Building the Analytical Base

A Summary of Results from Phase 1 of the Pilot Program for Climate Resilience in Tajikistan

PPCR

CLIMATE INVESTMENT FUNDS

WORLD BANK GROUP

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Foreword

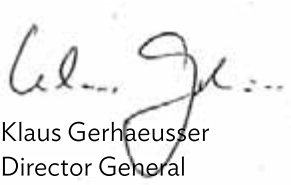
Dealing with climate change is a mammoth task in a landlocked mountainous developing country such as Tajikistan. Routinely affected by droughts and floods and dependent on natural resources, Tajikistan is highly vulnerable to climate variability and change. For the people in Tajikistan, climate change is a reality that affects daily life. For the Government of Tajikistan, addressing this development priority requires close cooperation with international and national institutions.

As a participating country in the Pilot Program for Climate Resilience (PPCR), Tajikistan has increased its understanding of climate change and has made significant progress in coping with climate change impacts. The PPCR studies and analytical work have unraveled the complex science of climate change and increased awareness in Tajikistan. The program has been a catalyzing force for action and has translated evidence-based knowledge into responses.

This report provides an overview of the technical assistance that was carried out in 2010 under phase 1 of the PPCR. The findings have shaped a multimillion-dollar investment program on climate resilience, the first of its kind in Tajikistan.

We appreciate the financial support from the Climate Investment Fund and would like to acknowledge the significant input of PPCR stakeholders in implementing phase 1 of the PPCR. We thank national and international experts, government, multilateral development banks, academia, civil society, and local communities for their invaluable contribution.

Murodali Alimardon
Deputy Prime Minister



Klaus Gerhaeusser
Director General
Central and West Asia Department
Asian Development Bank

Acknowledgments

This publication reflects the views and contributions of various stakeholders who participated in the Pilot Program for Climate Resilience (PPCR) consultations between September 2009 and March 2012. The input of all participants from line ministries, government departments, academia, international organizations, donors, nongovernment organizations, and media, and their continued support during phase 1 is appreciated.

The Strategic Climate Fund supported the activities described in this report. The Asian Development Bank (ADB) provided financial assistance through the (i) regional capacity development technical assistance for Enabling Climate Change Interventions in Central and West Asia, and (ii) technical assistance for Building Capacity for Climate Resilience under the Strategic Program for Climate Resilience (SPCR). This report was prepared in partnership with the Government of Tajikistan.

Melissa Alipalo, an ADB consultant, and Zafar Mahmoudov, communications manager for the PPCR secretariat in Tajikistan, prepared this report. Reviewers included Cinzia Losenno, senior climate change specialist at ADB; Craig Davies, senior manager, climate change adaptation at the European Bank for Reconstruction and Development; Angela Armstrong, senior operations officer and Global Environment Facility regional coordinator at the World Bank; and Ilhomjon Rajabov, chief technical advisor of the secretariat. Farhod Abdujaborov, office manager of the secretariat, provided support. The knowledge product benefited from close collaboration with Khairullo Ibodzoda, head of the Ecological Department of the President's Executive Office and the PPCR focal point in Tajikistan.

The content of this report is derived from the final reports produced by the development partners, government agencies, and consultants responsible for phase 1 activities. This report does not represent the official views of either the Government of Tajikistan or the Asian Development Bank.

Executive Summary

Since its first national communication in 2002 under the United Nations Framework Convention on Climate Change, Tajikistan has been assessing how changes in the global and regional climate will affect its natural resources, communities, and development infrastructure. Tajikistan is highly vulnerable—often cited as the most vulnerable in Eastern Europe and Central Asia—because of its unusual mountainous terrain, remote economic access, and unique environmental factors.

Recently downscaled climate models for the Pyanj and Vakhsh river basins, which cover 70% of the country, confirm regional trends, and a century ahead of warming temperatures, and seasonal as well as monthly fluctuations in precipitation. Compared with 2010, annual mean air temperatures are projected to increase by 1.7°C in the Pyanj River basin and 1.5°C in the Vakhsh River basin by 2050. By 2100, temperatures are expected to increase by up to 3.6°C compared with 2010.

Without increased resilience in key water-reliant sectors such as energy and agriculture, climate disasters put the country's social and economic activities highly at risk. Furthermore, without an increased capacity to deal with climate change, people's livelihoods and prospects are endangered. For example, not all farmers rely on irrigation infrastructure, yet the impact of climate change equally affects all. In the hilled territories, rain-fed wheat and fruit, which depend on precipitation, are vulnerable to variability or change in precipitation. Climate projections up to 2100 forecast a decrease in average precipitation and an increase in droughts.

Except where international assistance has made a difference, the country's public institutions and communities have not been able to respond or recover quickly from sudden disasters or even the long-evident climate trends that are affecting agricultural production and infrastructure. Institutional and community expertise in modern climate science and climate risk management are lacking. Historically, international donors, multilateral development banks, and nongovernment organizations (NGOs) have relied heavily on reactive and loosely coordinated interventions to support government efforts in mitigating, responding to, and recovering from the impact of climate disasters. However, Tajikistan's accession to the Pilot Program for Climate Resilience (PPCR) and its development of the Strategic Program for Climate Resilience (SPCR) demonstrate the government's recognition that climate change risks must be tackled.

