."

An increasing recognition of uncertainty as endemic to our modes of knowledge, understandings, and evidence has led to calls for a "post-normal" science. Such approaches turn away from the conventional paradigm that conceives of scientific problem-solving as a straightforward transfer of knowledge into decision-making (Ravetz, 1999), along with its associated technical and engineering-based models of project design built upon an assumption of stationarity. As such, academics and practitioners are increasingly turning toward *process-based* approaches as a way to take action in the face of acknowledged and inherent uncertainty. These approaches, including elements of adaptive management and its variants, aim to incorporate the inevitability of limitations and complexities in minimizing uncertainty into the project cycle by making it more malleable, thus making it more capable of addressing risk (which is, itself, bound up in uncertainty).

Adaptive management can thus be understood as "a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organized process of learning-by-doing" (Olson et al., 2004:75), and a process involving continuous feedback and iterative reflection including a multi-directional transfer of knowledge (Fisher et al., 2016). The concept of *social learning*, which the International Institute for Environment and Development (IIED) defines as being constituted by the key elements of knowledge sharing, joint learning, and co-creation of evidence among stakeholders around common issues (*ibid*), is the key idea embedded in the adaptive approach.

Central to this idea is the aforementioned notion of *iterative reflection*, conceptualized as continuous or cyclical collective learning to co-create or reflect on knowledge (Van Epp and Garside, 2014)—constantly testing hypotheses and evaluating outcomes in the project cycle (Varady et al., 2016). This is seen as remedial to a more "positivist" approach to decision-making which assumes stationarity and that decision-making is rational (i.e. that better information leads directly to better outcomes) (Bond et al., 2015), and which thus fails to account for inherent uncertainty, which can be commonly found in technical, engineering-based projects. In terms of the literature on resilience, this conventional, positivistic approach correlates with conceptualizations of resilience as a return or change to some scientifically-prescribed stable equilibrium state following a disturbance or shock to a SES. The problem with this understanding, as Davoudi et al (2012) intimate, is that it assumes such an equilibrium state as inherently worthwhile, without accounting for the circumstances (or processes) within which that knowledge was produced. This risks alienating certain actors or stakeholders who may hold different perspectives on, values for, or understandings of the SES from the process of decision-making in the investment process. Furthermore, this is especially true if they are marginalized social groups whose needs should, on the contrary, be amplified rather than washed out in a context of higher vulnerability to the hazards posed by climate change and disaster risk.

To be truly adaptive, an investment project needs to incorporate and account for the different timescales and needs of various stakeholder groups (Fisher et al., 2016) through processes which help enable joint understandings of norms, values, and assumptions. In spite of inevitable conflicts and discrepancies, this can facilitate collaborative decision-making to lead to consensus around action in the face of uncertainty. The emphasis should be on the fact that "decisions are provisional, there is often no 'right' or 'wrong' management decision, and that modifications are expected", acknowledging the limits of knowledge (National

Research Council, 2004: 20). In this sense, *flexible planning* in infrastructure investment—in terms of the project structure, the financing, and the engineering itself—serves as a cornerstone to risk-mitigation in the investment process by accounting for uncertainty and by strengthening the process of monitoring and evaluation (M&E) and its feedback into iterative processes of decision-making. With regard to climate risk and uncertainty, projects should be designed to be amenable to climate proofing at any stage, with the long-term in mind (ADB, 2012).

As a counterpoint to equilibrium-based conceptualizations of resilience, Davoudi et al. (2013) propose the notion of *evolutionary resilience*, which accounts for the fact that systems fluctuate and change over time in complex and uncertain ways, with or without any external disturbances (Bond et al., 2015). This suggests that what it means to be "resilient" is, by nature, situated and embedded within specific contexts of meaning-making, due to inherent uncertainty. It is with this in mind that this report understands one of the goals of social learning—and adaptive management more generally—as being to achieve "common understandings of challenges among individuals or institutions" (Wilder et al., 2010:919). In this sense, research objectives in projects that seek to be adaptive should be primarily *problem-driven* (as opposed to knowledge-driven), and should aim to define problems from the bottom up, incorporating the *users* of that research and those whom it affects into the process of knowledge-generation, thus making it "user-responsive" (Varady et al., 2016).

