WORKING PAPER

Critical success factors for resilient water infrastructure

By Anthony P. Hurford, Francesca Moschini and George A.F. Woolhouse

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About this Working Paper

Accelerating the shift to climate compatible development is CDKN's business and improving the lives of the most climate-affected people is our mission. A multi-year, GBP 130 million programme funded by the British and Dutch governments and many others, CDKN works to support climate compatible development in Asia, Africa, Latin America and the Caribbean.

Our programme provides technical assistance to governments as well as research-into-action projects that fill gaps in our understanding of climate change impacts and solutions. A further, crucial part of CDKN's programme is knowledge management and policy engagement, an effort to which this Working Paper contributes. We synthesise information on the collective performance of governments, as well as non-state actors, in tackling climate change. We convene online discussions and in-person events to assess how climate actions are serving the most climate-affected people and how climate action could be more ambitious and effective. Find more CDKN thought leadership, including news of our latest events, on www.cdkn.org or follow us on twitter @cdknetwork

What is climate compatible development?

Climate compatible development is defined as "a 'development first' approach that minimises the harm caused by climate impacts while maximising the many human development opportunities presented by a low-emissions, more resilient, future".[1] In other words, development, climate adaptation and climate mitigation should go hand in hand, and one should not undermine the others.

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Guide to acronyms

AMCOW – African Ministers' Council on Water

CDKN – Climate and Development Knowledge Network

GWP – Global Water Partnership

GIZ – Gesellschaft fur Internationale Zusammenarbeit (German Corporation for International Cooperation)

IDDRSI – IGAD Drought Resilience and Sustainability Initiative

IGAD – Intergovernmental Authority for Development

IPCC – Intergovernmental Panel on Climate Change

WACDEP – Water, Climate and Development Programme

Executive summary

Water security underpins the achievement of development agendas across many sectors – including health, energy, agriculture, environment, mining, and other industries. Water infrastructure is vital for delivering water security. Water infrastructure is generally long-lived and with high upfront costs, making it vulnerable to future climate change uncertainties.

Ensuring that water infrastructure developments are resilient to climate variability and long term change is a key challenge to maintaining development progress and avoiding investment in infrastructure which underperforms, or fails due to climate risks. Resilience is more than engineering design and can be viewed from a number of perspectives, from strategic national or basin level planning, through the project identification process, down to the detail of the engineering design process.

Incorporating climate risk management into infrastructure planning and design is critical to building societal resilience and protecting economic growth. As pressures grow to build new infrastructure to cope with growing populations and to support expanding economic agendas, it is critical to ensure that policy makers and development practitioners are aware of and commit to improving the resilience of infrastructure investments in a cost-effective manner. This is a challenging task, owing not only to the uncertainties about the future but also to the complex economic-social-environmental systems in which infrastructure operates.

This working paper presents a set of five critical factors for increasing the climate resilience of water infrastructure. It is based on a review of six Climate and Development Knowledge Network (CDKN) funded projects. The review included interviews with project stakeholders supported by a desk review of project outputs. Its objective is to provide development practitioners with synthesised lessons from these projects to improve the resilience of future infrastructure projects and development programmes.

The five critical factors are as follows:

Simple and effective communication of climate risks and uncertainties	*Effective communication of climate risks and uncertainties to decision makers is important to successfully inform project planning and subsequently design. Climate risks should be placed within the wider context of non-climate risks and vulnerabilities to ensure a complete picture of risk is available in the planning process.*
Involving the right stakeholders at every stage	*Stakeholder analysis at the outset of any intervention is crucial to informing stakeholder engagement. Making a clear plan for which stakeholders should be engaged at different stages and which could be 'champions' for and leaders of change is important. The purpose and the methods to be used will promote ownership of the intervention.*
Capitalising on entry points	*Gain a thorough understanding of the entry points into decision making and planning processes to maximise the opportunity for effective change. In order for the timing of interventions to be effective in delivering climate resilience, decision points must be identified that provide the necessary lead time before interventions are required.*
Going beyond the project	*Adjusting infrastructure design to improve resilience is important, but infrastructure should also support resilience within its broader environmental, social and institutional context. This means selecting, designing and operating infrastructure to minimise negative impacts and maximise co-benefits with other sectors and stakeholders.*
Building institutional capacity for assessment, design and financing	*Long-term prospects for increasing the climate resilience of infrastructure rely on investment to improve the capacity of national government agencies and river basin organisations to support action. Capacity development must be tailored to the specific gaps and needs of the beneficiary organisation, identified by working closely and collaboratively with development partners.*

Water security and climate resilient infrastructure in context

Having access to secure and reliable water resources underpins the achievement of development agendas across many sectors – including health, energy, agriculture, environment, mining, and other industries. Promoting water security also reinforces actions that reflect the overarching objectives of the Sustainable Development Goals (SDGs), including in particular Goal 6, which focusses on water management and sanitation. The achievement of other Goals which focus on poverty reduction, food and energy security, economic development, gender equality and environmental stewardship are also likely to be supported.

Investment in water infrastructure can enhance the security and resilience of the systems and the communities they serve, but the infrastructure must itself be resilient to a changing climate. While water infrastructure is a broad term, for the purpose of this paper it is meant to refer to the man-made infrastructure that is designed to complement, manipulate or harness the natural infrastructure already in place (such as a river, lake or wetland) in order to manage water supply (including for energy generation), waste-water or storm-water. Resilience can also be viewed from a number of perspectives, from strategic national or basin level, through the project identification process, to the detail of the engineering design process. Traditional engineering can help increase the resilience of physical structures, but more attention needs to be paid to institutions, the integration of built infrastructure with broader social, environmental and economic systems and 'softer' solutions which can provide more flexibility under uncertain conditions.

Water infrastructure is generally long-lived and with high upfront costs. Infrastructure is likely to be impacted by climatic changes in the course of its long life, but uncertainties about the direction and magnitude of any change makes taking a predictive approach to design for climate change difficult (see Box 1). Measures which manage existing climate variability can provide immediate benefits as well as performing under a broader range of future conditions.

Incorporating climate risk management into infrastructure planning and design is critical to building societal resilience and protecting economic growth, and helps reduce the potential for 'stranded assets' which lose their expected value owing to a change in circumstances, such as a decline in river flows. As pressures grow to build new infrastructure to cope with growing populations and to support expanding economic agendas, it is critical to ensure that policy makers and development practitioners are aware of and commit to improving the resilience of infrastructure investments in a cost-effective manner. Prospects for this can be enhanced by knowledge of the critical factors for increasing climate resilience through decision-making, design and implementation processes. It is also vital that the existing and additional financial resources needed to achieve this can be leveraged.

Introduction

Since 2010, CDKN has been supporting policy makers and development practitioners to pragmatically incorporate climate resilience into water infrastructure planning, design and implementation processes. Through this work, valuable lessons have been learned which provide an opportunity to inform future programmes of assistance to improve their effectiveness in achieving climate resilience.