The PPCR has given Tajikistan the opportunity to realize the economic and social impacts of climate change in more empirical terms and initiate transformational change in its meteorological services, natural resources management, and development planning. Tajikistan's program financing is administered by the Asian Development Bank (ADB), the European Bank for Reconstruction and Development, and the World Bank. Through joint missions, these development partners assisted Tajikistan in developing its SPCR. The missions, made possible through government leadership and broad stakeholder consultations, considered the various climate change-related activities in the country and agreed on the process of identifying and pursuing priority investment areas for building climate resilience.

In 2010, the PPCR Subcommittee (the program's governing body) endorsed Tajikistan's SPCR, which proposed six priority investment areas: (i) building capacity for climate resilience; (ii) improving delivery of weather, climate, and hydrological services; (iii) developing a climate

science and modeling program; (iv) enhancing the energy sector's climate resilience; (v) promoting sustainable land management; and (vi) building climate resilience in the Pyanj River basin.

The PPCR in Tajikistan is being implemented in two phases. For phase 1, in 2010, the PPCR Subcommittee awarded Tajikistan with a grant of $1.5 million, which funded six technical assistance projects (one for each priority area), to strengthen Tajikistan's capacity, conduct studies and assessments to build the analytical base, and prepare projects for phase 2 financing (the investment phase of the program). In general, the projects were designed to pilot ways of investing in vulnerable communities, critical ecosystems, and infrastructure to make them more resilient to climate change impacts. Phase 1 studies concluded in 2012 after 18 months of data gathering and analyses. The Government of Tajikistan and multilateral development banks organized a conference to inform stakeholder groups of phase 1 results. This report, prepared in partnership with the Government of Tajikistan, summarizes these results.

Phase 1 of the PPCR increased Tajikistan's understanding and awareness of climate variability and change. Evidence indicates that climate change is already affecting availability of water, with significant consequences on domestic water use, irrigation, and energy production. Glacier mass is decreasing, temperatures are rising, and precipitation patterns are changing, with more rain and less snowfall projected in the future. Technical assistance during phase 1 of the PPCR produced the country's first set of statistically downscaled general circulation models and three emissions scenarios at an approximately 11-kilometer (km) spatial resolution. These have given Tajikistan a reliable picture of climate change that can be expected in 70% of the country over the next century, and its effects on water resources. The risk of climate change impacts upon the population and key infrastructure was assessed to be generally high. Already, 21% of the population (i.e., 1.273 million people), 23,000 hectares of cropland, 148 bridges, and 345 km of roads in the Pyanj River basin were found vulnerable to climate hazards. Under phase 1, climate change impacts on the country's hydropower production and capacity were also analyzed. Overall, the annual discharges of the upper Syr Darya River appear to be more sensitive to climate change than those of the upper Vakhsh River, likely due to differences in the characteristics of the basin areas such as the extent of deglaciation and basin elevation. Nine hydrology scenarios of climate change show a wide margin of potential change in two of the country's critical hydropower resources: the Kairakkum Hydropower Plant on the Syr Darya River and the Nurek reservoirs on the Vakhsh River Cascade. For both hydropower systems, projections for firm capacity in 2100 range from about twice the current levels to zero.

Institutions and communities need to work together to improve water and land resource management, and strengthen the resilience of hydropower production. A shift to climate risk management in decision making and investment in climate-resilient infrastructure, such as transport, energy, and agriculture, are needed for the country's social and economic development.

These findings were used to design a multisectoral investment program. The PPCR Subcommittee allocated $57.8 million in grant financing for phase 2 investments, which at the time of this publication are at various stages of final preparation and approval for implementation. PPCR financing does not intend to resolve all climate-related issues in the country. Additional financing, however, may be leveraged in the future as a result of the PPCR's support for piloting approaches to climate financing and identifying best practices for the myriad of climate-related problems that are both common among some countries and unique to others.

Abbreviations

ADB	–	Asian Development Bank
EBRD	–	European Bank for Reconstruction and Development
MDB	–	multilateral development bank
NGO	–	nongovernment organization
PPCR	–	Pilot Program for Climate Resilience
SLM	–	sustainable land management
SPCR	–	Strategic Program for Climate Resilience
TA	–	technical assistance

NOTE

In this report, "$" refers to US dollars.

INTRODUCTION

1. The Pilot Program for Climate Resilience (PPCR) is a global initiative being implemented in nine countries and two regional programs in a number of countries[1] —including Tajikistan— that face exceptional risks to climate change. The program aims to help put countries on a climate-resilient development path that is consistent with their poverty reduction and sustainable development goals. Further, PPCR activities align with and leverage off other donor-funded activities to gain experience and obtain knowledge useful for designing scalable climate adaptation measures. Tajikistan's PPCR financing is administered by three multilateral development banks (MDBs): the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), and the World Bank.

2. The PPCR in Tajikistan is being implemented in two phases and covers six priority investment areas: (i) building capacity for climate resilience; (ii) improving delivery of weather, climate, and hydrological services; (iii) developing a climate science and modeling program; (iv) enhancing the energy sector's climate resilience; (v) promoting sustainable land management; and (vi) building climate resilience in the Pyanj River basin. Through joint missions, the MDBs have assisted Tajikistan in developing its Strategic Program for Climate Resilience, which is the investment plan and guiding document for the pilot program.

3. To begin phase 1 of the PPCR in 2010, the PPCR Subcommittee awarded Tajikistan with a $1.5 million grant, which funded six technical assistance (TA) activities (one for each priority area), including feasibility studies and assessments to strengthen the analytical base for phase 2 investments. The phase 2 TA activities were designed to pilot ways of investing in vulnerable communities, critical ecosystems, and infrastructure to ensure their resilience to climate change impacts.