While IWRM is more specifically designed to coordinate management of water-related resources and investments, adaptive management can be widely applied to other sectors. However, both are helpful in giving direction to the question of how to bolster the water infrastructure investment process, especially the project planning.

In the next section, two existing risks management frameworks (DRR and climate proofing) are introduced, drawing on lessons inspired by IWRM and AWM to refine the understanding and operation of the two.

Climate proofing and DRR

Introduction and Definitions

Disaster risk reduction (DRR) is a concept and practice that aims to reduce disaster risks by analysing, and consequently reducing, causal factors of disasters (UNISDR, nd). It focuses on prevention. Indeed, its significance to sustainable development is highlighted by the Sendai Framework for DRR (UNISDR, 2015).

C*limate proofing* is a process that aims to identify climate risks and reduce them to an acceptable level at different stages of an infrastructure investment. By *climate risks*, this report refers to harmful consequences or loss resulting from the interaction of climate hazards with the vulnerability of an investment project to climate change (ADB, 2016:3&27; IISD, 2012:6). Vulnerability includes the level of exposure, sensitivity, and adaptive capacity, where adaptive capacity is defined as "the ability of a system to adjust to [climate variability and extremes], to moderate potential damages, to take advantage of opportunities, or to cope with the consequences” (Herron et al., 2016).

Considering climate proofing and DRR together

Notably, it is crucial to integrate DRR and climate proofing into the water investment process owing to widespread contexts of rapid urbanization and climate change as well as the nature of water. In 2009, nine out of ten disasters were related to weather or climate (WMO, 2009). Furthermore, rapid urbanization and climate change are expected to cause an increase in hazard frequency and severity (Ibid). Climate change exacerbates the frequency, intensity, and severity of hazards—both water-related and otherwise—and will continue to do so in the future (WMO, 2009; UN, 2014). Additionally, the nature of water and water resources—free flowing and highly linked to hydrometeorological changes—inevitably ties global warming to the whole global water cycle (UN, 2014). Climate proofing and DRR must therefore be considered jointly.

Water infrastructure (including that of abstraction, treatment, distribution, and wastewater treatment), as well the availability and quality of water resources, are susceptible to dynamics brought about by the new context (ADB, 2016:vi). Aside from threatening the services provided by and the sustainability of water infrastructure, the lack of or poor DRR and climate proofing processes is highly likely to fail to reduce risks to the community and to the environment more generally, leading to major disruptions to economic growth, poverty reduction, and development (Tanner et al, 2007:4).

DRR and Climate Proofing in Practice

The procedures of climate-proofing and DRR tools are similar (see Table 1 for examples of both types of tools). The following four key procedures can be identified.

1. Undergo an initial screening to identify climate hazards and their potential impacts
2. Conduct a vulnerability assessment
3. Identify and implement appropriate measures to mitigate risks
4. Monitoring and evaluation

In DRR, steps one and two are generally referred to as ‘climate and disaster risk screening tools.’ For step three, DRR has many strategies. The most important are the following: early warning systems, medium and long-term sectoral planning (WMO, 2009) (which may be integrative), and revision throughout the course of an investment (which may be adaptive). Climate proofing focuses on identification and assessment of climate risks (including hazards and the uncertainty) and of the vulnerability of projects (including level of exposure, sensitivity, and adaptive capacity).

Although common steps can be identified, tools vary. As can be seen from Table 1, the emphases and target users of each tool vary, as does the weight each tool puts on different steps. WB risk screening tool does not tackle procedures three or four. CARE Netherlands proposes participation with the community to identify and implement appropriate measures to mitigate risks, whereas the entire CRiSTAL approach targets communities (IISD, 2012). This list provides some examples of tools and frameworks developed by different institutions.