This paper summarises learning from six projects across Africa, South Asia, Latin America and the Caribbean. Experience from these projects is diverse and stretches from small-scale community water supplies to large-scale multi-purpose dams and from infrastructure planning and design to institutional strengthening and capacity development.

The project titles are given here and further details are provided in Appendix A:

- **Adaptation Plan of Cartagena de Indias and its islands (referred to as the Cartagena project):** Cartagena is one of Colombia's most climate vulnerable cities. The objective of this project was to develop an Action Plan for Cartagena to adapt to climate change, with the goal of strengthening competitiveness and sectoral development in the city and in the surrounding islands. It delivered on this objective, helped develop two financially viable adaptation projects and provided methodological guidelines for adaptation in coastal urban areas.

- **AMCOW Capacity Building**: Building capacity for climate resilient decision-making in water investments (referred to as the AMCOW project): The African Ministers' Council on Water (AMCOW) was formed in 2002 in Abuja Nigeria, primarily to promote cooperation, security, social and economic development and poverty eradication among member states through the effective management of the continent's water resources and provision of water supply services. This project developed and implemented a training course to build AMCOW's skills and knowledge for developing 'no or low regret' investment strategies in water-related development planning. This built on a previous Global Water Partnership (GWP) project which designed a strategic framework to help senior professionals and decision-makers identify and develop no or low regret investment strategies, integrate these into planning processes, and influence future development activities to become more resilient to climate change and variability.
- **Water Resilience and Climate Resilience in the Horn of Africa (referred to as the Horn of Africa project):** The Horn of Africa is one of the world's most food insecure regions. The Intergovernmental Authority for Development (IGAD) is a regional inter-governmental organisation that aims to expand areas of cooperation between its eight members (Djibouti, Kenya, Ethiopia, Eritrea, Somalia, South Sudan, Sudan and Uganda) and to promote peace and stability in the region in order to attain food security, sustainable environmental management and sustainable development. This project explored potential opportunities bydesigning a comprehensive, regional water security and climate resilience programme for IGAD. IGAD's Drought Resilience and Sustainability Initiative (IDDRSI) has under-performed in project implementation so the project analysed why this was the case and proposed both a climate resilient investment facility (ICRIF) and provision of capacity building to address constraints.
- **Building Climate Resilience in the Limpopo Basin, Mozambique (referred to as the Limpopo project):** The Lower Limpopo Basin has experienced water scarcity in recent years. This project aimed to help address this in the context of climate variability and change. A large component of the project involved technical assistance to integrate socio-economic, environmental and economic considerations in project preparation for a large new water infrastructure project and review of project documents. Lessons were learned for implementing similar projects across Africa.
- **Climate Proofing the Sandy Bay water service improvement project, St. Vincent (referred to as the Sandy Bay project):** The local water utility had already developed a proposed design for a new water supply system upgrade at Sandy Bay. This project examined how this design could be 'climate-proofed' and how funding could be secured for its implementation. Adaptation measures were identified and prioritised on the basis of extensive stakeholder consultation and analysis of climate change impacts. A funding application to USAID's Climate Change Adaption Program (CCAP) was prepared for submission by the relevant national authorities.
- **Adaptation to Climate Change in the Hydro-electricity Sector in Nepal (referred to as the Nepal project):** Hydro-electricity dominates supply to Nepal's electricity grid but is highly vulnerable to climate variability and change, as identified by a previous CDKN project: Economic Impact Assessment of Climate Change in Nepal. This project provided the Ministry of Energy, Government of Nepal with stronger and more targeted evidence on the current and future impacts of climate change on the hydro-electricity sector. The focus of the project was to identify what would be required to mainstream adaptation to the impacts of climate change by improving the evidence base and enabling environment for the hydro-electricity sector.

The CDKN projects reviewed focus on development assistance to government agencies who are responsible for developing, and in some cases owning and operating infrastructure assets. The review has identified examples of successful approaches to increasing resilience of infrastructure which can be applied across a range of scales and world regions. As such, the lessons from this review are of most value to development practitioners such as bilateral and multilateral development agencies working with national government agencies on infrastructure development projects. This paper will also be useful to government agencies engaged in infrastructure project development to inform good practice.

The following five factors have been identified as critically important based on this review:

- Simple and effective communication of climate risks and uncertainties,
- Involving the right stakeholders at every stage,
- Capitalising on entry points,

- Going beyond the project, and
- Building institutional capacity for assessment, design, financing and implementation

Simple and effective communication of climate risks and uncertainties

Key message – Effective communication of climate risks and uncertainties to decision makers is important to successfully inform project planning and, subsequently, design. Climate risks should be placed within the wider context of non-climate risks and vulnerabilities to ensure a complete picture of risk is available in the planning process.

Box 1. Long-lived infrastructure planning horizons and climate change

Long-lived infrastructure, for example dams and bridges, is inherently exposed to climate risks through its longevity, high initial capital cost, and the challenges and costs associated with retrofitting. Major infrastructure is often designed for a lifetime measured in many decades. The figure below shows global climate change projections for temperature for two emissions scenarios, showing the range of possible futures. Indicative infrastructure lifetimes (based on construction in the year 2000) are plotted on to the projections showing the range of climate futures which the infrastructure may be subjected to over its lifetime (Figure 1).

Long-lived infrastructure is generally designed to accommodate an estimated level of climate variability based on historical records. This may be highly uncertain in itself, depending on the length and quality of available data on variability. When future climate change over the design life of the infrastructure is considered, uncertainty is substantially increased as the historical record becomes less valid for future planning, and a reliance is placed on the use of uncertain climate model outputs. The implications of climate patterns which are different from those anticipated during infrastructure planning can mean increased maintenance costs, service interruptions, and reduced safety of operations.

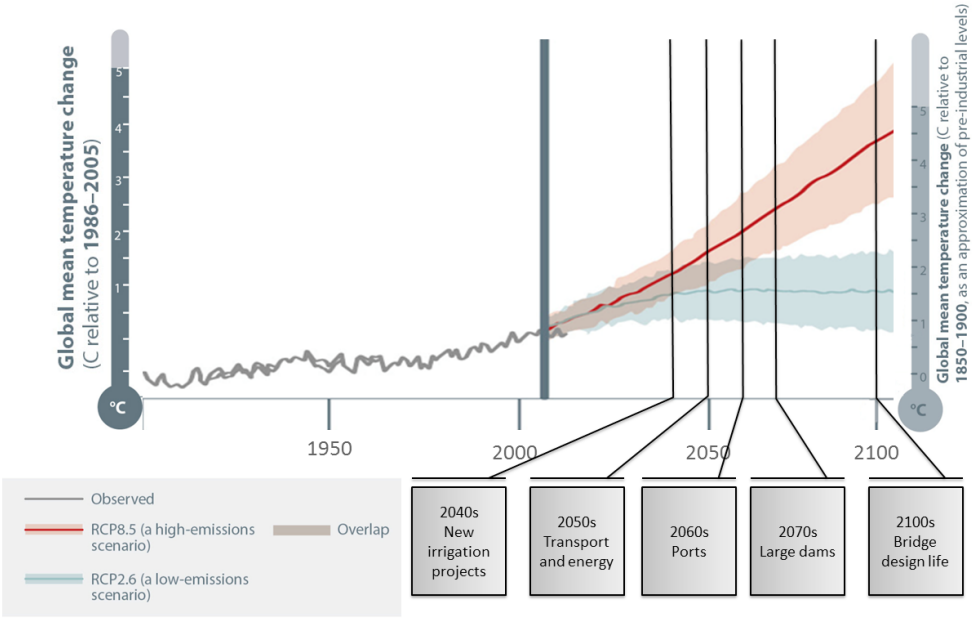

Figure 1: Indicative timescales of a range of infrastructure development set against global temperature change projections (Note that infrastructure lifetimes are indicative and will vary considerably in practice)

