ADAPTATION FUND

Strengthening Resilience through Disaster Disk Reduction and Early Warning Systems Interventions: Experiences and Lessons Learned from the Adaptation Fund Portfolio

AUGUST 2023

AF-funded project in Pekalongan, Indonesia
Photo by Adaptation Fund

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List of Acronyms

AF..... Adaptation Fund
COVID-19. .....Coronavirus Disease
CSO .....Civil Society Organization
CRED.....Centre for Research on the Epidemiology of Disasters
EM-DAT .....Emergency Events Database
EE..... Executing Entity
ESP.....Environmental and Social Policy
EWS.....Early Warning System
GIS .....Geographic Information System
GIZ .....The German Agency for International Cooperation
GLOF.....Glacial Lake Outburst Floods
IE.....Implementing Entity
IPCC .....Intergovernmental Panel on Climate Change
MET.....Meteorological information management
MTS.....Medium-Term Strategy
NGO.....Non-governmental Organization
MIE.....Multilateral Implementing Entity
NIE .....National Implementing Entity
UNDP.....United Nations Development Programme
UNDRR.....United Nations Office for Disaster Risk Reduction
UNEP.....United Nations Environment Programme
UNFCCC.....United Nations Framework Convention on Climate Change
WB .....World Bank
WMO.....World Meteorological Organization

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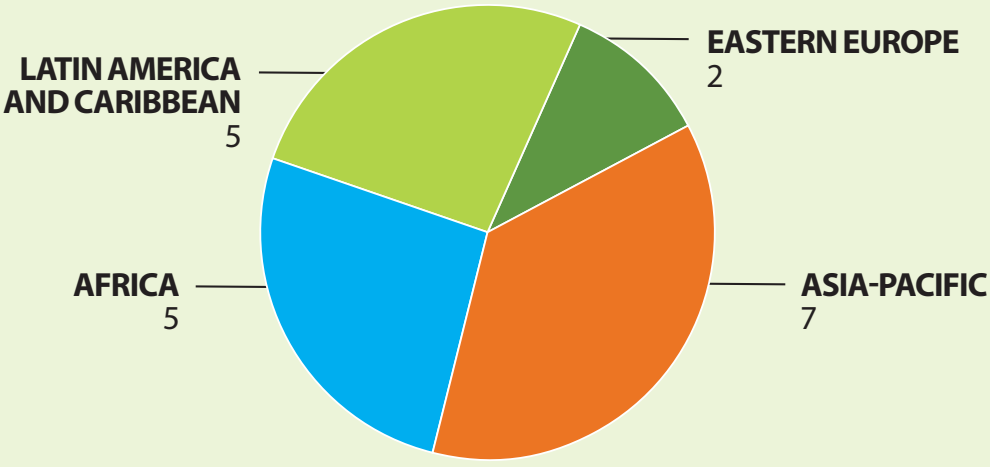
I. Executive Summary

Disaster risk reduction and early warning systems are considered essential tools to address rising climate risks. Extreme climate events, such as floods, droughts, extreme heat, cyclones and severe storms are increasing in frequency and intensity with devastating impacts on livelihoods, ecosystems, food security, economies, infrastructure, water security and health (EM-DAT 2022, WMO 2022). While some impacts can be addressed, loss and damage refers to the negative consequences that arise from unavoidable risks of climate change that are beyond adaptation limits (IPCC 2022). Most recently, at the UNFCCC COP 27 in Sharm El-Sheikh, Parties agreed to set up a new fund for loss and damage and committed to develop funding arrangements to support vulnerable countries to address the impacts of climate change (UNFCCC 2022).

The Adaptation Fund, with its large portfolio of adaptation projects and its long experience as a pioneer and innovator in adaptation finance, is preventing and averting loss and damage through disaster risk reduction and early warning systems projects. For example, 516 early warning systems have been installed, supporting communities to build resilience by increasing access to essential climate information and hydro-meteorological services (Adaptation Fund 2022). Such projects account for 18 per cent of the Fund portfolio (Adaptation Fund 2022). Together, the two types of projects cover US$112.3 million with budgets ranging between US$3.9 million and US$14 million. The projects are occurring in all regions across the globe as shown in the chart below.

This study offers an overview of the Fund's experience and lessons learned on disaster

Disaster risk reduction and early warning systems projects by region (as of April 2023)



AF-funded project to adapt to sea level rise in Pekalongan, Indonesia
Photo by Adaptation Fund

risk reduction and early warning systems interventions in strengthening long-term resilience to climate change, including case studies from across the portfolio. In this way, it aims to advance understanding among the wider adaptation community, as well as generate and share knowledge on project approaches. The study also fulfils one of the three strategic pillars of the Medium-Term Strategy (2023-2027), Learning and Sharing, which aims to develop knowledge and evidence on effective and innovative adaptation action and finance. Findings will be of interest to stakeholders, current and prospective Implementing Entities, Executing Entities, government officials, private sector, civil society groups, youth organizations, other adaptation practitioners and the public interested in approaches to disaster risk reduction and early warning systems.

The study methodology included document analysis covering a review of the academic and grey literature on disaster risk reduction and early warning, a review of Fund policies and guidelines related to the study, and a review of the Fund's disaster risk reduction and early warning portfolio and project documents. Finally, semi-structured interviews were conducted with project leaders and advisers to understand the project approaches, their effectiveness and lessons learned.

Approaches

Projects have tested innovative approaches to build long-term resilience. Drawing on the case studies, Fund projects are using a range of approaches, including:

- Working across scales
- Building risk management tools, technologies and systems
- Expanding grey and nature-based infrastructure
- Supporting community-based disaster risk reduction
- Developing policies and institutions
- Building capacity, learning and sharing information

Effective implementation of these approaches requires integrating across four areas: scales, sectors, stakeholders with a focus on vulnerable communities and groups, and design of complementary and reinforcing activities. The study has found that a combination of approaches that link across these areas provides a useful model for disaster risk reduction and early warning systems projects.

Lessons learned

Several lessons have resulted from the analysis of the case studies. For early warning systems, this analysis has found that:

- **Improved data quality leads to better decision-making,**
- **Understanding and communicating risks improves outcomes and**
- **Hydro-meteorological and community institutions fit for purpose, scale and context drives success.**

For disaster risk reduction, lessons include:

- **Community-led actions are crucial for long-term resilience,**
- **Alignment with government structures enables scaling up,**
- **Partnerships and coordination advance project goals and,**
- **Learning opportunities builds capacity and supports sustainability.**

II. Introduction

Extreme climate events, such as floods, droughts, extreme heat, cyclones and severe storms are increasing in frequency and intensity. These are generating devastating impacts on livelihoods, ecosystems, food security, economies, infrastructure, water security and health (EM-DAT 2022; WMO 2022). Between 2000 and 2019, 7,348 major disaster events were recorded, affecting 4.2 billion people, claiming 1.23 million lives and resulting in approximately US$2.97 trillion in global economic losses (CRED and UNDRR 2020). Additionally, exposure to climate risks is growing due to socioeconomic trends such as increasing inequality, urbanization and environmental degradation.

The impacts from extreme climate events are unequally distributed across the globe with the largest burden falling on poor vulnerable populations. Between 2010 and 2020, human mortality from floods, droughts and storms was 15 times higher for 3.3–3.6 billion people in highly vulnerable regions compared to regions with low vulnerability (IPCC 2023). Vulnerability is higher in locations with poverty, governance challenges and limited access to basic services and resources, violent conflict and high levels of climate-sensitive livelihoods (Ribot 2009). Vulnerability at different spatial levels is exacerbated by inequity and marginalization linked to gender, ethnicity, low income or combinations thereof, especially for many Indigenous Peoples and local communities (O'Brien and Leichenko 2000; IPCC 2023).

Extreme events are also compounding risks. As poor communities living on flood plains face repeated storms, they risk an increase in waterborne diseases and food insecurity as livestock are killed and agricultural fields are destroyed (Brooks et al. 2009). Similar patterns can be seen in informal urban settlements where climate hazards can destroy water, energy and food systems infrastructure leading to the scarcity of essential resources. There is strong evidence that, without effective disaster risk management and adaptation, loss and damage will entrench vulnerable communities in cycles of poverty (IPCC 2023).

Given the increasing urgency and extensive impacts, addressing extreme climate events is an issue of international concern. The Sendai Framework on Disaster Risk Reduction 2015–2030 focuses on measures that address all dimensions of disaster risk, including resilience building, and recognizes climate change as a driver of disaster risk. It sets clear targets "to increase the number of countries with national and local disaster risk reduction strategies by 2020, enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030 and substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030" (2015). It also recognizes that support, including through finance,

can strengthen the ability of developing countries to manage risks. The Framework is also linked with the Paris Agreement's inclusion of climate change adaptation and disaster risk reduction through the global adaptation goal, Article 7.1 (on enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change) and Article 8.1 (on averting, minimizing, and addressing loss and damage associated with the adverse effects of climate change) (UNFCCC 2015).

Loss and damage refers to the negative consequences that arise from unavoidable risks of climate change that are beyond adaptation limits (IPCC 2022). Most recently, at the UNFCCC COP 27 in Sharm El-Sheikh, Parties agreed to set up a new fund for loss and damage. They also committed to develop funding arrangements to support vulnerable countries to address the impacts of climate change (UNFCCC 2022). Over 2024, a Committee will provide recommendations for the Fund's operations including its form, which countries will contribute and where and how finance will be distributed.