Table 1: DRR and Climate proofing frameworks

	Disaster Risk Reduction			Climate proofing mechanisms		
Tools	WB[1]	CARE Netherland	CEDRIG	ADB	IDS ORCHID	IISD CRiSTAL
Target Users	Project designers and planners	Project designers and planners in participation with communities	Development and humanitarian actors	Project preparation teams on water & sanitation	DFID programmes planners and operators (India)	Local and community level project planners and managers
Steps Identified						
Step1	Gather project information (including location and development objectives)	Disaster risk assessment	In-depth context analysis	Preliminary climate risk screening (checklist)	Strategic overview of programmes & climate change and disaster profile	Describe livelihoods context
Step2	Exposure to different hazards at different time frames (using traffic light approach)	Action planning to decide on approach to disaster risk	Identify hazards, potential consequences, and vulnerabilities	Climate risk assessment	Identify high-risk programmes & risks	Analyze climate risk
Step3	Current and future project risk (to components/sub-sectors and at outcome/service level)	Design to ensure the project does not increase risk in society	Select priority risks based on likelihood & significance	Vulnerability assessment	Compile adaptation options & do multi-criteria analysis	Revise existing project activities
Step4	Identify key drivers of risk	Implement activities that reduce disaster risk	Identify potential measures and select based on weighted multi-criteria analysis.	Implementation arrangements	Integrate high-priority adaptation options	Design new project activities
Step5	Use end product to inform further consultation and planning	Monitoring and evaluation	Assess potential negative impacts of the project and estimate significance	Monitoring and evaluation	Risk screening process in the future programming	Identify key elements for monitoring and evaluation framework
Step6			Adapt project			
Step7			Select most significant			

[1] Project-level climate and disaster risk screening tool

			impacts and identify potential measures			
Step8			Select appropriate measures based on weighted multi-criteria analysis and adapt project.			
Key features						
	Produces matrices and uses a traffic light approach to rate risk intensity. Looks at different hazards and both current and future risk.	Decisions on approaches to disaster risk and project design are based on a participatory approach.	Multi-stakeholder workshop with a risk perspective and an impact perspective. Aims to mitigate risks *to* project and risks created *by* the project.	Technical feasibility and economic assessments of the climate-proofing options may lead to different decisions (no action, incremental action and immediate actions). Uncertainty levels determine the design of climate-proofing styles.	Focuses on livelihoods of local communities.	Climate considerations are embedded in wider scales of all kinds of risks, not just climate risk.

Sources: WB, n.d.; Rottier et al, 2011.; CEDRIG, n.d.; ADB, 2016; Tanner et al., 2007; IISD, 2012

In addition, UNEP has developed the Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA). PROVIA is a newly-developed network of scientists and high level decision-makers providing directions and coherence at the international level for research on vulnerability, impacts, and adaptation (VIA). It is not a screening tool in the conventional sense, but rather a gathering of information and clouts to mainstream and smoothen the climate risk management and adaptation issue (UNEP, PROVIA brochure, n.d.). Climate-proofing tools and schemes like PROVIA complement each other: the former give instruction on the steps on what should be monitored, and the latter sets up knowledge and information sharing platforms for climate-proofing.

Key Lessons

1. A checklist approach alone is insufficient.

Often, concrete targets and indicators are used to evaluate risk management. This may be insufficient, for two reasons. First, depending on the type of checklist, fulfilling the checklist does not necessarily mean appropriate goals are achieved. Having a checklist may shift incentives from proper management to simply obtaining checks in all the boxes. For example, including locals in meetings, or other types of participatory approaches, may not have any significant effect if there is no reflection on what they've said in meetings and no revision of plans accordingly. Participation and inclusivity in a literal understanding are insufficient. Second, the increasing level of uncertainty in investments makes checklists alone less robust in risk mitigation, as unforeseen risks cannot be checked.

Therefore, in addition to straightforwardly measurable checklists as a preliminary step, more explicitly collaborative and adaptive mechanisms such iterative social learning and workshop-based decision-making should be utilized.

2. Holistic approach: multi-scale, multi-stakeholder, multi-risk.

In practice, climate-proofing and DRR should take a holistic approach: multi-scale (including various temporal and spatial scales), multi-stakeholder, and multi-risk.

Various scales must be considered within a multi-risk approach. This is for two reasons. First, water-related risks are interrelated. Exclusively focusing on one or a few risks might miss vital links between risks and thus fail to make adequate contributions to the investment planning process.