(Source: Adapted from HR Wallingford 2014. Future Climate for Africa – Scoping Paper: The use of climate services for long lived port infrastructure. MAR5322 RT003 R01-00)

Evidence-based decision making is only possible when climate risks, vulnerabilities, uncertainties and resilience are well understood by all stakeholders involved, including policy-makers, institutional partners, project developers and investors. Challenges arise when technical or scientific staff need to present climate risk and uncertainty to stakeholders who are not familiar with these complex topics. Translating the information into indicators that stakeholders use in their sector or limiting the information provided to that which is most relevant to each sector can help.

The Cartagena project managed to overcome this challenge by presenting to the municipality the climate risk assessment, vulnerabilities, losses and opportunities by sector: population, tourism, agriculture, water availability and mangrove ecosystem. For example, in the tourism sector the first step was to measure the carbon and water footprint of hotels, then develop guidelines and actions to be taken to reduce this, leading to a saving on water and electricity bills. Technical studies were carried out on how to improve tourism by preserving the surrounding ecosystem and protecting the coastline. An online tool "CartaClima" was developed to support decision makers and investors in the sector by informing them of risks in different parts of the district and the influence of climate on all stages of an investment. The programme also includes plans to educate tourists on how tourism infrastructure impacts the environment and encourage them to be environmentally responsible. As a consequence, stakeholders could focus on and understand the connection between climate change and possible repercussions for their own sector and better direct their investments. At the same time the project provided a bigger picture of how all the sectors are interconnected and how they can influence each other. Once this type of information was understood by stakeholders, ownership of a process of change was fostered by involving them in the development of climate resilient frameworks, policy proposals, project prioritisation criteria and project proposals. Coordination of such activities by an external organisation with expertise in climate resilience and water issues, can ensure that useful information is disseminated, the balance among stakeholders is maintained and the focus on climate resilience does not get lost during the negotiation process.

In the case of Nepal, stakeholders in the hydropower sector were consulted to identify the key performance indicators used for evaluating the performance of different infrastructure designs. The project team then calculated how the current climate variability, future climate scenarios and related uncertainties could affect the indicator values (see Box 2) and conveyed that information back to the stakeholders.

In Saint Vincent, local water engineers have a detailed knowledge of their systems and the risks facing them, although this is not necessarily formally recorded. Therefore a simple matrix of likelihood and consequence was used to visualise the identified climate risks facing the supply system (Figure 2). The severity and likelihood classes were semi-quantitative to integrate anecdotal information from stakeholders. The main value of the process was in providing a common platform for assessing risks such as landslides and flooding across stakeholder groups, and in communicating risks to those unfamiliar with the specifics of the system. There was some previous experience with this approach in Saint Vincent as the Ministry of Health had drafted a Water Safety Plan which uses a similar risk matrix approach.

Box 2. Acting on adaptation in the hydro-electricity sector in Nepal; dealing with uncertainties in the hydro power sector.

A bottom-up Climate Risk Assessment (CRA) was carried out based on indicators suggested by stakeholders in the sector. These included energy generation, flood, geohazards and sediment thresholds, as well as economic performance and system level indicators. The CRA analysed how current and future climate and hydrological variability will alter the indicators in the future. Key findings were that future climate adaptation is not as important as previously thought and there is more need to address present challenges with climatic variability, which will also benefit future operations.

		Likelihood of occurrence				
Severity of impact		Very unlikely to occur	Occasional occurrence	Moderately frequent	Occurs often	Very frequent occurrence
	Extreme	High risk	High risk	Extreme risk	Extreme risk	Extreme risk
	Major	Moderate risk	High risk	High risk	Extreme risk	Extreme risk
	Moderate	Low risk	Moderate risk	High risk	High risk	Extreme risk
	Low	Low risk	Low risk	Moderate risk	High risk	High risk
	Very low	Negligible risk	Low risk	Low risk	Moderate risk	High risk

Figure 2. Severity and likelihood matrix used to elicit information from stakeholders in relation to climate risks identified for the Sandy Bay water supply improvement project

An important aspect of communicating uncertainties is understanding where knowledge gaps lie for different stakeholder groups, including consultants, government agencies or international bodies trying to implement the infrastructure projects. Two types of knowledge gaps are particularly relevant here: a lack of accessible climate-related information; and a lack of understanding about the institutions and processes involved in planning and implementing infrastructure projects (i.e. the political economy of a project).

In relation to knowledge gaps on climate-related information, in Nepal it was found that hydropower infrastructure could have brought higher benefits to investors by including low cost sediment control options in the infrastructure design, but lack of knowledge about current climate variability and sedimentation vulnerability precluded this opportunity. Sediment loads are expected to increase with climate change so measures to address a current issue could also have improved future climate resilience. Some suggested ways for governments to address such knowledge gaps are: making climate risk assessment mandatory, providing guidance, or offering free climate risk screening to developers to raise their awareness.

In relation to knowledge gaps on the political economy related to the implementation of infrastructure projects, the Water Resilience and Climate Resilience in the Horn of Africa project reviewed the institutional characteristics of the Intergovernmental Authority on Development in Eastern Africa (IGAD) Drought Disaster Resilience Sustainability Initiative (IDDRSI) and the reasons for past poor performance in relation to project implementation. As a result of this review, a Water Unit was established to provide expert and impartial technical support to the process of infrastructure programming and planning from skilled and trained staff from across the region.

Involving the right stakeholders at every stage

Key message – Stakeholder analysis at the outset of any intervention is crucial to informing stakeholder engagement. Making a clear plan for which stakeholders should be engaged at different stages and which could be 'champions' for and leaders of change is important. The purpose and the methods to be used will promote ownership of the intervention.

Climate resilience is most likely to be ensured in the long term if it becomes part of the normal process of selecting, planning and designing infrastructure. Local ownership and leadership on these issues is vital if processes are to be changed. The best way to promote ownership is to involve a wide range of stakeholders at every stage of a project. All CDKN infrastructure projects made a point of doing this.