4. This report summarizes the key results of phase 1, which concluded in 2012 after 18 months of data gathering and analyses. It outlines the institutional arrangements for managing the PPCR portfolio and summarizes each TA activity according to the methodologies, findings, and conclusions. The grant was implemented in four packages, as described below.[2]

Hydroclimate Modeling and the River Basin Approach to Climate Resilience

5. Administered by ADB and executed by the Committee of Environmental Protection and the Ministry of Land Reclamation and Water Resources, this TA activity provided $750,000 from

[1] Countries and regions participating in the program are Bangladesh, Bolivia, Cambodia, Dominica, Grenada, Haiti, Jamaica, Mozambique, Nepal, Niger, Papua New Guinea, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Tajikistan, Tonga, Yemen, Zambia, and the Pacific and Caribbean regions.

[2] Based on the outcomes of the six TA activities carried out during phase I, the investment activities of the four grant packages were developed. These comprise four activities covering all assistance activities from phase I.

the PPCR and $450,000 from ADB to produce the country's first set of statistically downscaled regional climate models. The hydroclimate modeling of the Pyanj and Vakhsh river basins, covering 70% of the country, confirms regional trends and another century of warming temperatures and seasonal, as well as monthly fluctuations in precipitation. Compared with 2010, annual mean air temperatures are projected to increase by 1.7°C in the Pyanj River basin and 1.5°C in the Vakhsh River basin by 2050.

6. These downscaled climate projections were a key input for the second portion of the TA activity: assessing climate risk and designing a robust methodology for increasing basin-wide management of climate change impacts. Without climate-resilient infrastructure—such as transport, energy, and agriculture—the country's social and economic activity is highly vulnerable to water-related disasters. A panel of national and international experts was established to assess the current needs for climate modeling and science.

7. This TA activity informed two of the five projects for phase 2. First, it provided the analytical and methodological base for a $21.55 million grant for the Building Climate Resilience in the Pyanj River Basin Project. The results have also informed the design of a $6 million capacity development TA that will continue the training started under phase 1 for government users, raise general public awareness, and generate the next dynamical downscaled climate models, which addresses the limitations of the phase 1 statistical downscaled models.

Improving the Climate Resilience of Tajikistan's Energy Sector

8. Administered by EBRD and executed by the Ministry of Energy and Industry, this TA activity provided $300,000 to examine opportunities for climate-proofing hydropower facilities in the country, specifically the Kairakkum plant on the Syr Darya River. Various models were applied to understand the implications of potential future changes in climate conditions, evaporation, and hydrology on energy production at the hydropower facility. The TA activity rendered detailed findings on changes in reservoir inflows, changes in hydropower production and firm capacity, hazards, sediment yields, and flood safety. The results of a regional scenario of central climate change and hydrology in 2015 and 2100 indicate that operational changes can potentially yield about the same production increases as the structural changes. Thus, a combination of operational and structural changes was recommended for the greatest benefit.

9. The Government of Tajikistan also requested EBRD to support the rehabilitation of the Kairakkum hydropower plant, and this investment is now being prepared. The feasibility study and environmental and social impact assessment will build on the analytical work of this TA activity, leading to additional climate-resilience features being incorporated into the plant's rehabilitation. This investment offers a valuable opportunity to pilot the integration of climate change analysis and climate-resilient measures into investment planning in hydropower, with potential transferable lessons for other hydropower plants in Tajikistan and beyond.

Sustainable Land Management Approaches for Climate Resilience

10. Administered by the World Bank and executed by the Ministry of Agriculture, this TA activity provided $200,000 to document current sustainable land management (SLM) technologies and approaches in the country. With assistance from 13 government and nongovernment organizations (NGOs), the team found 46 technologies and 24 approaches already being used. The technologies were analyzed for their potential to address climate change impacts and then grouped according to their functionality. The analysis proposes activities for three interactive zones: in-village, near-village, and off-village. Although the three-zone concept is applicable to all villages in all agro-climatic conditions of Tajikistan, each zone presents unique opportunities for addressing climate change risks.

11. With $11.45 million financing from Climate Investment Funds, and an additional $5.40 million from the Global Environment Facility, this project has been prepared for phase 2 to improve rural production and land resources management in villages, with some larger-scale initiatives. The Environmental Land Management and Rural Livelihoods Project will be implemented over 5 years in select climate-vulnerable districts—Baljuvan, Farkhor, Jirgatol, Khovaling, Kulob, and Tavildara—that span the three different agro-ecological zones of Tajikistan.

Measuring Institutional Capacity and Climate Change Awareness

12. Administered by the World Bank and executed by the Committee of Environmental Protection, this $250,000 TA activity examined the adaptive capacity of national laws and policies, national and subnational government institutions, and civil society to lead climate adaptation activities, specifically in response to risks within the water, agriculture, energy, and health sectors. This TA activity assessed how the education, awareness levels, and the opinions of stakeholders reflect their general understanding of the cause–effect relationships of climate change in the four key sectors and demonstrated stakeholders' ability to adapt.