Second, risks are highly complex by nature, especially climate- and hazard- related risks. Sources of risk are often global or regional, despite the impacts being local. Time uncertainty poses a risk in itself: uncertainty plagues predictions of whether risks that are present today will persist in the future, and whether any new risks will emerge. This can shape investment incentives, and therefore calls for a multi-scale consideration when planning for investment. Examples of how to give consideration to risks of various types and to different time frames can be found in the WB screening tools and IDS' ORCHID.[2]

Multi-scale and multi-risk are insufficient, however; the Sendai Framework for DRR highlights that responsibility for DRR should be shared among stakeholders (UNISDR, 2015). Indeed, research in Latin American cities shows that most effective approaches in DRR include a multi-stakeholder management of risk systems that integrates development, community participation, and land use management (Hardoy et al., 2011).

The success of the following case studies illustrates the importance of a holistic approach to climate proofing and DRR.

[2] Refer back to table 1 for a short summary and description of each.

Case study: Flooding in Santa Fe, Argentina

The region of Santa Fe's 'Secretariat of Water of the Ministry of Water, Public Services and Environment' is working on flood risk reduction. Three aspects of their work are worth highlighting.

1) They provide infrastructure support yet acknowledge that this alone is insufficient for risk reduction (Ibid).
2) They promote the creation of river basin committees "formed by representatives of the local government and local rural producers" (*ibid*:410).
3) They have a water and drainage protection program, through which they try to have a more balanced water system. They revise the water cycle and act accordingly. For example, they create reservoirs: during rain they reduce peak flows, and during dry periods they use them to replenish the water table (*ibid*).

As a result of this programme, the negative consequences of heavy rain in the city of Santa Fe in 2009-2010 were significantly reduced (*ibid*).

The Associated Programme on Flood Management (APFM)

AFPM, though relatively new, is very promising. It addresses flood management issues within the holistic framework that IWRM proposes. It takes a multi-scale approach to maximise benefits from flood plains whilst minimising the negative impacts from flooding. Appropriately, it is also very sensitive to context, guided largely by local conditions and experiences (APFM, n.d.). It is also multi-risk and multi-stakeholder, as it adopts an integrated hazard management approach and ensures collaborative participation.

3. Community participation and collaboration

As can be inferred from the holistic approach section, communication between stakeholders, including locals in a community, is vital. Indeed, DRR experiences in Latin American urban areas—including Argentina's Santa Fe—show that "in order to be effective, DRR has to be driven locally and must include the involvement of communities at risk" (Hardoy et al., 2011:401). The Sendai Framework's commitment to making risk reduction gender- and age-sensitive and inclusive of all stakeholders, including persons with disabilities, reflects this understanding (UNISDR, 2015).

However, whilst the idea of a 'resilient community' is appealing, attention should be paid to such a conceptualisation. Devolution of responsibility to the community should not occur without support (Aldunce et al., 2015). Self-reliance does not simply imply taking on more responsibility as part of disaster readiness, but also having commensurate capacity to do so. For this reason, *capacity building and training* are critical elements of an investment process—in addition to providing resources and institutional assistance where possible.

May and Plummer (2011) propose a paradigm they deem "Adaptive Collaborative Risk Management (ACRM)", which seeks to integrate conventional risk management approaches with adaptive management. In so doing, they argue for the benefit of seeking *collaboration*, as opposed to the more traditionally touted "consultation," which is often "narrowly defined and specifically precludes both sharing power and/or joint decision making" (May and Plummer, 2011:6). In contrast, a collaborative approach links actors into a process of exploring shared interest and pooling resources, including a pluralistic array of diverse and conflicting interests, and involving representation across scales. There is great scope here for social learning.

4. Joint knowledge production and social learning

A further question to be considered is who *produces* knowledge (during the processes of DRR and climate-proofing, and more generally, when making investment plans). Commonly, communities are portrayed as passive victims in need of information and education on climate adaptation and disaster preparedness. Such a conceptualisation results in efforts being concentrated in top-down information delivery (*ibid*). This means information is likely not to be nuanced to local context and knowledge.

How knowledge is understood should go beyond a perception that associates it solely with "expert knowledge and quantifiable information" (*ibid*). Otherwise, it can result in communities being disempowered because their knowledge is often considered non-expert and difficult to quantify. This can have negative implications. Vital sources of knowledge may be excluded. Furthermore, it can create tensions between different social actors (*ibid*). Finally, it can render risk management procedures ineffective. For example, early warning "requires *genuine ownership* of communities and other stakeholders" for effectiveness (IFRC, nd, emphasis added).