Box 3. Contrasting methods of selecting stakeholders

AMCOW capacity development:

Participants who work in government ministries, and national and regional organisations engaged with water security and climate change adaptation, were selected according to their educational background, position and motivation. Candidates were recruited through the Global Water Partnership (GWP) – Water, Climate and Development Programme (WACDEP) network and took a written test to assess their involvement in and knowledge of climate resilience within planning, project design and policy making. Thanks to their motivation and skills, the people selected are likely to remain in the political/institutional/academic environment even in the case of cabinet reshuffle or modification in the governance structure of a country, so the benefit of the training is rarely lost.

St Vincent. stakeholder matrix:

Stakeholder analysis was conducted using a matrix approach that analyses stakeholder impact, influence, methods of communication, and potential contributions to the project. From this analysis different perspectives were gathered as inputs to the project design. The mapping process also considered the role of central planners and decision makers who, as a subset of the stakeholders, had significant influence in terms of evaluating the contribution that the proposed climate resilient water infrastructure could make to the overall national development agenda, and indeed to ultimate decisions on whether to progress the proposals for financing.

Capitalising on entry points

Key message – Gain a thorough understanding of the entry points into decision making and planning processes to maximise the opportunity for effective change. In order for the timing of interventions to be effective in delivering climate resilience, decision points must be identified that provide the necessary lead time before interventions are required.

Entry points are opportunities to affect change in a project or process to increase resilience, and some examples are provided in the following paragraphs. The timing of interventions, and of decision points leading up to the intervention, is a critical factor in the success of building the climate resilience of water infrastructure. An understanding of existing institutional mandates and processes for planning infrastructure projects is important when identifying entry points to capitalise on. Beyond this, understanding the broader political economy of decision making is important to understand where changes may be possible, or unfeasible.

Engaging the right stakeholders is particularly important, especially at the institutional level, as a lack of political commitment can be a major barrier to effective engagement of other stakeholders and effective decision-making. Special attention should be given to mapping stakeholder perspectives, influences and drivers, as well as methods of selecting those who should be involved at different levels of a project including those well placed to be leaders or champions of change.

A range of different methods are available for selecting stakeholders (Box 3 has two examples). Stakeholder engagement should start at the earliest possible stage with the mapping of actors in the water sector. A balance between core stakeholders, newcomers and under-represented groups is crucial to avoid conflicts or a change of focus away from enhancing climate resilience.

A range of mechanisms can also be used for stakeholder engagement, the most popular being: meetings, workshops, expert panels, individual consultation and surveys. Different mechanisms can be combined, depending on the objective and the project stage. Meetings and workshops were the most common methods of engaging with stakeholders in the projects reviewed, combining them with other mechanisms according to the type of stakeholders engaged and the purpose (see Box 4).

Box 4. Water security and climate resilience in the horn of Africa. Engaging stakeholders

This project covered eight countries and required engagement with a wide range of stakeholders such as IGAD staff and member states, donors and relevant external stakeholders. Consultations were carried out through individual discussions and through workshops. The project team used the consultations to raise issues regarding donor priorities, potential projects, recommendations from other water initiatives and to brainstorm possible options for IGAD-IDDRISI regional water programme design. At the same time, the workshops served the purpose of spreading knowledge about the project and the IDDRISI programme and offered a forum for more general discussion between members from different countries and development agendas to make decisions on whether to progress the proposals for financing.

A particular entry point may not necessarily be a permanent feature of the institutional landscape, but may be specific window in time to be capitalised upon. For example, in Nepal a project on climate resilience in the hydropower sector was completed just as a hydropower and river basin master plan was about to be developed, so the outputs were available for that work, although uptake of the findings will only take place if stakeholders are sufficiently aware of and value the project. Similarly, the National Adaptation Plan for Nepal is able to draw on the findings of the study. Adjusting these timings may not be feasible, but it is good to be aware of them as opportunities to influence the future and perhaps involve their proponents as stakeholders.

Box 5 gives another example of how the timing of initiatives in relation to each other can enable the delivery of climate resilient water infrastructure.

In some instances the entry points for climate resilience issues are seen as part of the environmental impact assessment process, which is typically the responsibility of the environmental regulatory agency. In contrast, mainstreaming and developing new entry points in the core planning and project approval processes within government agencies responsible for infrastructure development can offer opportunities to influence projects and programmes at an earlier stage of development. Finance ministries need to be made more aware of the economic benefits of additional investment in resilience measures. This can be achieved through a combination of mainstreaming climate resilience and taking a more economy-wide approach, which relates to the critical factor of going beyond a project-based approach.

Box 5. AMCOW Capacity Development: maintaining the momentum in enhancing water security and climate resilient development.

The AMCOW project on capacity development demonstrates the effectiveness of capitalising on the entry point opportunity created by preceding work by GWP to develop a framework for the Water, Climate and Development Programme (WACDEP). The previous project designed a strategic framework to influence development activities to become more climate resilient and improve water security. AMCOW seized the opportunity to address the objectives set out in the framework, one of which is to develop the capacity of implementing bodies to deliver water security and climate resilient development. Timing the capacity development work to follow on from the WACDEP framework development contributes to the successful delivery of the WACDEP and, as a consequence, promotes climate resilient water infrastructure.

Going beyond the project

Key message – Adjusting infrastructure design to improve resilience is important, but infrastructure should also support resilience within its broader environmental, social and institutional context. This means selecting, designing and operating infrastructure to minimise negative impacts and maximise co-benefits with other sectors and stakeholders.

Box 6. Co-benefits of water supply resilience in Saint Vincent

The project considered a wider range of measures than infrastructure interventions, such as catchment management, which were outside the remit of the Central Water and Sewerage Authority (CWSA) but delivered co-benefits to the CWSA water system. The potential for developing partnerships and realising co-benefits offered a greater scope than the infrastructure itself. As the project engaged with stakeholders across multiple agencies, it was able to identify where measures would deliver multiple benefits.

The identification of these measures required detailed consultation with a range of stakeholders, including the community. Sensitivity was required in the community engagement to avoid excessively raising expectations. The two main concerns were over the uncertainty in securing funding to improve the water services from third parties (funding agencies) and the long lead in time between developing a project proposal and implementation. This is set within the context of a community suffering from poor water services, in urgent need of improvement.

The prioritisation and selection of resilience measures was carried out qualitatively on the basis of stakeholder engagement and feedback on draft proposals. A quantitative analysis was not possible due to a lack of data and the difficulties in estimating the diverse and often non-monetary benefits associated with many of the measures.

Working with a range of stakeholders to broaden a project's scope can help to identify co-benefits over and above the project's core objective. For example the resilience of water supply infrastructure projects can be improved by parallel interventions in catchment management which deliver ecosystems and livelihood benefits. Box 6 provides an example of how the scope of the Sandy Bay project was expanded to realise co-benefits.