13. More than 30 government agencies and educational institutions, and more than 30 NGOs, were involved in data collection and analysis. The TA activity identified six key findings: (i) the government is funding work on climate change both directly and indirectly, and there is an opportunity to prioritize and publicize this work; (ii) the government should endorse a national action plan on climate change and update related legislation; (iii) while public awareness of climate change may be greater than anticipated and continues to grow, information and outreach should now focus on specific adaptation activities; (iv) while capacity building in organizations is important, activities should be varied to avoid "training fatigue;" (v) bringing climate change issues into school curricula can increase knowledge quickly, but longer-term considerations are also important; and (vi) NGOs and community-based organizations should be leveraged as significant contributors to phase 2 activities, particularly in capacity building and training.

14. Based on the recommendations and implementation road maps from the phase 1 assessment, a $6 million capacity-building program, administered by ADB, was designed and approved for phase 2. While capacity building is mainstreamed in all PPCR components, a concentrated and substantial effort is made under the ongoing TA offered in phase 2.

Moving Forward in Phase 2

15. Since the conclusion of phase 1 activities and the comprehensive review of results, the government, the MDBs, and consultants had been preparing the investment package for phase 2. The PPCR Subcommittee has already allocated $57.8 million in grant financing for phase 2 investments, which, at the time of this publication, are at various stages of preparation and approval. Additional financing has been and can be leveraged in the future as a result of the PPCR's support for piloting approaches to climate financing and identifying best practices for the myriad of climate-related problems that are both common in some countries and unique to others.

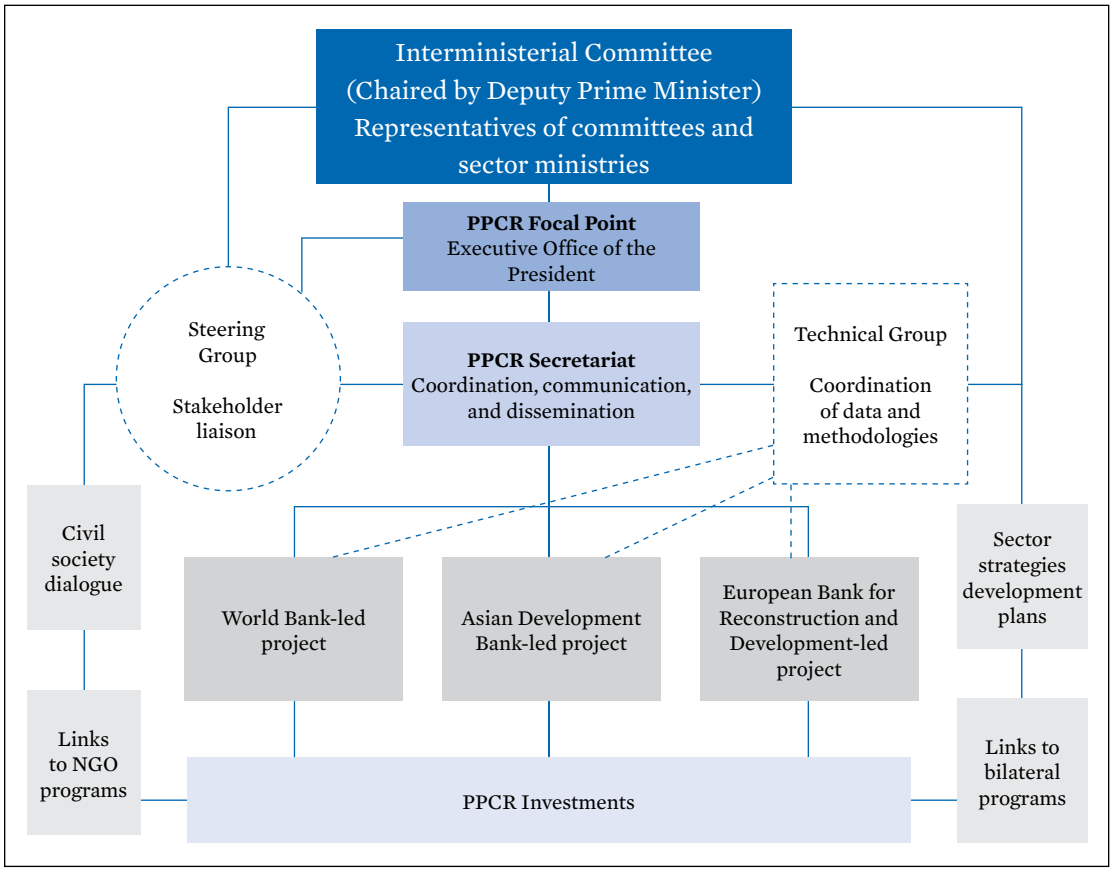
16. Collectively, phase 1 studies have helped identify specific opportunities for addressing climate risks, and their recommendations are being incorporated into the design of phase 2 investments. The reports produced during phase 1 are also valuable for developing national adaptation plans beyond the scope of the current strategic plan and PPCR financing.

INSTITUTIONAL ARRANGEMENTS IN TAJIKISTAN

17. Throughout phase 1 and during capacity self-assessment workshops, a multistakeholder group determined the PPCR coordination structure, its function, roles, reporting lines, and funding mechanisms. In October 2011, the structure was officially adopted. Figure 1 illustrates the wider framework for coordination.

18. **Interministerial Committee.** The Interministerial Committee is the ultimate body in the PPCR coordination mechanism to make final decisions on PPCR matters in Tajikistan. Its members

Figure 1 Coordination Framework for the Management of the Pilot Program for Climate Resilience in Tajikistan



NGO = nongovernment organization, PPCR = Pilot Program for Climate Resilience.