Social learning can be helpful in amending this angled bend toward positivistic views of knowledge, which lay the groundwork for assumptions that technical expert knowledge leads to better solutions. Iterative reflection invites a variety of local actors into the knowledge-formation process and engages them as agents rather than as passive victims or recipients. DRR and climate-proofing tools should further design their processes to reflect and enable social learning.

Understanding this can help improve current examples of good practice. For example, the Integrated Drought Management Programme (IDMP) takes a holistic (multi-stakeholder and multi-sector) approach to drought management. Additionally, it has a drought knowledge base and a mechanism for knowledge sharing (IDMP, 2014). Yet, IDMP focuses solely on 'scientific knowledge' (*ibid*). IDMP can be improved by bringing in social learning in the process of drought knowledge gathering and sharing.

Case study: Flooding in the city of Santa Fe, Argentina

Santa Fe suffers from flooding. In 2007, one third of the city flooded, causing casualties and intense infrastructure damage. Factors leading to flood risk in Santa Fe include climate-related issues (intense rainfall, deforestation, and changes in land use) and non-climate-related issues (including the city's pump and drainage systems not functioning as a result of lack of maintenance and vandalism). Importantly, the emergency system implemented by the city government did not work because "when the authorities transmitted evacuation information by radio during the night, no one heard it" (Hardoy et al., 2011:407).

Local NGO Canoas recognised that "there wasn't much understanding among local actors of the concepts of risk, risk reduction, vulnerability and their relation to development issues" (*ibid*:409). In response, Canoas supported "a neighbourhood process that generated awareness, training on risk reduction, the preparation of risk maps for the community, and the development of an emergency plan" (*ibid*:409). An evaluation after the floods of 2009-2010 found that the five neighbourhoods in which they worked, preparation and organisation was significantly better than in other areas of the city.

The investment in emergency system yields better results due to its awareness of multi-risk involved in the events, its later subscription to the practice of community participation and letting the local affected groups contribute to the process by bringing in their own experience and knowledge, which interplay with expert knowledge and generate new knowledge.

5. Focus on livelihoods

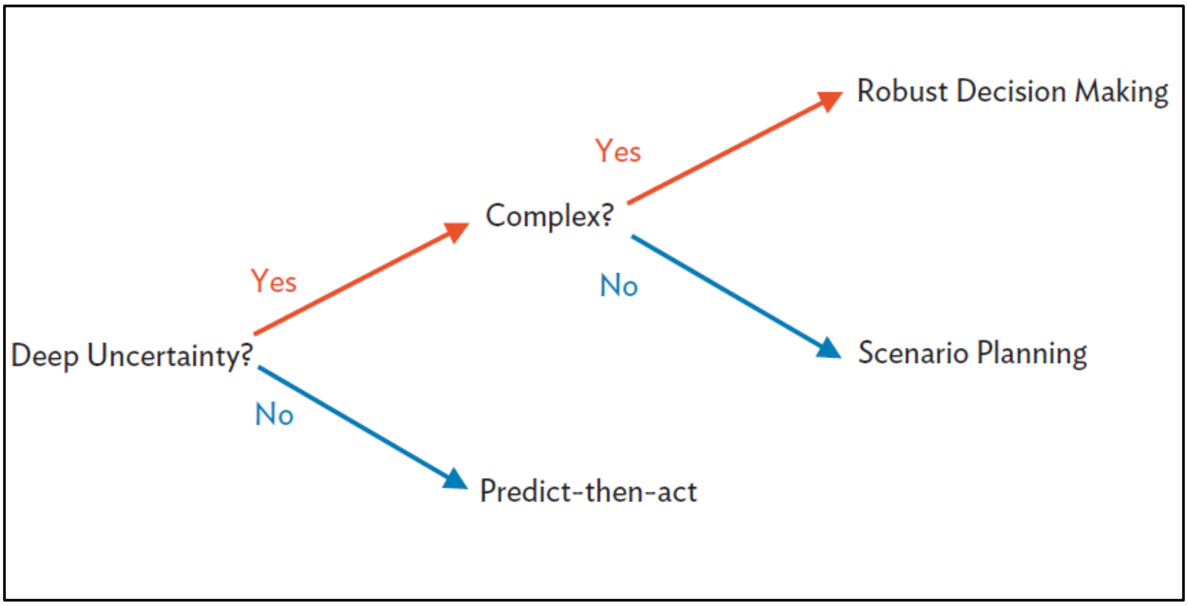
Climate proofing and DRR should focus on livelihoods, instead of purely on risks or constraints. This implies a focus on: 1) people's interests in the context of climate variability, in addition to treating climate risk as an environmental problem; 2) opportunities for, rather than just constraints to, development; and 3) actual access to and control over resources by local people, rather than just focusing on the mere presence or absence of such resources (IISD, 2012:10).