Once a project has been designed in outline, fewer opportunities are available for enhancing resilience than if it was considered at the initial project identification stage where a much broader range of possible options can be considered. During the Limpopo project, it became clear that individual infrastructure projects such as large dams should be evaluated as part of a portfolio of interventions. The investment framework developed as part of the Limpopo project identified and appraised an appropriate portfolio of projects. This programmatic approach to infrastructure planning allows resilience to be considered at a broad catchment scale (see Box 7).

Box 7. Investment framework for the Lower Limpopo Basin

The investment framework involved a number of steps. Firstly, a desktop literature study and site visit were performed, and in conjunction with the Climate Resilience Strategy, helped identify suitable interventions for increasing resilience in the basin. The site visit was focussed on stakeholder engagement to develop the list of possible interventions. The work also included a review of the enabling and financing conditions for water security investment in the basin and Mozambique nationally. Further stakeholder engagement was then used to validate the list of interventions and agree selection and prioritisation criteria. The team developed a scoring system in relation to the agreed criteria and scored each intervention for its fulfilment of the criteria. Highly ranked projects were then structured into preliminary portfolios of investments, outlining the purpose of each component and its contribution to building resilience in the basin.

In this context, considering climate related issues as part of an Environmental Impact Assessment (EIA) often occurs too late in the project development process once opportunities to affect project selection and design have passed. However, if projects are selected and designed using resilience criteria, including the use of frameworks accounting for systemic interactions, then a more strategic approach can be taken while it is possible affect change. An example of negative systemic interactions from the Nepal project relates to the revenue from hydropower projects being shared with communities. In some cases the communities use this money to undertake activities in the watershed upstream of the hydropower scheme which inadvertently degrade the land and increase sediment loads in the river. This, in turn, has negative impacts on hydropower generation. Such systemic interactions cannot always be foreseen, but they should be considered to the maximum extent possible when selecting and designing projects and policies.

Box 8. Barriers for adaptation in hydropower generation contracts.

Power purchase agreements signed between Nepal's Electricity Authority and private hydropower operators are usually long term to ensure stability of supply. Penalties for interruptions act as a barrier to time-consuming adaptation engineering works. However, simple contract break clauses could alleviate this problem and facilitate different behaviour.

In operating infrastructure to maximise co-benefits and take a strategic approach to building climate resilience, it can be helpful to consider whether the policies and practices in place are truly enabling a climate resilient outcome. Box 8 gives the example of how the contracting arrangements for hydropower in Nepal act as a barrier to adaptation and Box 9 gives the examples of how staff time, technical capacity and financial resources have constrained climate proofing activities in Saint Vincent.

Box 9. Resource and capacity related barriers for adaptation.

Two interesting examples of barriers arose from work in Saint Vincent on climate proofing the Sandy Bay water service improvement project. The first is a lack of staff time, technical capacity and financial resources in the water utility to take a strategic approach to improving the resilience of water supply systems. The Central Water and Sewerage Authority's (CWSA) role demands that water services are maintained to customers in the face of the impacts of climate variability that cause damage and disruption on a regular basis. This means that CWSA is continually (especially in the rainy season) responding reactively, to climate related threats as they arise, by repairing systems. This makes strategic planning difficult as budgets may be reallocated to immediate priorities. In this sense the longer term changes as a result of climate change are a lower priority than the immediate threats posed by climate variability. The second fundamental challenge in Saint Vincent is the fact that in many instances few alternative options exist for designing or locating water supply infrastructure to avoid climate related risks. The topography of the island is such that pipelines necessarily traverse steep and landslide prone areas, and intense storms cause debris laden flooding to damage infrastructure.

All the projects reviewed which focused on the development of resilient infrastructure started with a risk and vulnerability assessment of the area. Those assessments were carried out using quantitative and/or qualitative methods, and standardised or tailored approaches according to the context and data availability. In the Limpopo river basin, a vulnerability assessment was carried out using a standardized method in line with Intergovernmental Panel on Climate Change (IPCC) and GIZ guidelines (see Box 10). By following this approach the climate risk information was incorporated into the decision making process and proposed interventions were derived as components of a resilience strategy.

Box 10. Basin-wide vulnerability assessment, Limpopo River Basin, Mozambique.

This project included the development of a basin-wide resilience strategy based on a vulnerability assessment. The vulnerability assessment approach was aligned with the generic concepts and guidance of IPCC's fourth assessment report and GIZ's Vulnerability Guidelines. Vulnerability was evaluated by subtracting the risk from the adaptation capacity of a defined system or sector. For the Limpopo basin, five different sectors and three different sub-regions were assessed. For each pair of sector and sub region the vulnerability was assessed against four current and future climate related factors. The final output consists of a summary table for each sector sub-region where the vulnerability is expressed as low, medium or high for current exposure, sensitivity, risk adaptive capacity, and future exposure.

Building institutional capacity for assessment, design and financing

Key message – Long-term prospects for increasing the climate resilience of infrastructure rely on investment in capacity development to support action by national government agencies, or in the case of transboundary river basins, river basin organisations. Capacity development must be tailored to the specific gaps and needs of the beneficiary organisation, identified by working closely and collaboratively with development partners.

Institutional capacity currently varies greatly across government agencies in developing countries, however the future climate resilience of infrastructure depends heavily on decision-makers being able to assess vulnerabilities, identify intervention strategies to address vulnerabilities and secure financing for implementation. Consultants can be employed to support these activities in the short-term, but this is counter to the idea of promoting ownership of the resilience agenda at national level. Long-term prospects for increasing the climate resilience of infrastructure rely on investment in capacity development to support action by national government agencies, or in the case of transboundary river basins, river basin organisations.

Existing institutions which are responsible for the preparation of infrastructure projects and the development of climate resilience criteria sometimes have limited capacity to do this effectively. Climate resilience can be a new concept to the people involved in these activities, and making decisions about selecting and designing projects given climate risks and a broad range of future uncertainties can

be extremely challenging. Coupled with this, financial institutions have stringent requirements and processes for obtaining finance for infrastructure, especially in relation to the safeguards on social and environmental impacts, which often relate to water infrastructure.

Understanding how infrastructure has already been or is in the process of being financed, the approach taken and how it has performed can help to identify risks and opportunities for the financing of future projects from traditional and climate-related sources. In the context of the Nepal project, a review of financing options and specialist support helped to remove the barrier of limited awareness of financing options, see Box 11.

In the context of the Sandy Bay project the water utility had limited experience in accessing external finance, and no experience with specialist climate change sources of finance. The Ministry of Finance coordinates external development assistance, and therefore the utility was not aware of the full range of external financing sources which may be available. Improving the coordination between the Ministry of Finance and technical agencies such as the water utility would help to align needs with upcoming financing opportunities. In addition to limited awareness of the financing opportunities, the utility lacked the staff time and experience in preparing the often detailed project proposals for external financing, with technical staff being very stretched in responding to short term priority issues.