A. Importance of disaster risk reduction and early warning systems to build resilience

Disaster risk reduction, early warning systems and climate services are considered important tools to address climate risks (IPCC 2023). Disaster risk reduction is a preventive approach to build resilience to hazards and reduce vulnerability that goes beyond a simple focus on post-disaster recovery. It takes an all-of-society approach involving individuals, communities, governments, civil society and the private sector. It includes efforts at all scales of governance.

Early warning systems have become increasingly important as the means for governments to warn their citizens about climate- and weather-related hazards, including floods, cyclones and droughts. For example, "early warnings" of potentially poor seasons have been successful at informing key actions for agricultural planning on longer timescales and for producing proactive responses (Vogel and O'Brien 2006). Effective early warning systems often comprise four elements: (1) generation of risk knowledge, including monitoring and forecasting; (2) surveillance and warning services; (3) dissemination and communication; and (4) response capability (Basher 2006). Evidence suggests that countries reporting good multi-hazard early warning systems coverage have lower mortality rates compared to those with little or no such coverage (WMO 2022). While the importance these systems for adaptation is well known, less than half of Least Developed Countries and one-third of Small Island Developing States reported having one. In response, the United Nations is promoting an "Early Warning for All" Initiative. This aims to have every person protected by early warning systems within five years.

Relatedly, international, regional and national efforts have enhanced the provision of "climate services." One example is the Alliance for Hydromet Development; the Fund is a founding member. The Alliance is

committed to scale up and unite efforts to strengthen the capacity of National Meteorological and Hydrological Services. Climate services involve the timely production, translation, and delivery of climate data, information and knowledge for decision-making to improve disaster risk reduction and adaptation. Climate services adapted to different contexts can lead to improved agricultural practices, inform better water use and efficiency, and enable resilient infrastructure planning (IPCC 2023).

To build better systems, there are increasing calls for stakeholder engagement in disaster risk reduction, early warning systems and climate services. This includes partnerships with institutions and users from climate-sensitive sectors and especially vulnerable communities (van Aalst, Cannon and Burton 2008). Stakeholder involvement produces more effective and sustainable outcomes through linking scientific, indigenous, local and practitioner knowledge, and local contexts and values (Lemos et al. 2019).

Combining early warning systems with infrastructural measures and nature-based solutions has reduced loss of lives and proven to be cost-effective (IPCC 2023). Additionally, building climate-resilient housing and safe shelters is a key adaptation action to protect vulnerable people (IPCC 2012). Ecosystem conservation provides long-term protection from climate extremes. At the same time, it enables improvements in economic livelihoods and human well-being, particularly for the poor and vulnerable (Opperman and Galloway 2022). Finally, policies and institutions play a strong role in strengthening resilience (Agrawal 2010). Policies define the roles of different parts of the government, enable coordination between sectors and scales, and support regular budgeting for adaptation activities (Dovers and Hezri 2010).

B. The Adaptation Fund

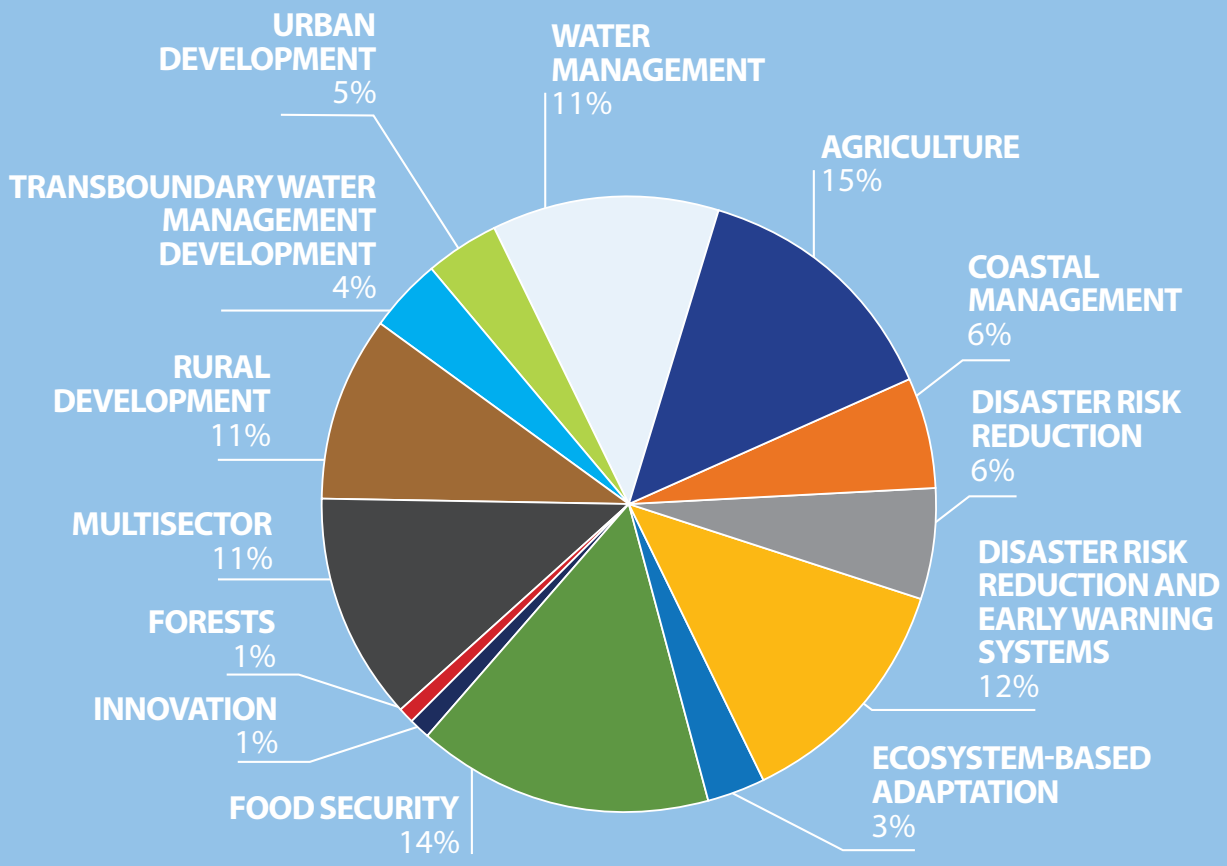
Building long-term resilience through disaster risk reduction and early warning systems is a key area of the Fund's work with its large portfolio of adaptation projects and its long experience as a pioneer and innovator in adaptation finance. Established in 2001 under the United Nations Framework Convention on Climate Change (UNFCCC), the Fund is mandated to assist developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse impacts of climate change. Specifically, it helps them meet the costs of adaptation by financing concrete adaptation projects and programmes that are country driven and based on the needs, views and priorities of eligible Parties. It also pioneered Direct Access, empowering countries to access funding and develop projects directly through accredited national Implementing Entities.

Over the last 12 years, the Fund has built resilience for over 38 million people in almost 100 vulnerable countries. This includes 22 Small Island Developing States and 41 Least Developed Countries. As of 30 June 2022, over US$923.5 million has supported 132 adaptation projects and programmes (Adaptation Fund 2022). There

are ongoing projects in Africa, Asia-Pacific, Eastern Europe, and Latin America and the Caribbean, as well as two global projects.

While this report focuses on disaster risk reduction and early warning systems projects, projects are addressing adaptation across a range of sectors. The chart below presents the various sectors represented in the portfolio. These include food security, disaster risk reduction and early warning systems, water management, rural development, coastal management, urban development and ecosystem-based adaptation.

Figure 1. Adaptation Fund investments by sector as of June 30 2022 (US$ millions)



Source: Adaptation Fund 2022.

III. Objective

This study offers an overview of the Fund's experience and lessons learned on disaster risk reduction and early warning systems interventions in strengthening long-term resilience to climate change. In this way, it seeks to advance understanding among the wider adaptation community, as well as generate and share knowledge on project approaches. The study also fulfils one of the three strategic pillars of the Medium-Term Strategy (2023-2027), Learning and Sharing, which aims to develop knowledge and evidence on effective and innovative adaptation action and finance.

Findings will be of interest to the Fund's stakeholders, current and prospective Implementing Entities, Executing Entities, government officials, private sector, civil society groups, youth organizations, other adaptation practitioners and the public interested in approaches to disaster risk reduction and early warning systems.

Disaster risk reduction project site visit in Colombia
Photo by Adaptation Fund

IV. Methodology

The study methods include document analysis and semi-structured interviews. Analysis covered a review of the academic and grey literature on disaster risk reduction and early warning; a review of Fund policies and guidelines related to the study, including the Strategic Results Framework, Environmental and Social Policy, Medium-Term Strategy (MTS 2023-2027) and the Fund's 2019, 2020, 2021 and 2022 Annual Performance Reports; and a review of its disaster risk reduction and early warning systems portfolio. The portfolio review was used to understand the general characteristics of the projects and informed the case study selection. The case studies were chosen based on four criteria: (1) at least midpoint in implementation, (2) a diversity of approaches, (3) geographic diversity, and (4) significant results. For each case study, the authors reviewed all available documents, including Project Performance Reports, Mid-Term Reviews, Terminal Evaluations, project completion summaries and Project Monitoring Mission reports, where available. They also examined project websites, newsletters and social media. Finally, semi-structured interviews were conducted with project leaders and advisers to understand project approaches, their effectiveness and lessons learned.