6. Strategic Ultilization of Uncertainty

As demonstrated throughout the report, the uncertainty brought about mostly by climate change but also by other factors, is in itself a risk for investments, especially for water infrastructure. DRR and climate proofing, as presented in the WB decision-tree framework and the ADB climate-proofing tool, can and should go beyond just acknowledging uncertainty as a risk. The assessment of the level of uncertainty can act as a determining factor for the design of climate-proofing in the investment process (ADB, 2016:45; Ray and Brown, 2015).

Evaluation of the degree of uncertainty and its level of complexity (concerning multiple hydroclimatic variables or not) hints at how to design and adjust project plans depending on what is known and unknown, in the context of limited fund and resources. It leads to two different styles of climate risk management: impact-driven and vulnerability-driven.

Figure 1: Factors Determining When Impact-Driven or Vulnerability-Driven Approach is Appropriate



Source: ADB, 2016:30

An **impact-driven approach** (blue arrows) may be sufficient if no deep uncertainty brought about by climate change in the project can be identified. It designs solutions to risks based on previous scientific and expert knowledge and modeling without detailed re-evaluation of local context. Such "predict-and-act" choices are top-down, yet present an acceptable and cost-effective choice in the context of low level of uncertainty and limited resources.

On the other hand, a **vulnerability-driven approach** (red arrows) should be applied when there are too many unpredictable factors identified or unknown potential factors. Such an approach is bottom-up, as it considers the socio-economic context by evaluating the level of exposure, sensitivity, and adaptive capacity of the project and local people. Depending on the level of complexity, management strategies should decide whether to add on sophisticated analytical tools to the scenario planning or not, which can be costly and time-consuming. Sophisticated analytical tools facilitate the robustness of the decision-making by conducting detailed local context research ("Robust Decision Making"), rather than simply building scenarios according to previous and potentially outdated information ("Scenario Planning"). These two approaches should be seen as complementary, rather than mutually exclusive, and scenario planning should always be participatory.

7. There will be trade-offs

Despite best efforts, decisions made on risk reduction necessarily involve judgements and trade-offs, both across regions or sectors. This is particularly true in the context of uncertainty about future changes (Tanner et al., 2007:6).

As Namara and Giordano (2017:47) demonstrate, for example, there can be highly divergent economic gains and losses across riparian countries in a basin cooperative scheme. There are also inter-sectoral trade-offs, especially for the upstream countries, between energy generation, irrigation development, and restoration of natural flooding. Different decisions will have very different implications for risk reduction and management for upstream and downstream countries.

This is where an integrated (IWRM) approach to cross-sectoral dialogue could strengthen an investment project's long-term resilience to risk. However, as Engle et al. (2011:7) argue using an example of water governance reform in Brazil, the desire of IWRM to be cross-sectoral and non-hierarchical may, depending on context, conflict with a need for a project to be flexible and experimental: "systems that exhibit stronger remnants of centralization, e.g. technical bodies, sectoral dominance, etc., seem to be more equipped to make rapid and conjectural decisions in response to surprises than those that have successfully transformed into deliberative, participatory, and pluralistic forums". This implies potential additional trade-offs, for example, between technocratic flexibility and pluralistic accountability, or efficiency and deliberation.