Box 11. Institutional barriers for financing infrastructure in Nepal:

Analysis of financing models for present, planned and future dams showed that local institutions and lenders have the capacity to finance small-medium infrastructure projects, but large projects require international financing sources. The latter introduce much more complex requirements for planning and loan/grant applications which government institutions are poorly equipped to handle. However, international financial institutions do have their own strong environmental and social safeguards and resilience requirements, so their involvement can help address some resilience issues where national policies and processes may be weaker in this regard. This type of analysis can help identify barriers and suggest how to overcome them to develop climate resilient infrastructure. In Nepal support was needed to investigate and apply for international finance and conduct robust cost-benefit analysis of different development options.

Those aiming to enhance the climate resilience of water infrastructure need to work with existing institutions responsible for developing and operating infrastructure to understand where support is required to address gaps and needs. This can inform what kind of support would be most effective in enabling them to include climate resilient criteria and/or supporting them in the inclusion of climate resilience factors when writing infrastructure proposals. For example, institutions can be supported though capacity development sessions, the revision of technical documents for a specific project or hand-holding through a real process. The impacts of capacity development are difficult to quantify and it takes time to see tangible benefits. Nevertheless, the projects reviewed highlight a number of factors that have been shown to improve capacity development effectiveness in the experience of those involved:

Keep the knowledge in the beneficiary organisation:

One of the limitations of capacity development is the stability of the political and institutional context in which it is implemented. Those trained might not stay in their institutions long enough to transfer the skills acquired or improve the institution's competence as desired. In the case of the AMCOW Capacity Building project one of the criteria for participant selection was the likelihood of their remaining in the institution long enough to transfer knowledge and incorporate it in the institutions. This project considered that the probability of maintaining knowledge within an institution or sector is increased by training mid-level or senior staff. Thanks to their existing experience and status, such people are likely to remain in the sector and to influence projects and decisions from other positions, even in the case they are reassigned.

Utilise local expertise whenever possible:

Providing a strong local dimension during capacity development helps create ownership, crucial for long term success. Local trainers are typically university professors, or from governmental institutions and have the knowledge to adapt programme content and objectives to the national context. Together with a common cultural background, this helps in creating a climate of collaboration and ownership where teachers and

participants are working together for policies' improvement. International experts will lack this detailed understanding of the local context. Where appropriate using a combination of local and international expertise can help to blend local contextual knowledge with broader international perspectives.

Balance national and international dimensions:

As useful as it is to acquire and apply skills at national and local level for technical staff, planners and decision makers, capacity development can also help ease international negotiation on the implementation of transboundary water infrastructure. If workshops and training sessions are organized at international level, the information conveyed is shared between countries. High level decision makers in attendance thereafter have a position of common background knowledge from which to discuss climate resilience, share country experiences and engage in the process of negotiation for the implementation of common solutions for climate change adaptation.

Integrate training with national processes:

Training can be integrated with participants' roles, rather than delivered through lectures and theoretical exercises. This has the dual benefit of being more interesting for the participant as well as potentially generating useful outputs. In the AMCOW Capacity Building project, trainees were supported in writing real-world climate resilient water infrastructure project proposals and the development of climate resilient action plans and/or policies for their country/region. Some outcomes are already tangible at policy and infrastructural level, with the revision of national plans and the financing of projects that were written during the training sessions (Box 12).

Implement temporary / innovative solutions where necessary:

If institutions significantly lack skills or experience and are not able to address certain stages of the project cycle, capacity development sessions may become ineffective and expensive. Since changing the structure of an existing institution is usually not an option, the capacity of an institution can be temporarily increased by contracting an external body, with the required expertise, that can fill the gaps and build capacity over time by collaborating with the institution it is working with. This was suggested as an approach to support IGAD in enhancing its capacity in the writing of bankable water infrastructure in the Horn of Africa. (Box 13)

Box 12. AMCOW Capacity Development: Building Capacity in Water Security and Climate Resilient Development.

In order to support planners in writing bankable project proposals an innovative and interactive approach was used for the training. Twelve planners from each country were trained "on-the-job" for 14 months, meaning that the training was fully integrated in their work routine and therefore more easily assimilated. By avoiding only lectures, and integrating group exercises, real case studies and assignments pertaining to their country's development, the participants gained a sense of ownership of the framework and became part of the development process of their country. Usually institutions tend to receive support at the middle and later stage of project preparation, but the AMCOW project filled this gap and developed planners' skills in the identification and concept development stages of a project. The participants learned how to understand challenges connected to climate change and socio-economic scenarios and identify relevant stakeholders. From the problem identification planners learnt how to develop a balanced portfolio of possible investment options, prioritising no/low regret options and prepare business cases that included costs and benefits of resilience measures.

While the above lessons are broadly applicable, it is necessary to consider which is appropriate to the context of any new training and capacity development, given the specific context, goals of the capacity development and resources available.

Box 13. Water security and climate resilience in the horn of Africa. The advantages of a Transaction Service Provider (TSP) for unlocking climate finance.

A lack of experience in transaction management was identified in this project as hindering IGAD-IDDRSI from implementing water infrastructure in the region. In order to address this limitation a Transaction Service Provider (TSP) was recommended to help with the preparation of bankable project proposals. A TSP is a service provided by a private sector company or consortium that could be contracted by a lead donor to provide high level, specialized technical service and assist in the identification and prioritisation of projects. TSPs are already widely used by the public sector for design, preparation and project implementation. By covering the duties of a unit of an institution they can help avoid extra project costs and their expertise can increase efficiency and transfer knowledge to the contracting institution.

Concluding remarks

Increasing the climate resilience of water infrastructure is a challenging and urgent task. It involves dealing with a wide range of uncertainties about the future and complex economic-social-environmental systems in which it can sometimes be hard to predict the consequences of interventions. Not only must infrastructure itself be able to withstand uncertain future conditions and continue to provide satisfactory performance, its impacts within a system should also improve rather than degrade overall climate resilience. Owing to the long-lived nature of much water infrastructure (See Box 1) decisions which are taken in the next five to ten years will have implications for decades to come. This working paper has drawn on the experience from six CDKN projects across Africa, Asia, South America and the Caribbean to identify critical factors for increasing resilience in this context.

The review of available evidence has identified five critical factors deemed to have a significant influence on the resilience of water infrastructure and which are broadly applicable across a range of scales and geographic locations. They are by no means the only factors affecting success, but drawing on the evidence available from CDKN's project experience they represent solid foundations on which to build locally specific projects and programmes.

The benefits from some of the critical success factors are not limited to increasing climate resilience of infrastructure; for example, extensive stakeholder engagement is a prerequisite for success in most development assistance interventions. However, it is especially important in relation to water infrastructure, which has impacts across sectors and scales. Other factors, such as the communication of risk and uncertainty, are more specific to achieving climate resilience.

These success factors will provide a checklist for development practitioners such as bi-lateral and multi-lateral development agencies engaged in technical assistance and financing for water infrastructure development. Each factor is evidenced from the CDKN projects to highlight their application in practice. However, it should be noted that this review has taken a very broad overview of water infrastructure, ranging from small-scale rural water supplies to national-scale hydropower to regional infrastructure development agencies, and therefore the critical factors are necessarily broad. As such, they must be interpreted in the context of each intervention to which they are applied.