Early Warning Systems (EWS) technician showcasing the server room, Cook Islands
Photo by Melina Tuiravakai

V. Approaches to strengthen resilience through disaster risk reduction and early warning systems interventions

Adaptation Fund's disaster risk reduction and early warning systems portfolio

The Fund's disaster risk reduction and early warning systems portfolio works to support vulnerable countries to strengthen long-term resilience. This goal is achieved through alignment with the Fund's Medium-Term Strategies (2018-2022 and 2023-2037) and three strategic pillars: Action, Innovation, and Learning and Sharing (Adaptation Fund 2018; 2023). These integrated strategies are being harnessed along with funding models to build projects effectively, diffuse innovative disaster risk reduction and early warning technologies and practices, and generate and disseminate knowledge on best practices. As of June 2022, 516 early warning systems have been installed, supporting communities to build resilience by increasing access to climate information and hydromet services (Adaptation Fund 2022).

According to the 2022 Annual Performance Report, disaster risk reduction and early warning systems projects account for 18 per cent of the Fund portfolio (Adaptation Fund 2022). The two types of projects combined cover US$112.3 million with budgets ranging between US$3.9 million and US$14 million. These projects make up one of the highest funded sectors in multiple regions. For example, US$60.5 million has been invested in Africa, while funding reached US$35.3 million in Latin America and the Caribbean (Adaptation Fund 2022). Within the current portfolio, this funding led to establishment of 332 early warning systems in Africa, 129 in Latin America and Caribbean, 54 in Asia-Pacific and one in Eastern Europe.

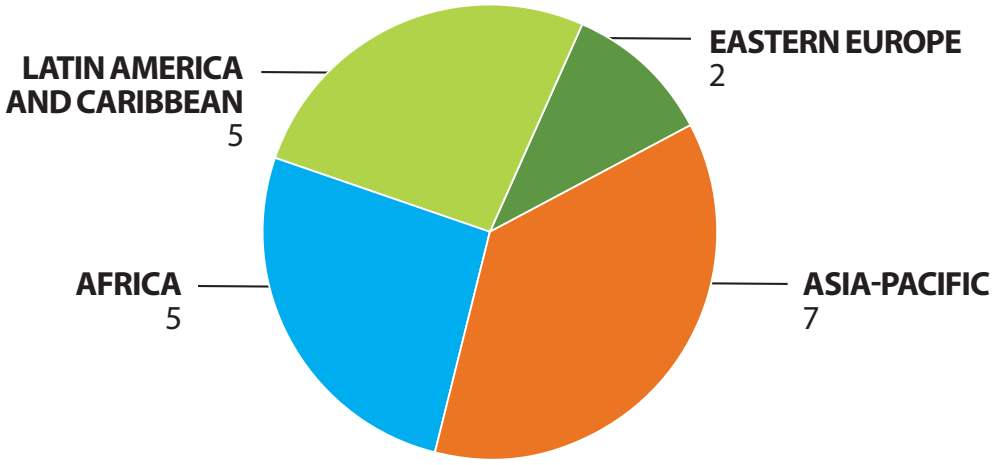
The Fund began its first disaster risk reduction and early warning systems project in 2012. The portfolio comprises 19 projects in 33 countries across the globe. Only four projects have been completed with the rest still in process. Most projects started in the last two years. They are evenly distributed across geographic regions, other than Eastern Europe which has only a few countries eligible for finance. More than half are regional projects, encompassing at least two countries. The large number of regional or transboundary projects is aligned with the Fund's increase in regional programmes, including in other sectors.

Beyond its project portfolio, the Fund has joined multiple global efforts to advance early warning systems such as the United Nations' "Early Warning for All" Initiative, the Alliance for Hydromet Development and its Systematic Observation Financing facility (SOFF). Combined these initiatives are working to reduce climate impacts through increase access weather and climate data, increasing early warning systems and increasing capacities of National Meteorological and Hydrological Services.

Table 1. Snapshot of the disaster risk reduction and early warning systems portfolio (as of April 2023)

Total number of projects	Projects completed	Projects under implementation	Total number of countries	Regional projects
19	4	15	36	10
Project countries	Albania, Argentina, Bangladesh, Benin, Burkina Faso, Chad, Chile, Colombia, Cook Islands, Côte d'Ivoire, Djibouti, Ecuador, Former Yugoslav Republic of Macedonia, Ghana, Haiti, Lao PDR, Kazakhstan, Kenya, Kyrgyzstan, Madagascar, Malawi, Mali, Mongolia, Montenegro, Mozambique, Niger, Pakistan, Papua New Guinea, Peru, Sudan, Tajikistan, Togo, Uganda, Uruguay, Uzbekistan, Union of Comoros			

Figure 2. Disaster risk reduction and early warning systems projects by region (as of April 2023)



Key approaches to strengthen resilience through disaster risk reduction and early warning systems interventions

The Fund's disaster risk reduction and early warning systems portfolio applies a range of approaches to build long-term resilience. Based on an analysis of the case studies included in this report, the primary approaches are the following:

- Multi-scalar
- Risk management tools, technologies and systems
- Community-based disaster risk reduction
- Grey and green infrastructure
- Policy and institutional development
- Capacity-building, learning and information sharing

The section below describes the key approaches and some activities implemented within them. The next chapter includes case studies with more detail on the development and implementation of the various approaches.

Table 2. Adaptation Fund project approaches

Multi-scalar Community – Village – City – District-State-Province-National – Regional – Transboundary – Basin-wide – Mountain Range				
Risk management tools, technologies and systems	Community-based disaster risk reduction	Grey and green infrastructure	Policy and institutional development	Capacity-building, learning and information sharing

Multi-scalar approaches: Administrative and ecological – community, state, national, regional, mountain range, basin-wide

Projects are working across scales depending on the climate risk and focus of the intervention. This includes both administrative and ecological scales. Administratively, projects are linking communities, villages, districts, cities, states, provinces, countries and regions. Ecologically, this includes both river basins and mountain ranges. This approach recognizes the interlinkages between scales to support disaster risk management and early warning systems. The approaches below are implemented across these various scales.

Risk management tools, technologies and systems

Risk management tools, technologies and systems are a key component of all disaster

risk management and early warning systems projects. This includes multipurpose early warning systems that address more than one disaster risk, such as floods and droughts. It also includes automatic hydrological and meteorological stations, hazard, climate risk and vulnerability mapping, disaster risk assessments, scenario planning, monitoring equipment and developing tools to understand, use and store metrological, climate and hydrological data.

Community-based disaster risk reduction

In community-based disaster risk reduction, communities actively engage in the identification, assessment, planning and implementation for hazards. This includes interventions such as community planning, and adaptation and resilience-building activities such as strengthening food, water and economic security.

Grey and green infrastructure

Projects combine hard and nature-based approaches to address existing risks. Hard infrastructure includes building walls, drainage channels and dams to manage flood risks. Ecosystem-based approaches include mangrove restoration to protect coastlines from storms, planting trees to reduce soil erosion, and urban greening to reduce stormwater run-off.

Policy and institutional development

Building an enabling environment that can support disaster risk management requires the development and support of policies and institutions. Projects established new community groups such as hazard watch groups and local disaster management offices. An enabling environment also includes developing new policies, mainstreaming disaster risks and urban resilience into existing plans, and developing new coordination mechanisms or integrating disaster risk reduction planning into existing mechanisms.

Capacity-building, learning and information sharing

A key component to all projects is capacity building, learning and information sharing around disaster risk information, technologies and management to strengthen country systems and empower communities. This occurs through awareness-raising activities, workshops, conferences, trainings, meetings and through the public media. Projects are engaging a wide range of stakeholders through these activities to reach those both within and outside the project, including regional and global audiences.

Automatic weather stations installed in the West Africa,
Volta Basin - Benin, Cote D'Ivoire and Ghana
Photo by Adaptation Fund

VI. Experiences from the Adaptation Fund portfolio

This section provides seven case studies of disaster risk reduction and early warning systems projects from the Fund portfolio. The cases cross all regions and reflect the diversity of sectors and stakeholders. Building on key approaches identified in Chapter Five, the case studies highlight: **(1) the range of approaches, (2) how these approaches are contextualized depending on climate risk, local conditions and needs, (3) how the approaches have been implemented effectively, and (4) initial lessons within these approaches, including key factors that have enabled success.** Given the range and number of approaches within and across cases, each study features a selection of approaches and activities from the project. Most projects are still under implementation and lessons continue to be learned and captured.

The case studies are divided into three categories based on the primary scale of the project – **community, regional, and basin approaches:**

Community approaches are grounded in local disaster risks and related needs. Locally led adaptation is a core component of the Fund's work as it seeks to empower and engage vulnerable groups. This approach is widely recognized as necessary for building long-term resilience effectively (IPCC 2022).