The common inevitability of such trade-offs implies that not all kinds of risk are prioritized by some governments and institutions, or can necessarily be mitigated. The ultimate aim of climate-proofing is not purely to put climate issues at the top of the agenda, but to place climate considerations within a holistic picture of all potential risks threatening the community and environment. Moreover, it urges some form of instruments that enable operation (and which IWRM falls short in developing), such as compensation or benefit-sharing mechanisms to incentivize cooperation. These instruments can help address the risks of social exclusion and inequitable distribution of benefits—which, in a holistic picture, can have an alleviating effect on the whole system of risk.

Conclusion and Recommendations

This report has argued that by refining the investment process itself, investment project planners and operators can mitigate some risks for the investors, the community, and the environment. It has emphasized that project designers and operators should subscribe to holistic and adaptive approaches to risk management, which acknowledge and strategically utilize the uncertainty embedded in water infrastructure projects. Inherent to this notion of holism is that such an approach cannot be limited to the water or infrastructure sectors, but must find itself embedded in investment practice across the board.

By holistic, this report refers to multi-risk, multi-scale, and multi-stakeholder considerations for project planning and operation. By adaptive, it suggests a move away from "assumed stationarity of historical trends" (Ray and Brown, 2015:1) and an embrace of iterative reflection and social learning, which can be combined with historical data and models, in order to facilitate robustness in confrontating risks.

To take this one step further, by learning from the limitations of existing frameworks of risk management and outstanding sources of risks in practice, this report provides recommendations that may help in the further refinement of investment processes and the mitigation of the risks involved (see Table 2 below).

Table 2: Limitations and strategies to tackle

Limitations	Recommendations
Assumption of stationarity and expert knowledge dominates decision-making in risk-proofing and management processes	Apply social learning & iterative reflection; Strengthen communication pathways, paying attention to the "spaces in and between organizations" (Pelling et al., 2008) as important pathways for social learning, including an emphasis on bridging and boundary organizations (May and Plummer, 2011) Incorporate multi-looping learning into the monitoring and evaluation process ● CCSL Monitoring & Evaluation Framework for Social Learning (Van Epp and Garside, 2014)
Insufficient stakeholder participation and collaboration under the face of high uncertainty	Apply stakeholder identification in the initial scoping process, including stakeholder mapping and power analyses (Fisher et al., 2016) Apply scenario-building to account for stakeholders' vision for the future, as well as internal and external influences and possible contingencies (Bond et al., 2015). This includes backcasting as an alternative to forecasting. *Backcasting* starts with an articulation of desired (or undesired) visions of the future by the stakeholders, then tries to identify possible actions that might lead to (or avoid) them***** (van't Klooster et al., 2011, in WWAP, 2012:245)

Insufficient understanding of uncertainty, especially that of climate change (beyond acknowledgement of it as a risk itself)	Design and adjust styles of risk management tools according to the level of uncertainty ● Impact-driven (predict-then-act) or ● Vulnerability-driven (robust decison-making and/or scenario planning) or ● Finding the right balance depending on context
Need for updated data and knowledge on climate change and changes in local hydrometeorological and water-related features**	Engage global information-sharing plaftforms on climate change ● UNEP-PROVIA (network of scientists and high-level decision-makers) Be aware of the sources of knowledge and data—they should come from both experts/ scientists and the local community ● IISD-CRiSTAL (its part on data collection guidance for local communities) ● Backcasting that invites local communities to incorporate their perspectives into the planning
Lack of instruments to enable operation of best practice ideas/approaches under the context of inevitable trade-offs	Include multi-criteria analyses and benefit-sharing mechanisms to enhance robustness of decision-making and motivate cooperation Include compensation schemes to facilitate beneficial cooperation

*for more explanations of backcasting v.s. forecasting refer to Figure 2 in Appendix.
**although this limitation is most relevant to water investment in particular, investments in some other sectors are also affected by climate change and disasters. Therefore, the recommendation can be widely useful.

This list is by no means exhaustive, but aims to provide a general picture of the sorts of practices that can make an investment project more integrative and adaptive, and therefore more flexible to circumstances of uncertainty, enabling greater resilience to risk. However, consideration of the pre-existing institutional environment, and what it can and cannot accommodate, is also important. While projects should aspire to be both integrative and adaptive, in practice planners and implementers should be open to experimentation and cognizant of the complexities involved.