Appendix A – Project descriptions

Adaptation Plan of Cartagena de Indias and its islands (Project Reference: TALA 0028b)

Source and further information: https://cdkn.org/project/adaptation-plan-of-cartagena-de-indias-and-its-islands/?loclang=en_gb

Entry points	Going beyond the project	Climate risk and uncertainty in perspective	Involving stakeholders at every stage	Building institutional capacity

Background
According to the Institute of Marine and Coastal Research (INVEMAR) Cartagena is one of Colombia's top five cities most vulnerable to climate change. Like numerous other coastal cities in the world and throughout the country, the historic Caribbean city, its population and economy, suffer the consequences of a changing climate and extreme environmental phenomena. This situation required a shift to turn these threats into opportunities for development in order to benefit the population and economic sectors of Cartagena.

Cities that plan and prepare for future climate changes will be more competitive than those that do not. Taking measures now to prepare and adapt to future climate conditions will be much more cost effective than waiting until poorly planned emergency measures are necessary. In addition, adaptation can give the city an array of possibilities for growth. A greener Cartagena will mean using its natural resources, like beaches, mangroves and wetlands, more efficiently. It will have clean water and coastal wetlands with regenerated fish populations. This will lead to increasing numbers of tourists who appreciate natural beauty and quality of life, which will in turn promote job creation and a sustained economic growth for the entire city.

The objective of the project was to develop an Action Plan for Cartagena to adapt to climate change, which included an analysis of vulnerabilities and guidelines for adaptation for island territories, with the goal of strengthening competitiveness and sectoral development in the city and in the surrounding islands.

Specific objectives were to:

- formulate financially feasible project proposals to apply for international and national funding.
- define an operative, political, institutional and financial framework for the implementation of an Adaptation Plan.
- produce a methodological guide and document of lessons learned for the construction of adaptation plans in coastal urban areas that can be scaled nationally.
- identify and analyse climate vulnerability in island territories of Cartagena.
- formulate guidelines for adaptation of island territories of Cartagena.
- create greater awareness about climate change among institutions, sectors and communities in Cartagena and in the island territories through participatory processes.

Outcomes:

- Adaptation Plan for Cartagena, including an analysis of vulnerability and policy guidelines for adaptation for island territories.
- Two financially viable projects.
- Methodological guides and lessons learned in adaptation to climate change in urban coastal areas.

Beneficiaries:

- Direct Beneficiaries: Public institutions in Cartagena, principal business associations in the city, island communities and the Ministry of the Environment and Sustainable Development.
- Indirect Beneficiaries: National authorities, communities in Cartagena and academia and research centres

AMCOW Capacity Building – Building capacity for climate resilient decision-making in water investments (Project Reference: TAAF-0039)

Source and further information: https://cdkn.org/project/amcow-capacity-building-building-capacity-for-climate-resilient-decision-making-in-water-investments/?loclang=en_gb

Entry points	Going beyond the project	Climate risk and uncertainty in perspective	Involving stakeholders at every stage	Building institutional capacity

Background
Through consultation with WACDEP and the Global Water Partnership, the elected supplier, NIRAS has:

- Developed a training course on the skills and knowledge required for no/low regret investment strategies in water-related development planning
- Coordinated the design, translation, printing and web dissemination of course materials
- Subcontracted, trained and managed regional and national Capacity Building Teams to deliver the course to end users

This project built directly on TAAF-0026, Global Water Partnership: Framework for Water and Climate Development Programme. The previous project designed a strategic framework to help senior professionals and decision-makers identify and develop 'no or low regret' investment strategies, integrate these into planning processes, and influence future development activities to become more resilient to climate change and variability. This project funded the implementation of the Capacity Development work package of TAAF-0026. It has deepened the knowledge of methods and concepts outlined in the GWP Framework and supporting technical documents.

Water Resilience and Climate Resilience in the Horn of Africa (Project Reference: TAAF-0067)

Source and further information: https://cdkn.org/project/water-resilience-climate-resilience-horn-africa-reference/?loclang=en_gb

Entry points	Going beyond the project	Climate risk and uncertainty in perspective	Involving stakeholders at every stage	Building institutional capacity

Background
The Horn of Africa is one of the world's most food insecure regions. The Intergovernmental Authority for Development (IGAD) is a regional inter-governmental organisation that aims to expand areas of cooperation between its 8 members (Djibouti, Kenya, Ethiopia, Eritrea, Somalia, South Sudan, Sudan and Uganda) and to promote peace and stability in the region in order to attain food security, sustainable environmental management and sustainable development.

In 2014, IGAD approached the Stockholm International Water Institute (SIWI), seeking support for the development of their Regional Water Policy. Consequently, Adam Smith International (ASI) and SIWI, supported by the Global Water Partnership, joined forces to explore potential opportunities in designing a comprehensive, regional water security and climate resilience programme for IGAD. Funding for the research was provided by CDKN.

The project had two specific objectives:

1. Improve the capacity of IGAD to develop fundable proposals for climate-resilient water management projects within its region from its current level

2. Increase the available knowledge on climate finance in the water sector in the IGAD region.

As a move toward its own regional programme for transboundary water infrastructure development IGAD held its first meeting of the Ministers of Water Resources of its member states in January 2015. They passed a Regional Water Resources Policy and urged the IGAD Secretariat to establish a unit or platform linked closely to the IGAD Drought Resilience and Sustainability Initiative (IDDRSI) that will support the implementation of this Policy and the sustainable management of water resources in the region. IDDRSI is the flagship, semi-autonomous programme of IGAD with the goal of building drought disaster resilient communities, institutions and ecosystems by 2027.

Whilst the IDDRSI Strategy has been successful in some areas, such as resource mobilisation, it has been less successful in implementing projects 'on the ground'. There is little evidence of impact on the lives of the poorest and most vulnerable communities. The project analysed the constraints and causes of slow project implementation in IDDRSI.

The project team responded to both the expressed needs of IGAD and donors through the proposed IGAD Climate Resilient Investment Facility 'ICRIF'. ICRIF aims to establish an international transaction service provider to mobilise the existing IDDRSI funding toward infrastructure development in the short term, while working with the IGAD Water Unit and Secretariat to strengthen gradually their capacity to take on these functions in the medium term.

In addition, the project sought to build the capacities and enhance skills of the relevant IGAD officials through a IGAD-CRIDF study tour. This proved to be an effective method to build understanding of, and ownership for ICRIF among the IGAD officials.

Building Climate Resilience in the Limpopo Basin, Mozambique (Project Reference: TAAF-0048a)

Source and further information: https://cdkn.org/project/building-climate-resilience-in-the-limpopo-basin/?loclang=en_gb

Entry points	Going beyond the project	Climate risk and uncertainty in perspective	Involving stakeholders at every stage	Building institutional capacity

Background
Infrastructure development is seen as one of the key investment areas in enhancing water security in Africa. This project aimed to build climate resilience into the infrastructure planned for the Lower Limpopo River Basin, Mozambique.