Regional approaches link two or more countries in the same geographic region or adjacent regions that face similar adaptation challenges. Often, these regions are also united by other climate projects, such as the African Adaptation Initiative. Regional approaches have been promoted in disaster risk reduction and early warning projects for two reasons: disaster risks cross borders; and the increasing evidence of opportunities arising from joint climate information sharing and learning.

Basin cooperation is a regional approach that unites countries across a transboundary river basin. Starting in 1996, the Convention on the Protection and Use of Transboundary Watercourses and International Lakes required Parties to engage in transboundary water management given the need to manage shared water resources. More recently, the Transboundary Water Cooperation Coalition and Global Environment Facility's International Waters Learning Exchange and Resource Network and others including the Fund have advanced basin-wide cooperation for managing water resources, including flood and drought planning in a changing climate.

Gabion wall built by local communities to effectively control flash flood, project funded by AF in Northern Pakistan.
Photo by UNDP

A. Community approaches

Pakistan: Reducing risks and vulnerabilities from Glacial Lake Outburst Floods in northern Pakistan

Project amount: US$3,906,000
Implementing Entity: United Nations Development Programme
Implementation period: 2011-2015 (completed)

Background

Glacial Lake Outburst Floods (GLOFs) are a growing climate hazard in remote northern Pakistan. Large mountain glaciers combined with increasing temperatures are leading to cascading impacts as melting ice fills glacial lakes beyond their capacities. This, in turn, increases the threat of the lake bursting and discharging a huge volume of water and debris. Ultimately, this causes flooding that brings devasting impacts to downstream communities. An assessment has catalogued 52 lakes as potentially hazardous and likely to cause GLOFs over the next few years to decades.

To address this increasing risk, the project sought to reduce climate change-induced risks of GLOFs in Gilgit-Baltistan and Chitral regions of Pakistan. Working with national, provincial, district authorities and communities to prioritize and implement climate change adaptation measures, the project was designed around four outcomes: (1) strengthened institutional capacities to

implement policies, plans and investments that prevent human and material losses from GLOF events in vulnerable areas of northern Pakistan; (2) improved access of disaster management planners and policymakers to knowledge, information and research on GLOF risks; (3) reduced human and material losses in vulnerable communities in northern Pakistan through GLOF early warnings and other adaptation measures; and (4) documented and replicated project experiences.

Achievements

- 27 flood protection walls constructed in Bagrote Valley and Bindo Gol Valley
- 23 safe havens constructed, including safe access routes
- 26 Village Hazards Watch Groups established and trained
- 107 workshops on GLOF risks hosted, including for women, youth, disabled and elderly people
- 25 studies on GLOFs and its various impacts on region to inform disaster planning

Approaches and lessons

Multi-scalar approaches

A multi-scalar approach, grounded in community interventions, builds a sense of ownership. Working across scales and linking various institutions engage stakeholders and support empowerment, thus building sustainability of project outcomes. By working with national, provincial, district authorities and communities, the project developed constructive roles for various institutions to address GLOF risks within their mandates and build effective disaster management processes that met local needs. Building ownership was also supported through embedding the project in a government entity, the Climate Change Division of the Ministry of Environment. This was key to the project's success and ultimately supported the scaling up of the project to other communities in Pakistan with financing from the Green Climate Fund.

Capacity building, learning and information sharing

Using a comprehensive approach to build awareness around GLOF risks both inside and outside the country was essential for project effectiveness. At the outset, little was known in Pakistan about GLOFs or ways to mitigate the increasingly severe hazards. To educate the public, radio and TV programmes were developed and broadcast across the country. This was combined with media training workshops to increase knowledge among journalists and to ultimately produce more informed media reports on the issue. To support stakeholder learning and the scaling up of best practices, the project held tailored seminars, workshops, trainings and exchange visits. These included site visits whereby national and provincial government department and stakeholders could see project lessons first-hand. The project even included a visit to Bhutan to learn from best practices in their early warning systems and disaster risk management programmes. An international GLOF conference, with attendees from 11 countries, was held at the end of the

project. It brought stakeholders from other countries facing GLOF risks to share lessons and increase the project's impact beyond Pakistan.

Policy and institutional development

To secure the sustainability of project outcomes, GLOFs were integrated into government plans and local institutions. At the national level, GLOFs were mainstreamed in policy, including the National Disaster Management Plan and National Disaster Management Act. At the provincial level, the Disaster Risk Management and Disaster Risk Reduction Plan also incorporated GLOFs for the first time. This provided the long-term institutional structures to support actions across the government to reduce GLOF risks and improve resilience. The project also developed disaster risk reduction and disaster risk management manuals to inform future risk management planning across the country, allowing for the scaling up of project activities.

At the local level, community groups were established to support long-term disaster risk management beyond the project's lifetime. Disaster Risk Management Committees and village-based Hazard Watch Groups were given skills, a mandate and equipment, all resources needed to monitor glacial areas effectively and build early warning systems that meet local needs. In fact, these groups led community engagement in the project's newly built safe havens during a GLOF event. These groups were coupled with a disaster risk management endowment fund to provide financial resources for households for disaster recovery and resilience efforts. Beyond addressing GLOFs, the groups became a forum to address other important community issues as well, empowering local decision-making and social cohesion that can support long-term resilience.

Meeting with beneficiaries during AF project visit in Ulaanbaatar, Mongolia
Photo by Adaptation Fund

Mongolia: Flood resilience in Ulaanbaatar Ger Areas – climate change adaptation through community-driven small-scale protective and basic services interventions

Project amount: US$4,495,235
Implementing Entity: UN-Habitat
Implementation period: 2019-2024 (under implementation)

Background

The capital of Mongolia, Ulaanbaatar, is home to half of the country's citizens and is attracting an increasing population of poor migrants who are moving into informal "Ger" (nomadic tent) settlements. This has led to increasing pressure on urban infrastructure and the environment as the government lacks the resources and technical capacity to provide climate-resilient utilities and services. Due to increasingly warm summers because of climate change, urban floods have become more frequent. Meanwhile, the city also suffers from flash floods and groundwater flooding. Unplanned Ger areas are sited in the high-risk northern areas of the city, including in gullies or dried riverbeds. Thus, as these areas expand rapidly, so do flood risks. Moreover, floods cause latrines to overflow, resulting in contaminated water and soil, which in turn leads to public health issues and water scarcity.

To build resilience of the seven most vulnerable Ger subdistricts (khoroo) settlements in Ulaanbaatar, the project includes the following components: (1) improve

knowledge on flood hazard and risk exposure and vulnerability for these areas; (2) improve the resilience and adaptive capacity of Ger settlements through a community-based gender-responsive approach; (3) increase resilience of the physical infrastructure and services, supported by enhanced capacities of the responsible district level and khoroo authorities; and (4) strengthen institutional capacity to reduce risks and capture and replicate lessons and good practices.

Achievements

- 3,878 inhabitants trained in disaster risk reduction and preparedness, climate change and adaptation measures, environmental hygiene, disease prevention, solid waste management and the People's Process approach
- 1,700 people from 350 households trained to ensure efficient implementation and management of the improved resilient toilets
- 70 community groups established, representing 845 families, to improve disaster risk decision-making
- Two drainage channels and a flood retention dam completed in different communities providing direct flood protection for over 2,000 households

Approaches and lessons

Community-based disaster risk reduction

A community-based, gender-responsive approach was instrumental in ensuring that project activities met the needs of vulnerable community members. Women were empowered to be leaders and key members of the 70 community groups and mobilized to design and manage the flood risk interventions. One key community priority was building flood-resilient toilets. The inclusion of women led to improvement and adaptation of toilet design to address accessibility and safety concerns of the entire household, including women, children, elderly and the disabled. The community, including women, were central to the construction, procurement of materials, quality control and negotiations with the government. They will also operate and maintain the infrastructure. The community-driven process has provided community members with skills to guarantee the sustainability of infrastructure investments.

Risk management tools, technologies and systems

Co-developing flood risk maps between communities and the government has led to improved stakeholder decision-making. Prior to the project, there was no publicly available flood risk information to inform land-use decisions in the Ger areas. To address this gap, the project combined community information gathered through consultations with data from various government departments at the municipality, district and khoroo level. In this way, it produced flood vulnerability, flood hazard mapping and a simulation model for future climate and flood risks for each community. These assessments were used to understand the community's perspectives and risk experience and integrate them into planning. As much evidence has shown, risk maps provide probabilities that can be

useful for planning. They also contain uncertainties that are better understood and managed through a deliberative process. Using a participatory approach, the maps became a tool for community members, including women, elderly and youth, to better understand flood risks, identify areas affected by frequent flooding, and focus on the most vulnerable community members. In this way, it underscored the importance of collective action to address flood risks. Ultimately, involving the municipal government has enabled the maps to be integrated into land-use plans, institutionalizing resilient decision-making.