Source: Government of Tajikistan.

review recommendations on PPCR activities and prepare and issue orders and/or administer follow-up actions. The recommendations are developed during steering group meetings and delivered to the Interministerial Committee by the chair of the steering group, who is also the PPCR focal point.

19. **Steering group.** The steering group comprises representatives of various PPCR stakeholder groups who observe PPCR activities in Tajikistan and develop recommendations for the Interministerial Committee. The PPCR focal point is the chair, and members include national coordinators from ministries, representatives from civil society organizations, the media, the MDBs, bilateral donors (e.g., the Department for International Development of the United Kingdom and the German Society for International Cooperation), and the Agency for Technical Cooperation and Development.

20. The chair convenes a meeting twice a year, about 1 month prior to the Interministerial Committee meeting. Each member of the steering group can raise any PPCR-related issue for consideration on behalf of the group he or she represents. Meetings are open to observers who may give recommendations and comment on discussions.

21. The objectives of the steering group are as follows: (i) contribute to the development and approval of the PPCR strategy; (ii) assess overall progress of PPCR implementation based on official monitoring data, technical group data, independent experts, and information received from beneficiaries; and (iii) develop recommendations to improve program implementation.

22. During its first meeting, on 3 February 2012, the steering group introduced the terms of reference, reviewed membership, elected members, and developed the first recommendations for the Interministerial Committee.

23. **Technical group.** The technical group aims to ensure consistency and use of best practices in PPCR projects. It facilitates the exchange of information on data and methodologies adopted for the PPCR projects, and provides technical input and expertise as required. Key members are technical experts and consultants from the project teams and government agencies. The government and MDBs may involve additional experts in assessing special cases or projects. The chief technical advisor of the PPCR secretariat chairs the technical group meetings. If needed, terms of reference may be developed for the technical group at the steering group meetings.

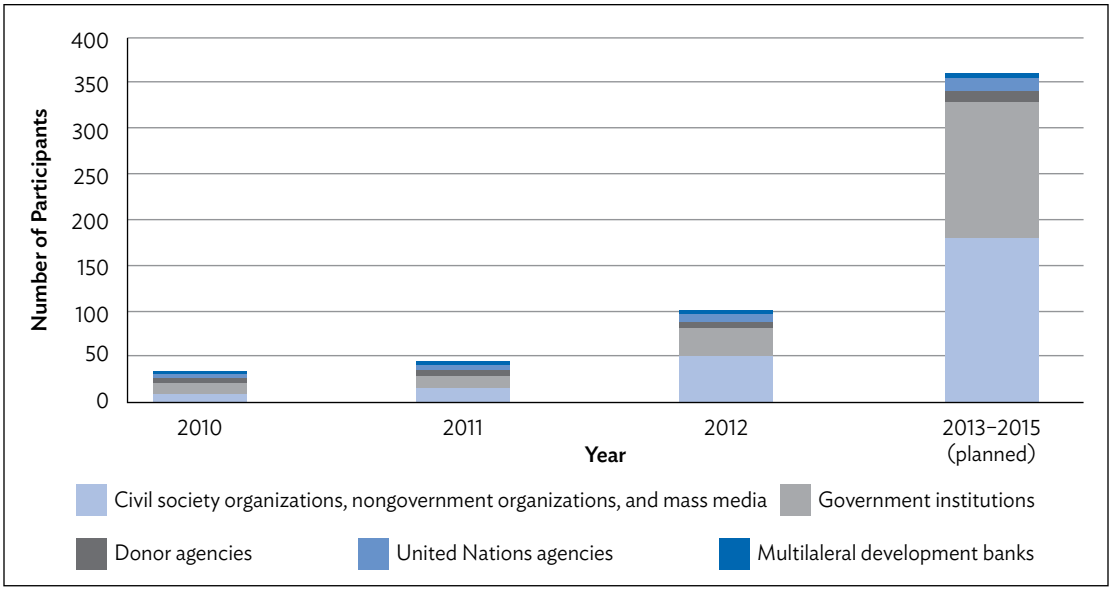
24. **Pilot Program for Climate Resilience secretariat.** Comments and recommendations raised by stakeholders in the Strategic Program for Climate Resilience (SPCR) indicated the urgent need to establish a secretariat in Tajikistan that would coordinate the implementation of PPCR projects and communicate PPCR findings to the government and other stakeholders domestically and internationally. Thus, a major output of phase 1 was the establishment of the coordination mechanism and the PPCR secretariat.

25. The PPCR secretariat was established in March 2011 with financial support from ADB. It is staffed by three independent consultants: a chief technical advisor who coordinates, supervises, and manages all secretariat activities; a communications manager, responsible for developing a communications and stakeholder engagement strategy, managing all public and media relations, and developing knowledge products, including creating and maintaining a PPCR website; and a senior office administrator performing general administration, bookkeeping, and logistical support.

26. The secretariat provides overall interagency coordination and communication of PPCR activities in Tajikistan. It also serves as a single point of contact for government, ministries, the MDBs and donor agencies, and NGOs to minimize confusion, improve communication and knowledge exchange, and engage government and civil society better.

27. **Stakeholder engagement.** Various representatives from the government, civil society, and the private sector, as well as individuals, were involved in designing the original strategic plan and phase 1. Figure 2 illustrates the rapid increase in the number of stakeholders, particularly mass media and civil society organizations as phase 1 progressed. By March 2012, the number of PPCR stakeholders increased from about 70 to over 200.