The infrastructure development aims to not only ensure water security for the citizens of the Lower Limpopo Basin in periods of water scarcity, but to ensure that the citizens are spared from the impacts of water abundance that may result in flooding, and changing conditions, such as climate change.

This project highlighted the advantages of integrating all essential considerations (including socio-economic, environmental and economic aspects) during all the stages of the project preparation cycle to ensure that the optimal engineering solution is sought. This was achieved through a comprehensive set of pre-feasibility, feasibility studies and assessments, supported by the Africa Water Facility (AWF).

CDKN complemented this work through its support of ARA-Sul (the Southern Region Water Administration within the Ministry of Public Works, Housing and Water Resources, Mozambique) to strengthen the incorporation of essential considerations (socio-economic, environmental and atmospheric aspects) into the studies, and ensure that the benefits of the project were clearly communicated.

The supplier, Pegasys, provided technical assistance to assist the successful execution of the infrastructure

development as a whole, the integration of climate resilience in the project cycle, and technical review of the studies to be developed (not only from a climate science perspective but for their overall technical quality, rigor and environmental, socio-economic standards).

The project also served as a knowledge-generation opportunity for similar projects across Africa and other developing countries, and the lessons learnt in the implementation of this project will be key in promoting resilient development and water security across Africa.

Ultimately, this project will support the Government of Mozambique with the design and development of a large-scale water infrastructure project in the Limpopo Basin as a significant long-term response to the challenges posed by climate change and hydrological variability.

Climate Proofing the Sandy Bay water service improvement project, St. Vincent (Project Reference: TALA-0042)

Further info: https://cdkn.org/project/project-climate-proofing-sandy-bay-water-service-improvement-project-st-vincent/?loclang=en_gb

Entry points	Going beyond the project	Climate risk and uncertainty in perspective	Involving stakeholders at every stage	Building institutional capacity

Background

The CDKN funded project "Climate proofing the Sandy Bay water service improvement project, St. Vincent" has supported the St Vincent and the Grenadines Central Water and Sewerage Authority (CWSA) to develop a project proposal for climate proofing a water supply system in a highly vulnerable rural community. The CWSA had already developed a proposed design for a water supply system upgrade, and this CDKN funded project examined how this could be 'climate proofed' and funding could be secured for its implementation. A financing source for the project proposal was identified (USAID CCAP programme), and the proposal was shaped into the CCAP funding application templates for finalisation and submission by the relevant national authorities.

Adaptation measures to climate proof the water supply improvements were identified and prioritised on the basis of an analysis of the impacts of climate change and extensive stakeholder consultation. The consultation involved meetings and a workshops with CWSA, the Ministry of Agriculture (Forestry and Agricultural extension departments), the National Emergency Management Organisation (NEMO), Ministry of Finance and the Sandy Bay Community amongst others.

The adaptation measures ranged from adjusting the infrastructure specification through to catchment management interventions and disaster risk reduction at the community level. These measures were appraised with CWSA and shaped into a proposal which packaged the measures together. The aim was to expand on the CWSA infrastructure option to include 'soft' measures which could be co-beneficial. For example, by improving land cover upstream of the water supply system, raw water quality is improved as well as the ecosystem and flood/landslide risk benefits which are realised. The rationale being that by taking a holistic approach and working with multiple partners the overall resilience of the catchment, community and water system will be improved.

A financial and economic appraisal for the project was then undertaken, which demonstrated its financial sustainability, and made recommendations on avoiding financial and operational risks to the system.

As the proposal was being developed, a screening exercise for funding sources was undertaken. This included a workshop with national stakeholders on identifying and accessing funds, focusing particularly on climate funds, which was in addition to the original scope of the project. This resulted in the selection of the USAID CCAP funding programme to target for securing funds for project implementation. The proposal was then re-shaped into the USAID CCAP template, for finalisation and submission by the relevant authorities at national level.

Once implemented the project will provide more resilient water services to the Sandy Bay community, as well as improved disaster resilience and ecosystems services. In addition CWSA and other national stakeholders have realised capacity development benefits from participating in the process of climate risk assessment, project preparation and identification of funding sources.

The project resulted in useful lessons on climate proofing infrastructure and accessing climate finance. These have been captured in four learning modules which were produced as part of the CDKN project.

Adaptation to Climate Change in the Hydro-electricity Sector in Nepal (Project Reference: TAAS-0045)

Source and further information: https://cdkn.org/project/acting-adaptation-hydro-electricity-sector/?loclang=en_gb

Entry points	Going beyond the project	Climate risk and uncertainty in perspective	Involving stakeholders at every stage	Building institutional capacity

Background
Hydro-electricity is the main contributor to the overall Nepal electricity generation mix. CDKN's project on the Economic Impact Assessments of Climate Change in Nepal identified the hydro-electricity sector as being at risk from climate change impacts, and identified a significant lack of adaptation capacity within the sector. This had a direct impact on the country's growth and poverty reduction potential.

CDKN addressed this issue by identifying exactly where and how adaptation action should be taken, and exploring the wider enabling environment for mainstreaming adaptation in the hydro-electricity sector. The project provided the Ministry of Energy, Government of Nepal with stronger and more targeted evidence on the current and future impacts of climate change on the hydro-electricity sector. The focus of the project was to identify what is required to mainstream adaptation to the impacts of climate change by improving the evidence base and enabling environment for the hydro-electricity sector.

The Project aimed to achieve the following:

- Develop an evidence base on the vulnerability of the hydro-electricity sector from the impacts of climate change to make a strong case for the climate compatible development benefits of adaptation actions.
- Identify adaptation options for the hydro-electricity sector which are viable and which will improve the resilience and productivity of the sector for the benefit of Nepal's growth and poverty reduction targets.
- Understand and address institutional challenges to mainstreaming adaptation to the impacts of climate change in the hydro-electricity sector
- Make all decision-makers involved in the hydro-electricity understand and accept the need for adaptation action in the hydro-electricity sector

Deliverables and Introductions
A policy brief was produced under this project under the title 'Adaptation to Climate Change in the Hydro-electricity Sector in Nepal.' The policy brief discusses the climate change induced hazards, and the fact that climate change adaptation must depend on the specific context, vulnerability and demands of the area.

An infographic was produced under the project which lists all the data that was gathered for the project. It included current climate variability, disaster risk management, hydro-met data improvement, and risk audit and good practices.

The final report of the project analysed and assessed all the activities and the research approaches that were undertaken. The Climate Risk Assessment Approach (CRA), Adaptation Pathways and Institutional Analysis and Mainstreaming were the main approaches and have been discussed in this report.

About CDKN

The Climate and Development Knowledge Network (CDKN) supports decision-makers in developing countries in designing and delivering climate compatible development. It does this by combining research, advisory services and knowledge-sharing in support of locally owned and managed policy processes. CDKN works in partnership with decision-makers in the public, private and non-governmental sectors nationally, regionally and globally.

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