Capacity-building, learning and information sharing

Consultations, training and workshops were developed to share knowledge, build capacity and support learning across scales. At the community level, trainings were conducted on disaster risk reduction and preparedness, climate change and adaptation measures, environmental hygiene, disease prevention, solid waste management and the People's Process approach (UN-Habitat 2008). Additionally, communities were trained as trainers for disaster risk reduction and resilience building, enabling them to teach others outside the project area. Communities learned new skills through working with field engineers on the construction and maintenance of improved climate-resilient toilets. Empowered with new information, skills, knowledge and with the new community institutions in place to address concerns, the project has built ways for communities, including women and youth, to address their current and future adaptation needs. At the national level, the project has trained a range of government officials from the Ministry of Environment and Tourism, two municipality organizations and three offices of district governors, as well as the Mongolian University for Science and Technology and selected community organizations, to build awareness of flood risks and urban adaptation, and to support continued effective community engagement.

Farmers with climate-smart irrigation systems, supporting food security needs, Cook Islands
Photo by Adaptation Fund

Cook Islands: "Akamatutu'anga kia Tukatau te Ora'anga ite Pa Enua" Pa Enua Action for Resilient Livelihoods (PEARL)

Project amount: US$2,999,125
Implementing Entity: Ministry of Finance and Economic Management, Cook Islands
Implementation period: 2018-2022 (completed)

Background

The Cook Islands, located in the Pacific Ocean, include 15 small islands scattered over about 2 million square kilometres (km2). The islands experience climate hazards that include tropical cyclones, floods and droughts. The outer islands (Pa Enua), both to the north and south of the capital, are home to only 27 percent of the population with limited economic resources to recover from disasters. This island group had insufficient early warning systems and tools to address drought risk.

The programme used an integrated approach to further increase the adaptive capacity of remote island communities and ecosystems to disaster risk and climate change impacts. The objectives were to: (1) strengthen national and local capacity for monitoring and decision-making to respond and to reduce risks associated with climate change; (2) establish climate- resilient water management instruments; and (3) raise awareness and establish a knowledge exchange platform to increase adaptive capacity to revitalize agriculture production systems.

Achievements

- All 13 islands have early warning systems in place
- Local Disaster Management Plans endorsed for the Pa Enua
- Completed National Disaster Risk Management Plan, National Disaster Risk Policy and National Disaster Risk Act 2023
- 25 farms with built irrigation systems, supporting food security needs for all the islands in the Southern Group

Approaches and lessons

Multi-sector and multi-scale approach

A multi-sector and multi-scale approach improves project effectiveness. This approach was developed based on lessons learned through the previous Fund-supported Program Strengthening the Resilience of our Islands and Communities to Climate Change (SRIC-CC). Working across key national agencies and local island governments, the project engaged all relevant government stakeholders from the start to meet government priorities and build ownership and buy-in in the project activities. Relying on the Climate Change Unit in the Prime Minister's Office to coordinate and monitor the project, the Emergency Management Cook Islands, MET Office and Ministry of Agriculture and Infrastructure were involved from the development of the project through its execution. This structure was key to the project's success but also a challenge to develop as these agencies had never worked together before. Ultimately, the strong working relationship between the agencies provided the mechanism for effective implementation.

Risk management tools, technologies and systems

The project installed or strengthened early warning systems, improving the monitoring capacity across all the outer islands. These data are now directly connected to the central systems in the capital and shared with regional partners to inform climate information across the Pacific Islands. In this way, they support a meteorological information exchange that is essential for effective early warning systems. It also supports development of key planning tools for agriculture such as the early rainfall summary as a tool to prepare for droughts for all the islands. MET Services decided to train a team of young Cook Islanders to install the equipment rather than following the regular process of hiring outside experts. This was a challenge since no one had done this before, but it built youth capacity and confidence. Given that equipment will need to be updated and repaired in the future, developing this local capacity qualifies as part of the project's success.

By integrating indigenous knowledge and skills learned through trainings, the project supported more effective disaster planning for the outer islands. One part of the effort included household surveys. On each island, the survey assessed all the buildings and counted and categorized the number of people with special needs such as the elderly, children, people with

disabilities and people with asthma by age and gender. This provided important information to guide each island's planning and to ensure the local government knows who will need support during an evacuation, where they live and the financial and capacity resources required. Ultimately, this process has supported the long-term institutionalization of disaster risk management, including development of an updated Disaster Management Plan at the national level and endorsed plans on the Pa Enua.

Community-based disaster risk reduction

An important aspect to build resilience from future droughts is to diversify water and food supplies by working directly with government and community members, including women farmers and youth. New rainwater harvesting systems, community water tanks, rain gauges and water tank monitoring equipment were installed to ensure drinking water resources are sufficient and managed effectively. Historical climate data from the Cook Islands and wider region were sourced from the national MET Office and regional agencies. These informed the most suitable options for water catchment and storage, while storage locations were based on community infrastructure and needs.

Other infrastructure was built, including irrigation systems and nurseries to ensure that an island could supply itself with food without relying on imports from other islands, while building long-term resilience. This is particularly important in case of a disaster where it may take a long time for ships to reach the island. Additionally, the project expanded markets for farmers to diversify economic opportunities by exporting crops to the capital, Rarotonga. Engaging youth through developing school and home gardens and incorporating gardens into their school's curriculum was essential to support near- and long-term food security and to improve livelihoods.

Engaging with Andean local communities, AF-funded regional project in Chile, Colombia and Peru
Photo by WMO

B. Regional approaches

Chile, Columbia, Peru: Enhancing adaptive capacity of Andean communities through climate services

Project amount: US$7,432,250
Implementing Entity: World Meteorological Organization
Implementation period: 2021-2025 (under implementation)

Background

Chile, Colombia and Peru are vulnerable to climate change due to high levels and impacts of poverty. They share the presence and influence on their climate of the Andes that run continuously near the western coast of South America for over 7,000 km, from Colombia to southern Chile. Climate change has been observed in South America, including changes in climate variability, extreme events and the retreat of Andean glaciers that impacts stream flow and water supplies for cities, agriculture and hydropower generation. The goal of "Enhancing Adaptive Capacity of Andean Communities through Climate Services" (ENANDES) is to enhance the capacity of society and communities to adapt to a varying and changing climate. To that end, the project produces, communicates, and assesses the use of credible, authoritative, and usable information as scientific evidence for decision and policymaking on preparedness for, and

reduction of damages from climatic hazards.

Achievements

- Scaled up to include three more countries in the region with financing from the Swiss Government
- Wide participation across 12 countries in region for workshops, including on the WMO Integrated Global Observing System and the WMO Information System
- Implementation of multi-stakeholder platforms for participatory decision-making in the energy and agricultural sector

Approaches and lessons

Regional approach

A regional approach to climate information services brings opportunities to develop better climate information tools, including weather and climate prediction modelling, beyond what one country can do alone. In this case, the countries are also united by shared risks from the influence of the Andes on their climates and the cross-border nature of the risks. The project's sustainability is supported by working directly with the primary agencies in charge of climate services: the National Meteorology and Hydrology Service of Peru; the Institute of Hydrology, Meteorology and Environmental Studies of Colombia; and the Meteorological Directorate of Chile. This approach is also supported by a regional partner, the International Center for Research on the El Niño Phenomenon. However, working across three countries also brings unique challenges as each country has its own legal framework and institutional structures. Furthermore, linking climate services information systems requires shared data sources. While working directly with public institutions allows for capacity to be built within the institutions, it has also led to delay and disruption due to recent government changes.

Demonstrating the usefulness of working across the region, the project has recently been scaled up with additional funding from the Swiss Government. This has helped the project bring in three more countries, Bolivia, Ecuador and Argentina. Consequently, it has expanded its reach to six National Meteorology and Hydrology Services and four regional centres. Multiple factors have supported the scaling up of the project. First, although the project initially focused on three countries, the overall strategy was to build regional cooperation across all Andean countries. Therefore, the project brought in other countries from the outset. This included involving 16 countries in the project inception workshops. Second, the first set of countries have high levels of capacity and technical resources that have enabled production and delivery of enhanced climate services. Finally, the region primarily uses one language, which removes a common barrier to cooperation and exchange.

Policy and institutional development

The Ministry of Agriculture and Rural Development in Colombia is using Technical

Agroclimatic Committees, an existing institution, to build resilience of the agricultural sector. These committees serve as participatory, multi-stakeholder decision-making platforms to share agro-climatic forecasts. These forecasts combine analysis of seasonal predictions for the region, crop models and approaches to address impact scenarios and to develop adaptation strategies. The committees exist at the national level and in 18 regions covering the various parts of the country. They bring together government, community-based organizations, farmers, fishers and academics. The model is working so well as a decision-making body that it will be replicated in Chile and Peru.

In Chile, the energy sector has been engaged in discussions around climate information for the first time. The country relies on hydropower for its electricity needs, making it a climate- vulnerable sector. The National Meteorology and Hydrology Service, with the support of the Ministry of Energy, created an Energy Roundtable with regular meetings to address the needs of energy utilities, providers and consumers. It aimed to optimize and improve climate products and services for the sector. This engagement has supported the National Meteorology and Hydrology Service to understand how to tailor information needs for the sector and to develop an improved database interface to support decision-making. In the future, these discussions are planned at the local level to understand their data needs as well.