Figure 2 Rate of Increase in Stakeholder Participation during Phase 1



Source: PPCR Secretariat.

28. To ensure broad disclosure of information, a database of stakeholders and PPCR outputs is made available.[3] The PPCR secretariat also runs an e-mail distribution list, through which all press releases, quarterly reports, and other news events regarding the PPCR are distributed. Further, the PPCR secretariat maintains a directory of stakeholders,[4] which is updated regularly and disseminated to all partners for their review.

[3] See Tajikistan: Pilot Program for Climate Resilience. http://www.ppcr.tj
[4] The database of PPCR stakeholders is available at http://ppcr.tj/List_of_PPCR_stakeholders.pdf

PHASE 1 RESULTS: BUILDING THE ANALYTICAL BASE FOR CLIMATE-RESILIENT INVESTMENTS

29. Phase 1 of the PPCR in Tajikistan aimed to develop a common vision for climate resilience in Tajikistan—resilience that would safeguard the country's vulnerable rural communities, the natural resources on which they depend, and ecosystems that are valuable to the region. This vision was to be empirically based and the results shared and agreed upon by various stakeholder groups. The studies helped identify specific opportunities for building resilience to climate change, and their recommendations are being incorporated into the design of phase 2 investments.

ADB

Flood protection infrastructure in 10 *jamoats* (municipalities) in the Pyanj River basin will be climate-proofed in phase 2 of the Pilot Program for Climate Resiliance in Tajikistan.

Hydroclimate Modeling and the River Basin Approach to Climate Resilience

Executing agency	State Administration for Hydrometeorology and the Ministry of Land Reclamation and Water Resources
Development partner	Asian Development Bank
Implementing consultants	Mott MacDonald
Implementation period	October 2010–September 2011
Climate Investment Funds grant amount	$750,000 total ($350,000 for climate science and impact modeling partnership; $400,000 for analysis and methodological development of river basin approach to resilience building)

30. The Climate Resiliency for Natural Resources Investment Project, administered by ADB, produced the country's first generation of downscaled general circulation models and three emissions scenarios, which estimate the likely climate changes for 70% of the country at an approximately 11-kilometer (km) spatial resolution. The downscaled climate variables, such as precipitation and air temperature, were used to develop projections of river runoff and glacier regimes in the project area.

31. With a critical shortage of expertise in modern climate science and managing the impacts of climate change, Tajikistan has historically defaulted to reactive and loosely coordinated interventions to mitigate, respond to, and recover from the impacts of climate disasters. Even these interventions have been partial and limited. This TA activity, however, aimed to (i) build capacity with the State Administration for Hydrometeorology to use the downscaled hydroclimate models that were produced to project climate change impacts on critical water-dependent sectors; and (ii) use the models for assessing climate change risks and adaptation options that would protect communities, economic assets, and ecosystems.

32. **Methodology.** The project was organized into three major activities. The first activity formed the Climate Science and Impact Modeling Partnership, an international panel of experts working with Hydromet and other Tajikistan experts to assess the country's capacity-building needs for climate science and impact modeling (see *Panel of Experts Visits Tajikistan*, page 10). The panel conducted a gap analysis of institutional capacity at several levels, including at the community level, focusing on the Pyanj River basin. The partnership assisted in assessing institutional capacity and collecting historical climate disaster data. This partnership involved the 12 government institutions, 11 NGOs, and 34 district councils in the project area, in addition to direct support by the Information Management and Analytical Centre within the Committee for Emergency Situations and Civil Defense, Hydromet, the Agency for Technical Cooperation and Development, and Focus Humanitarian Assistance.

33. The second activity was based on a learning-by-doing model that trained 15 staff members of Hydromet over a 4-month period on hydroclimate modeling. They assisted in downscaling climate impact models for two important river basins in Tajikistan: the Vakhsh and Pyanj, which cover 70% of the country. Historical climate and disaster data were collected from 12 government institutions, 11 NGOs, and 34 district councils in the project area.

34. The third activity produced climate change projections of daily air temperature, precipitation, evapotranspiration, runoff, and river flow up to 2100 by statistically downscaling selected global circulation model projections, modeling runoff and river flow in the Vakhsh and Pyanj river basins, and modeling daily balances of water stored in glaciers and snowfields. The projections were downscaled from a 200–300-kilometer resolution to an 11-kilometer grid, the finest resolution applied in Tajikistan to date.

35. These downscaled climate projections were a key input into climate risk assessments and the design of a methodology for increasing basin-wide resilience. A robust, systematic computational method to assess risk based on the climate models was applied to each of the 34 districts and 208 communities in the Pyanj and Vakhsh river basins to derive climate-change risk indexes for four periods (i.e., 1980–2010, 2010–2040, 2040–2070, and 2070–2099). The risk indexes were then ranked in seven categories, ranging from "extremely high" to "extremely low," creating 119,808 individual risk assessments in the two basins. For practical reasons, analysis was limited to (i) the three climate hazards of mudflows, floods, and droughts; (ii) the three sectors of population, agriculture, and transport; and (iii) 115 communities in the Pyanj River basin.