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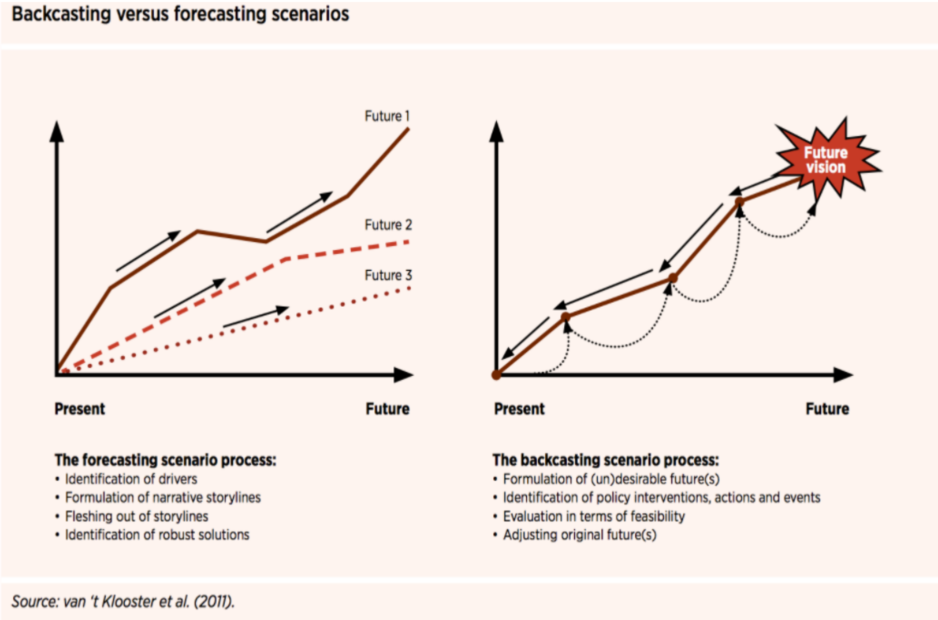
Appendix

Figure 2: Backcasting versus forecasting in scenario building



Backcasting: Instead of taking the present as the starting point, backcasting starts with the articulation of one or more desired (or even undesired) futures and then tries to identify possible actions that lead to them

Source: WWAP, 2012:245

Terms of Reference

1. Project Title
Mitigating investment risk for social and environmental protection and management.

2. Client
Partners for Resilience (PfR) is an alliance of five organisations working on climate change and ecosystem management. A member of the OCHA/UNEP-led Environment and Humanitarian Action (EHA), PfR Alliance members are Netherlands Red Cross, Red Cross Red Crescent Climate Centre, Cordaid, CARE Netherlands and Wetlands International.

3. Research question
How can investment risk be mitigated to entail social and environmental protection and management?

4. Purpose

- To identify patterns of risk across different geographical regions.
- To learn from the best practices of development investments on managing social and environmental risks.
- To propose policy recommendations on the management of universal and region-specific risks.

5. Methodology

Style of research: Qualitative (Literature Review)
Research design:

- Narrowing down the research question with justifications
    - Water management infrastructure

Outline:

1. Introduction
    a. Conceptual definitions
    b. Justifications for research design
2. Identification of risk patterns
    a. Universal
    b. Regional (Africa, Southeast Asia, South Asia, Latin America and the Caribbean)
3. Approaches to risk management
    a. Conceptual approaches to risk and uncertainty
    b. Implementing concepts into existing frameworks
4. Recommendations and conclusion

6. Timeline
Report is to be concluded by 24th April 2017.

Narrow down question	February Week 3
Final Outline	March Week 1
First Draft	April Week 1
Designed Report (physical copy if possible)	April Week 2
Final Report (10,000 words)	April Week 2

7. Case selection criteria

The focus of the research should be geographically spread out to cover Africa, South & Southeast Asia and Latin America and the Caribbean. The selection of project sector will be based on the interest to the development community and relevance to the question.

The case studies will be driven mainly from a positive spectrum, highlight key risk mitigating procedures, what is working at implementation level and where improvements are required. This is to minimize confrontational approach but also retain a focus on humanitarian interest to represent vulnerable people.