Capacity-building, learning and information sharing

Workshops have been organized on topics such as data management, climate monitoring and adaptation planning to increase the capacity of National Metrological and Hydrological Services to deliver improved climate services. Stakeholders across Central and South America have been able to take part, providing opportunities for cooperation, lesson sharing and learning beyond the project countries. Given COVID-19 restrictions, these activities have happened virtually rather than in person. This has enabled broader participation at no increased cost. Trainings have also been tailored for specific offices and have raised stakeholder awareness. For example, National Metrological and Hydrological Services in Chile did not previously view adaptation as part of its work. Now it wants training to better support adaptation policy goals.

Meeting with national and local stakeholders,
AF-funded project in south-eastern Africa
Photo by UN-Habitat/OXFAM

Madagascar, Malawi, Mozambique, Union of Comoros: Building urban resilience in south-eastern Africa

Project amount: US$13,997,423
Implementing Entity: UN-Habitat
Implementation period: 2020-2024 (under implementation)

Background

Madagascar, Malawi, Mozambique and Union of Comoros in south-eastern Africa that are impacted by various transboundary climate change-induced hazards. These include increased frequency, unpredictability, severity of cyclones, floods, droughts and rainfall variability. Urban areas in Africa are rapidly growing and vulnerable to risks due to their dense, marginalized and poor populations and inadequate infrastructure. Working in four cities – Chokwe in Mozambique, Moroni in the Union of Comoros, Morondava in Madagascar and Zomba in Malawi – the project is building urban resilience. The project has two objectives: (1) To develop capacities and establish conditions to adapt to the adverse effects of climate change in vulnerable cities; (2) To promote inter-country experience sharing and cross-fertilization regarding the adaptation to transboundary climate-related natural hazards and disseminate lessons learned for progressively building urban climate resilience in south-eastern Africa.

Achievements:

- Development of the national guidelines, policies and laws for promoting gender-sensitive urban climate resilience

- Operationalization of Disaster Risk Management, Sustainability and Urban Resilience (DiMSUR) to facilitate the intraregional experience and lesson sharing on gender-sensitive disaster risk management and urban resilience-building practices
- Two drainage systems completed in Zomba with three-quarters of the target community's participation in the project, including 30 per cent women
- Early warning system completed in Chokwe, benefiting almost 40,000 people
- In Morondava, the project constructed a multipurpose safe haven that more than 200 people used during the January 2023 cyclone.

Approaches and lessons

Regional approach

Urban resilience is more effective through a collaborative multi-scale regional approach that builds on the resources, mandates and governance structures of city, national and regional actors. At the city level, interventions have been designed using a participatory approach. They aimed to contribute insights that inform the national government's plans to replicate good resilience-building practices in other cities. The national government provides the policy and institutional enabling environment that supports urban resilience. The regional level provides a venue and process for the cities and national governments to share experiences and ultimately support the scaling up of innovations.

While there are clear benefits, a regional approach brings coordination challenges among governments and the various stakeholders. Capacity, financial resources and time are needed to develop partnerships and effective procedures across project countries and cities. The timely exchange of information and experiences is key to promote coordination and transmit lessons to inform action in other project countries. The project has also learned it would be more effective with a regional-level partner. To address this, the project has worked to build the operational capacity and empowerment of DiMSUR, which will support regional coordination and collect and share best practices.

Community-based disaster risk reduction, and hard and nature-based infrastructure

Adapting a regional project to the national and local context increases project relevance and potential sustainability. Using a participatory process, the project teams applied the CityRAP tool to identify risks, prioritize actions and plan for urban resilience for each city while also integrating gender considerations. Building on this process, the cities determined appropriate urban resilience interventions for each context.

An integrated combination of hard infrastructure, nature-based climate solutions and early warning systems reduces urban flood risks by building on the strengths of each invention. In the city of Morondava in Madagascar, the interventions combine mangrove rehabilitation, urban greening

with city-wide flood early warning systems, evacuation centre construction, enhancement of drainage, improved solid waste management and reconstruction of bridges. In this case, nature-based solutions work to reduce flood risks over the long term. At the same time, the hard infrastructure reduces water levels during the flood event; the early warning systems allow for citizens to adequately prepare; and the evacuation centre provides a safe venue during the disaster event. This integrated approach has been effective at preventing loss of lives and property. A similar combination of interventions in Zomba, Malawi, including nature-based solutions, reduced landsides and protected residents and their homes during a recent disaster.

Policy and institutional development

The alignment of activities with existing policy structures provides a strong framework for enabling action and has been a driver of project success. Project activities link to the existing disaster risk management policies and strategies, national environmental policies and the city-level Resilience Action Plans. The project is also supporting integration of urban resilience into existing planning structures. In Malawi, this was achieved due to the long engagement with the national government; alignment of the project with the review of national policy; UN-Habitat's role in the project and support for the draft review; and the effectiveness of interventions from the Fund's project and other urban resilience actions.

Removing deposited sediment and overgrown vegetation from the river led to resilient flood risk planning in the Black Drin River, Struga, North Macedonia
Photo by UNDP Euroasia

C. Basin-wide approaches

Albania, the former Yugoslav Republic of Macedonia, Montenegro: Integrated climate-resilient transboundary flood risk management in the Drin River Basin in the western Balkans

Project amount: US$9,927,750
Implementing Entity: United Nations Development Programme
Implementation period: 2019-2024 (under implementation)

Background

Spanning across North Macedonia, Albania and Montenegro, the Drin River Basin is home to 1.6 million people. It encompasses essential ecosystems including rivers, lakes, forests, and agricultural and urban areas. The basin and its waters provide a variety of benefits for the environment, agriculture, energy, water supply and sanitation, tourism and well-being. Climate change has been increasing the frequency, intensity and impact of flooding as flooded areas have been significantly expanding over the last decade. Other impacts such as water scarcity, intensified erosion and sedimentation, water quality deterioration and ecosystem loss are forecasted. To address the increasing risks to vulnerable populations, the project is implementing an integrated transboundary flood risk management approach framework including: (1) improved climate risk knowledge and information; (2) improved transboundary cooperation arrangements and policy

framework for flood risk management and (3) concrete flood risk management interventions.

Achievements

- Procurement of 9 new hydrological and 8 meteorological fully automatic monitoring stations and upgrade of 11 existing hydrological and 5 meteorological stations
- 1000 people in the Struga Municipality in North Macedonia were directly protected by removing an estimated 22,000 cubic meters of deposited sediment and overgrown vegetation from the river
- 47 public officials and other key national and regional stakeholders from the three riparian states trained in advanced climate risk management planning and flood prevention measures, including hydraulic modelling

Approaches and lessons

Basin-wide flood risk management

Bringing together countries across the entire basin, the project developed an integrated transboundary approach. The basin-wide approach builds on existing recommendations from the European Union for flood management and provides multiple advantages for the project. The project yielded three key lessons. First, models and flood risk maps could be developed for the entire basin, providing more comprehensive understanding for effective long-term planning. Second, a basin-wide approach used technical and financial resources efficiently, leading to significant cost savings and streamlined project and country resources. Finally, it provided a mechanism for learning and information exchange across the basin countries to build capacity for current challenges and to address future flood risks. To embed this approach beyond the project, a more long-term framework and formal institutions is required to support basin-wide planning. The current mechanism, the Drin Core Group, is based on a memorandum of understanding between riparian nations signed 10 years ago to consider transboundary issues in the basin. However, it does not have the formal authority to address the current basin-wide challenges.

Risk management tools, technologies and systems

The development of climate risk information tools, including improved early warning system infrastructure, maps and modelling, has led to more evidence-based decision-making in the basin. North Macedonia and Montenegro now have new, fully automatic hydrological and meteorological monitoring stations. Meanwhile, existing systems in North Macedonia have also been upgraded, leading to improved flood forecasting and early warning systems. Numerous basin-wide hydrological models were also developed to inform decision-making and development of flood hazard and flood risk maps for all high-risk flood plains. Combined, these data and information have informed decision-making in areas such as spatial planning, construc-

tion zoning and design of flood protection infrastructure. This has led to more resilient flood risk planning.

Developing the basin-wide flood risk maps and models requires high quality data over time and space. This was a challenge as no centralized, basin-wide database of hydrometeorological data existed in a digital format before the project. By developing effective national partnerships, building capacity and connecting with international organizations, the project collected the data needed, including using satellite imagery to address existing national information gaps. This successful approach of linking different data sources and partners could be replicated in other countries and regions that lack adequate data sources. The project has developed a flood risk modelling and mapping technical guidance document to help share lessons in other jurisdictions.

Learning, capacity building and information sharing

Coordination and effective partnerships were essential to support learning and information exchange across sectors at the national and regional scale. This went beyond the data collection phase to the entire project – from preparation through implementation. It included engaging with the regional coordination mechanism, National Hydrometeorological Service, National Water Administrations and relevant ministries. Basin-wide technical working groups on hydrometeorological monitoring and flood risk mapping provided a forum to receive guidance, share information and connect the project with other initiatives in the basin. Learning and training programmes were also held for national and regional stakeholders in advanced climate risk management planning and flood prevention measures to support long-term resilience. Hydromet services staff received hands-on training in hydrometric network design, and operation and maintenance. The training covered topics such as planning, design, establishment and upgrading of monitoring stations. This aimed to meet a range of needs and methods for data exchange to ensure that infrastructure investments are effective. At the same time, the project successfully aligned itself and coordinated with other development partner initiatives in the basin, such as The German Agency for International Cooperation (GIZ), to build on lesson learned and use existing management frameworks and coordination mechanisms improving resource efficiency.