Based on the risk analysis, essential climate adaptation options were identified for the short and medium term. This required an assessment of the benefits and challenges of using a cross-sector, ecosystem-based approach to building the resilience of communities, existing infrastructure, and future sector development projects. By adapting an integrated basin-wide approach to climate resilience, the TA project could also address the potential collateral consequences of upstream climate change impacts and adaptations on downstream communities, assets, and ecosystems.

Panel of Experts Visits Tajikistan

During the second half of September 2011, the Government of Tajikistan, in cooperation with the Asian Development Bank (ADB), invited a panel of international experts on climate change to raise government awareness on climate modeling and climate science.[a] This visit was part of the climate science and modeling partnership, and aimed to assess needs for adaptation planning and to inform the capacity building technical assistance project. The panel, along with specialists from ADB, the Committee of Environmental Protection, State Administration for Hydrometeorology, and Pilot Program for Climate Resilience secretariat consultants, visited the Pyanj River basin, where they met with the local population, local authorities, and community leaders. The main items discussed related to the increasing number of droughts, floods, and landslides that have occurred during the last decades. A video documenting their work can be viewed at http://www.adb.org/news/videos/meeting-climate-challenge

[a] The panel included the following international scientists: Vladimir Aizen, University of Idaho; Declan Conway, University of East Anglia; Richard Jones, UK Met Office; and Nicholas Silver, London School of Economics.

36. **Findings.** This TA activity provided Tajikistan with a reliable picture of the climate changes that can be expected in 70% of the country over the next century. Based on these climate change projections, the TA activity has been able to project the effect of climate change on water resources and the people and key infrastructure on which they depend (Table 1).

Table 1 Projected Climate Changes for Tajikistan

Annual mean air temperature (compared with 2010)	For Pyanj River basin: Increase by 1.7°C by 2050 and 3.6°C in 2100 For Vakhsh River basin: Increase by 1.5°C by 2050 and 3.5°C by 2100
Maximum and minimum daily air temperatures	Likely to increase
Annual potential evapotranspiration	Likely to increase due to increase in air temperatures; risk of drought may also increase, significantly affecting the availability of water resources
Mean annual precipitation	Annual rainfall likely to increase while annual snowfall likely to decrease; such changes may result in an increase in flash floods during the winter and early spring, and also in significant seasonal change of the hydrological cycle
Mean monthly rainfall, snowfall	Likely significant changes during the winter and spring seasons
Magnitude of extreme daily precipitation	Likely to increase; when combined with increased snowmelt due to higher air temperatures, rainfall-runoff floods/mudflows may be more frequent

Source: ADB.

37. The impact of these climate changes on the country's main water resources in the Pyanj and Vakhsh river basins has been projected by complementary river modeling of annual and monthly river flows, flood frequency, and irrigation demand. Although there appears to be significant surpluses of river water in both the Pyanj and Vakhsh river basins in the spring through the simulation period, increasing evapotranspiration, the need to share water, and the mismatch between availability of water and cropping season mean that shortages of irrigation water are inevitable in the Pyanj River basin. Constructing reservoirs in the basin and properly operating the existing and proposed reservoirs in the Vakhsh River basin could change this scenario. Based on river flow projections between 1960 and 2040, one summer in every 10 years will experience relatively fewer shortages of irrigation water, with more frequent and severe shortages beyond 2040.

38. The risk of climate change impacts upon the population and key infrastructure was assessed to be generally high. Already, 21% of the population (i.e., 1.273 million people), 23,000 hectares of cropland, 148 bridges, and 345 kilometers of roads in the Pyanj River basin were found vulnerable to climate hazards. More specifically, people in 57% of *jamoats*[5] in the Pyanj River basin are currently at direct risk from mudflows caused by intense rainfall and rapid snowmelt in the spring.[6] Without adaptation, the risk will increase to 63% by 2040; 71% of the communities in the Pyanj River basin have roads at risk from mudflows, and this will rise to 78% by 2040. According

[5] *Jamoat* refers to the third-level administrative divisions, similar to communes or municipalities. There are about 406 *jamoats* in Tajikistan.

[6] Mudflows are rapid onset torrents of mud and water in small rivers and steep slopes in response to intense rainfall and snowmelt on degraded or naturally unstable land.

to the risk assessment methodology, the communities most at risk from mudflows are located in Baljuvan, Dangara, Murgab, Pyanj, Rashtkala, and Rushan districts. During site visits, the consultants witnessed the impact of increased recent mudflows in the Khamadoni and Kulyab districts. The river overflowed its banks and washed down villages, roads, and other infrastructure.

39. Floods from summer snowmelt are less dramatic and less widespread than those from mudflows but nevertheless significant. For instance, 14% of people and 17% of flood embankments are currently at risk from floods. This will rise to 20% of people and 23% of flood embankments by 2070.

40. In the case of meteorological droughts, rain-fed agriculture in 50% of *jamoats* is currently at risk from low precipitation at the beginning of the growing season. This is likely to increase to 72% by 2070. In the case of hydrological droughts, up to about 2040, there will be a 10% chance of water shortages in the Pyanj River in the summer. After 2040, however, the shortages are projected to become more frequent and severe; after 2080, there may be serious shortages every summer, amounting to 1 cubic kilometer (i.e., 44% of current irrigation demand) or more in the worst cases. Clearly, in the medium to long term, these shortages would have a major impact on agriculture.