Community members observe first-hand EWS technology used to transmit weather data, in Benin, Volta Basin
Photo by Adaptation Fund

Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, Togo: Integrating flood and drought management and early warning for climate change adaptation in the Volta Basin

Project amount: US$7,920,000
Implementing Entity: World Meteorological Organization
Implementation period: 2019-2024 (under implementation)

Background

The Volta River Basin, a 400,000 km2 transboundary river basin, crosses six countries: Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali and Togo. With varied ecologies from semi-arid to subhumid, the basin and the 25 million people who rely on the river for irrigation and drinking water are highly vulnerable to climate change. Many live in areas prone to floods and landslides and are economically vulnerable subsistence farmers. Consequently, over the last 20 years, almost 2 million people have been impacted by floods. The climate is expected to continue to change with a reduction in the average annual precipitation and an increase in temperatures, placing increasing pressure on valuable water resources.

As the first large-scale and transboundary implementation of integrated flood and drought management, the project has the following objectives: 1) develop capacity and established frameworks at the local, national and regional levels to ensure risk-informed decision-making; 2) develop concrete adaptation and environmentally friendly actions with an integrated

approach; and 3) strengthen policy and institutional capacity for integrated flood and drought management at the local, national and transboundary levels.

Achievements

- Activation of VOLTALARM drought and flood early warning system for the basin
- Automatic weather stations installed at all pilot sites
- Vulnerability assessments in 60 communities in the six pilot sites
- About 5,000 people supported through community-based flood and drought management capacity-building activities at six pilot sites
- Integration of data from the newly installed weather station into the disaster risk reduction planning of northern Benin pilot site

Approaches and lessons

Multi-scale basin-wide approach

An interlinked multi-scale model provides a mechanism for bottom-up approaches to reach regional planning forums and include meaningful stakeholder participation. Drawing on an existing regional agency, the VOLTA Basin Authority, the project has a regional coordination mechanism so the six countries can address flood and drought risks across the basin. Concurrently, the project works at the national level with National Meteorological and Hydrological Services and other relevant national agencies such as environment agencies, and sustainable development and national statistics offices. There are also interventions at the community level to develop capacity and inform national actions. While a basin-level approach is an appropriate scale for planning given shared risks, it also brings challenges. Building a project across six countries with multiple languages, capacities and political instability poses implementation challenges. This has required the project to adapt over time and closely coordinate among stakeholders.

Risk management tools, technologies and systems

Several sets of tools have been developed to support more informed decision-making in the basin: VOLTALARM EWS and climate risk mapping. Through development and installation of an innovative tool, the VOLTALARM EWS, the basin can monitor and forecast flood and drought risks. This integrated system is especially important as the basin can experience both droughts and floods at the same time. The powerful system links global and local data, overlays and analyses risk scenarios in real time, and then communicates alerts. Capacity- building activities, including training national officials, are ensuring sustainability of the system beyond the project: national and regional authorities are committed to begin using the system. At the same time, by combining the data across all basin states at the regional level, the tool improves forecasting capabilities and the coordination of disaster responses.

Two lessons were learned from developing the risk maps and climate scenarios for the basin. First, collaboration is important as national and local stakeholders helped collect social and hydrometeorological data and developed GIS layers on exposure and vulnerabilities. Second, the sharing of maps with appropriate stakeholders allows for joint monitoring of the flood and drought situation and to disseminate warnings to the local population. Key stakeholders included National Meteorological and Hydrological Services, Civil Protection and Water Resources agencies.

Community-based disaster risk reduction and nature-based solutions

The National Meteorological and Hydrological Services has worked with communities to understand their disaster communication needs and support development of a more effective early warning system. For example, communities shared that understanding the amount of rain was not helpful. Rather, they would like to know the impact of the storm on their crops, livestock and property and understand how the climate will impact agricultural cycles. In the future, meteorological warnings will be used to share information to enable decisions about the appropriate timing for farmers to cut and dry their crops.

Through partnering with local NGOs, the project has been successful in building awareness of flood risks and disaster management skills, as well as in incorporating nature-based solutions into flood management. NGOs led participatory flood risk mapping workshops for community members to understand flood areas. In each pilot community, flood-level markings were placed on houses so that community members could recognize normal flood levels and know when to evacuate. Flood marking is also being used to raise the level of future homes to reduce risks. Using traditional knowledge, markers were placed in the river to note when waters are too high and dangerous to cross. The trainings included nature-based solutions for flood and drought management, as these are appropriate for the context and their livelihoods as farmers. This included ways to combat soil erosion or increase soil water retention through planting endemic species.

Planting mangroves to protect against coastal erosion and floods, Cook Islands
Photo by Adaptation Fund

VII. Findings and lessons learned

Effective approaches for disaster risk reduction and early warning projects

Fund projects have developed approaches to achieve long-term resilience. Drawing on the case studies, effective implementation of disaster risk reduction and early warning project approaches requires integration across four areas:

(1) Multi-scale
(2) Multi-sector
(3) Multi-stakeholder, grounded in community and vulnerable groups engagement
(4) Complementary and reinforcing approaches

Multi-scale

Projects are successfully working across multiple jurisdictional and ecological scales to build long-term resilience. This includes communities and municipalities, as well as national, regional and often international levels. At ecological scales, projects are crossing mountain ranges (Andes) and river basins (Volta and Drin). This recognizes both the transboundary nature of hazards and climate risks and the important roles of governments at all levels. This provides concrete evidence to support one of the tenets of the Sendai Framework for Disaster Risk Reduction. It calls for international, regional, subregional and transboundary cooperation as key to reduce disaster risk. Additionally, evidence from the projects has shown that basin- or region-wide approaches are cost-effective and provide opportunities for learning and knowledge transfer throughout the project period.

Multi-sector

Projects are bringing together a range of government departments to implement project activities as mandates and responsibilities for disaster management and early warning systems cross sectoral agencies. This includes the National Hydrology and Meteorology Services; agencies that manage climate change, environment, housing and urban development, land-use planning, public works, public health, water resources and agriculture; and even the Armed Forces. By bringing departments together, projects have enabled integrated risk management planning, more effective early warning systems and development of coordination mechanisms that will help implement cross-sectoral adaptation actions.

Multi-stakeholder engagement grounded in community and vulnerable groups

Projects have demonstrated that planning for disasters and building resilience requires all of society. There is strong engagement in projects from communities, international NGOs, community-based organizations, universities, the media and the private sector. These various groups bring expertise, evidence and support for changing behavior

towards more resilient actions. Projects are working extensively to reach, understand, involve and meet the needs of vulnerable groups including women, youth and elderly. This is crucial as hazards and risks are not affecting groups or communities equally and require tailored approaches.

Complementary and reinforcing approaches

Designing projects with interlinked and reinforcing approaches strengthens resilience. This includes developing both hard and soft infrastructure such as early warning systems, barrier walls and rainwater harvesting systems. This is combined with nature-based approaches such as urban greening and reforestation to reduce landslides and soil erosion. Projects are developing a knowledge base through hazard, vulnerability and risk mapping; building the infrastructure to collect hydrological and meteorological data; and supporting integration of all these data sources to provide comprehensive understanding of climate risks. This information is being developed in collaboration with a range of stakeholders from government and communities to enable informed decision-making. Additionally, providing awareness-raising, trainings and workshops provides a mechanism to bring stakeholders together to build capacity, trust and understanding, and to share lessons.

Challenges

Multiple challenges emerged from an analysis of the case studies.

Coordination among stakeholders

Coordination across partners and stakeholders is time and resource intensive. This became a challenge in many projects as disaster risk reduction and early warning systems involve several government stakeholders that do not traditionally work together. In addition, regional projects need to engage across scales and countries. This increases the number of partners and stakeholders that need to be kept informed to ensure effective implementation and learning throughout the project. For National Hydrology and Meteorology Services, there is also a challenge in sharing climate information within and across countries to be able to coordinate early warning systems.

Limited data and technical capacity

Meteorological and hydrological services are understaffed and lack technical capacity to address the many components of an early warning system. Countries lack the skilled technicians, hydrologists and meteorologists needed to develop and maintain these systems. National Hydrology and Meteorology Services also lacks capacity to understand the data needs of other parts of the government and local communities; this makes it difficult to adapt information for their needs. Finally, many countries lack the basic data to develop the modeling required to make effective long-term decisions.

Sustainability: Finance to support long-term needs of early warning systems

While projects are currently funding this work, it's unclear how the programmes will continue to be financed. Countries lack the regular, annual budgetary funding for collection and storage of long-term hydrology and meteorological data and for the operation and maintenance of infrastructure such as automatic weather stations. Many such stations will need to be updated or replaced in six years, requiring the development of iterative budgets for installation and maintenance rather than one-time funding.

COVID-19

COVID-19 affected all the projects, slowing implementation and leading to cancellation of some activities. For some projects, work could not start at all. Some global repercussions of COVID-19, including supply chain issues, also led to increasing costs and delays.

Lessons learned

Early warning systems and climate services

Improved data quality leads to better decision-making

The development of robust data has led to more informed decision-making and proactive approaches to climate risk planning. Understanding future disaster risks requires detailed hydrometeorological data over time and space. To address these local data gaps, projects developed innovative approaches, such as using international satellite data. Ground truthing and community engagement was found to be a powerful tool for data collection and for validation of national government data. Multi-purpose early warning systems, such as for both floods and droughts, have the potential to maximize and deliver on multiple adaptation benefits and to reduce the need for duplicative systems.

Integrating multiple forms of information is important for building robust assessments such as risk mapping, vulnerability assessments, scenario planning and land-use planning. This requires linking hydrological, meteorological and climate data combined with local knowledge. In Pakistan, early warning systems used automatic weather monitoring equipment and local hazard groups to bring together scientific and community information. The location of safe havens during GLOFs was based on surveying the area and local knowledge to ensure communities could and would access them.

Understanding and communicating risks improves outcomes

Early warning systems are only as good as their ability to meet the needs of users and give people enough time to act. It's now understood that different hazards and different sectors often require unique preparedness, warnings and response strategies (Basher 2006, UNISDR 2006). Projects have generated evidence that different

communities need different information and in different forms to enable action. Engaging communities in disaster risk management decision-making requires them to have access to the appropriate information in the right form and from the appropriate messenger. The ENANDES project is working to tailor information to indigenous groups and different government sectors such as agriculture and energy. In Mongolia, communities did not realize they were putting their homes in a flood risk area; the information had not been shared with them before the project and they were new arrivals to the area. Supplying new information and co-developing the hazards maps is leading to behaviour changes that are producing more resilient communities.

Institutions fit for purpose, scale and context drive success

While installing hydrological or meteorological stations is important, projects also need technical staff with appropriate skills and sufficient budgets. In this way, they can maintain, operate and manage the incoming data for use in early warning. For regional projects, appropriate institutions with a formal legal mandate should also exist at the regional level. In the Volta Basin, the regional institution is providing a home for all the early warning tools and to support regional data collection and management after the project ends. In the Drin Basin, this formal institution does not exist, hindering the project's ability to implement regional actions. At the community and local level, disaster management offices and community groups that can support the collection and use climate information are key.

Disaster risk reduction

Community-led actions are crucial for long-term resilience

Urban and rural communities, and especially vulnerable groups, are an essential component of building resilience. It cannot be done in an effective or sustainable way without them. Risk planning is more effective with the involvement of communities for several reasons. Given the uncertainties of risks, community-based approaches integrate local knowledge, empower meaningful participation and deliberative decision-making, and build common understanding of impacts, disaster management procedures and ownership over the outcomes. For projects with early warning systems components, community involvement made such systems more responsive to community needs and provided the appropriate forms of information sharing. Several projects successfully engaged communities from the preparation phase, building their needs, values and experiences around disaster risks and solutions into the project. This was successful in tailoring the proposal but also produced challenges in building trust given the long lag times between proposal development and implementation.

Alignment with government structures and policies enables scaling up

Working within existing government structures and in a supportive policy envi-

ronment enables the scaling up of project activities. By linking projects with policy and government programmes, interventions are sustainable, support existing priorities and provide ownership and buy-in. It also supports the long-term institutionalization of activities within government mandates. In the Cook Islands, where the government was the Implementing Entity, the project combined existing government priorities and built community resilience effectively.

Partnerships and coordination advance goals

Partnerships have been key to the success of projects as each partner brings different skills, resources and networks. NGOs and CSOs enabled projects to fulfil many of their goals. These organizations are trusted in the communities and can share information and produce outcomes that cannot be achieved without a strong partner. In the urban south-eastern Africa project, NGOs have been a strong partner in implementing urban resilience interventions. In the Volta Basin project, local NGOs helped form groups that were useful for training activities in areas such as sustainable agriculture. These local groups are useful beyond project activities. With support from a group, for example, the community launched a basket weaving business to diversify livelihoods beyond farming. This will help the community build economic resilience to withstand future disasters.

Learning builds capacity and supports long-term sustainability

Learning is happening at multiple levels in these projects, leading to a transfer of disaster risk and adaptation knowledge and supporting the long-term sustainability of activities. There is learning within communities, across project sites and across cities, countries, national jurisdictions and regions. Workshops, training programmes, site visits and informal knowledge sharing have led to better understanding of climate risks and the effective implementation of activities. Stakeholders have used new skills and information to share best practices and integrate lessons into policy and planning structures. Projects are also building on successful approaches from past efforts and learning from other development projects in the country. This is leading to more effective, sustainable outcomes.

Discussions with project committee and community leaders, Volta Basin
Photo by Adaptation Fund

VIII. Conclusion

One-third of the world, including 60 per cent of Africa, does not have access to early warning and climate information services (UNFCCC 2022). Disaster risk reduction and early warning systems are essential to address climate risk and build long-term resilience. Fund projects have tested innovative, integrated and effective approaches to achieve these goals. The Fund's work in this area can demonstrate how disaster risk reduction and early warning systems can help countries manage the impacts of climate change and avoid severe loss and damage.

Fund projects use a range of approaches, including working across scales; building risk management tools, technologies and systems; expanding hard and nature-based infrastructure; supporting community-based disaster risk reduction; developing policies and institutions; and building capacity, learning and sharing information. Effective implementation of these approaches requires integrating across four areas: scales, sectors, stakeholders with a focus on vulnerable communities and groups, and design of complementary and reinforcing activities. The study has found a combination of approaches that integrates these areas provide a useful model for disaster risk reduction and early warning systems projects. However, there is still much work to do. The Fund's approaches provide key lessons for building a more resilient future for the world's vulnerable people.

Meteorology and hydrology specialist explains how weather station gathers data, an AF-funded project to reduce disaster risks in Benin
Photo by Adaptation Fund

IX. Recommendations

Recommendations provide ways that the Fund, Implementing Entities and countries can strengthen climate resilience through disaster risk reduction and early warning systems projects.

Adaptation Fund

1 Support sustainable systems

Integrating projects into country systems supports sustainability after the project ends. There needs to be more effort to build support systems for countries during the term of a project. This could include ensuring climate services or disaster management have an annual budget or creating innovative financing mechanisms for long-term support. In addition, more effort is needed to advance more affordable solutions for countries to use to collect, hold and manage climate information such as free software.

2 Increase resources for coordination

With increasingly complex, regional projects with a host of interventions, more financial and capacity resources are needed for coordination across sites and countries. This is not straightforward, requiring time and effort to build mechanisms and trust among stakeholders who may have never worked together.

3 Build alignment with other initiatives

Projects are increasingly regional in scope with more adaptation projects spanning over several countries. Consequently, there are more partners implementing projects on the ground. This is a challenge as governments need to balance commitments across projects and projects need to plan around existing efforts. It is also an opportunity for learning and alignment to support synergies and increase cost-effectiveness and efficiency. The UN's "Early Warning for All" Initiative, for example, aims for early warning systems to protect every person within five years. This initiative can be used to reinforce existing efforts and scale up project lessons. The Fund should also continue its active engagement with international partnerships such as the Alliance for Hydromet Development and its Systematic Observation Financing facility.

4 Promote adaptative management and learning

One driver of project success has been the ability to adapt to new circumstances whether driven by increasing climate risks, global pandemics or conflict and political instability. Building mechanisms for projects to change and learn improves outcomes. Lessons on how projects can address changing conditions and learn are also important to share across project teams.

5 Avoiding Loss and Damage

As disasters increase in frequency and intensity, so does the importance of building resilience to future impacts. Early Warning Systems and disaster risk reduction have reduced climate impacts including loss and damage of lives and property. The Fund should further explore the link between these projects and loss and damage. This could include developing an internal guidance document and seeking alignment with upcoming funds and funding arrangements for loss and damage.

Implementing Entities and countries

1 Focus on the last mile to support near- and long-term planning

Local communities need to use the climate information and receive it in a timely manner to act. Lessons have shown that vulnerable communities want to understand the impacts of hazards on their lives, livelihoods and property rather than receive information on rain levels and wind speeds. This calls for a rethinking of the type of information shared and the form most useful to enable the appropriate response. More effort needs to be focused on ensuring information makes it to the last mile, the vulnerable communities that need it most.

2 Build capacity of climate services agencies and climate-sensitive sectors

While technology has improved in early warning systems, there is still a gap in translating information into a form useful for decision-making. According to the Sendai Framework Monitor, only half of countries have accessible, understandable and usable

disaster risk information adaptable for their various needs. When such information does exist, much of it is sitting with National Meteorological and Hydrological Services, which lacks capacity or formal mechanisms to collaborate with climate-vulnerable sectors and local governments. ENANDES is providing a good model for how meteorological agencies can learn to share and develop appropriate data in a form that enables empowerment and action within vulnerable sectors. This requires capacity-building in both National Meteorological and Hydrological Services and in climate-sensitive sectors so that information can be tailored and used effectively.

3 Co-develop disaster plans with communities

Communities are central to making disaster plans that understand and address local risks. Projects, such as in African cities, Mongolia and Pakistan, are demonstrating ways for communities to be engaged through the entire planning and implementation cycle. This can range from co-creating data and discussing risks and long-term solutions to implementing interventions and the continued operation and management of infrastructure and nature-based solutions.

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