Hazard mapping illustrates the distribution and degree of recent water-related disasters. In the Pyanj River basin, mudflows were particularly frequent in eastern Khatlon, with Vose District experiencing 19–25 events in 1997–2009. The location of floods in the Pyanj River basin is almost the inverse of the location of the majority of mudflows. As many as 10 major floods occurred on the Pyanj River in Khatlon Region. Jilikul District in the flood plain of the Vakhsh River in southwest Khatlon experienced up to 10 floods during 1997–2009. Also, with the unlikely exception of Kulyab District and possible exception of Murghab District (located in an already arid zone), the Pyanj River basin experienced one to three droughts (i.e., periods of below average rainfall) during 1997–2009.

41. The government's capacity to monitor climate change and plan accordingly was assessed through a gap analysis of Hydromet and then with senior officers from eight ministries that use Hydromet services. Table 2 summarizes the key government stakeholders and their roles in addressing climate change.

42. A gap analysis of the hydrometeorological climate change modeling and forecasting capacity within Hydromet found that insufficient financing, access to reliable technology, and inadequate computer and technical skills of staff members undermined Hydromet's ability to provide usable and timely climate change information. The six most senior staff members cited their greatest deficiencies: (i) a shortage of professional staff members, (ii) lack of educational institutions for studying hydrometeorology, (iii) old and uncalibrated equipment, and (iv) a need for more logistical support at regional stations.

43 A gap analysis among eight other ministries showed that 1 in 8 agencies planned for climate change impacts, but 7 out of 10 were affected by climate change impacts, leaving a gap between planning for impact management and actual impacts. On the question "whether your organization has measures in place to mitigate the impacts of climate change," 82% of respondents answered yes; but 82% also answered no to whether their organization had plans to respond to climate change. Although ambiguous, this suggests that ministry responses to climate change impacts are ad hoc and reactive. On the issue of what additional resources and support were needed to better manage climate change impacts, 59% of respondents replied more equipment, 53% improved technical skills, and 41% better training.

Table 2 Government Stakeholders in Climate Change Risk Management

Ministry or Agency	Role and Stake in Climate Change
Ministry of Agriculture	There is a significant need for agrometeorological forecasts, as agriculture plays an important role in the national economy and engages a large proportion of the population. Agricultural land occupies most of the flat areas in Tajikistan. Soil in such places is often exposed to water and wind erosion. Intensive rainfall can damage young crops.
Committee of Emergency Situations and Civil Defense	The Committee of Emergency Situations and Civil Defense is directly involved in disaster management, with many hazards resulting from hydrometeorological events. Up-to-date weather forecasts from Hydromet are therefore necessary. Having climate and climate change projections would allow the committee to assess risk and prepare action plans.
Committee of Environmental Protection and Hydromet	Hydromet is responsible for weather forecasting and issuing warnings for hazardous weather events, which include floods, heavy and prolonged rainfall, heavy and prolonged snowfall, strong winds, hailstorms, extreme heat and cold, and mudflows and avalanches caused by rain or snow. Under the committee, it is also responsible for the assessment of climate change hazards.
Ministry of Economy and Trade	Climate change projections can be used for optimizing economic development and planning.
Ministry of Energy and Industry	Seasonal forecasts of snow cover and precipitation and climate change projections that can be used for the design, construction, and operation of hydropower stations are needed.
Ministry of Education	Educational institutions do not provide education on climate change, but this ministry must understand climate change issues for longer-term curriculum development.
Ministry of Land Reclamation and Water Resources	This ministry supervises Tajikistan's river systems and irrigation networks. In addition, most of the agriculture sector is dependent on irrigation, which requires close cooperation between this ministry, the Ministry of Agriculture, and Hydromet for weather forecasts and climate projections. Hazardous weather warnings are needed as floods, mudflows, and other climate impact may damage rivers, river management structures, and irrigation systems.
Ministry of Finance	This ministry uses information on disasters to develop financing options for hazard and disaster mitigation. Climate change projections and associated risk assessments are necessary to develop financial instruments for risk reduction, create administrative systems for funds disbursement, and plan for financial contributions to climate impact mitigation and adaptation.
Ministry of Transport and Communications	With many remote and topographically challenging areas, road and air transport is important for internal and external communications, but both transport modes are vulnerable to climate impact disruption. Roads are exposed to flooding, falling rocks, mudslides, and avalanches, and air transport is subject to disruption by poor weather. This ministry requires short-term hazardous weather forecasting and longer-term climate projects to develop protective systems for roads and appropriate design standards.

Source: ADB.

44. Although there is broad awareness of climate change issues in Tajikistan, there is not yet any effective institutional or civil society capacity for climate change science, risk assessment, and adaptation. Notable capacity for disaster response is concentrated mainly in the Committee of Emergency Situations and Civil Defense and delivered with limited resources through its regional and district local offices.

45. Overall, a move from short-term, reactive responses to longer-term, development strategies integrated across government and vertically from *jamoat* to the national level is critical for enhanced adaptive capacity.

46. **Recommendations.** The TA activity recommendations focus on physical and nonphysical options for climate change adaptations. Physical adaptation options protect people, key infrastructure, and ecosystems from the specific climate change-related risks of mudflows, floods from summer snowmelts, and droughts. They include practical interventions such as river basin management measures (e.g., protecting and maintaining ecosystems, initializing conservative land use, stabilizing steep slopes, and checking dams in eroding gullies) and mudflow and flood defense measures (e.g., using mudflow diverters, flood embankments, and heavy machinery).

47. Nonphysical options build the capacity of national, regional, and local levels to utilize climate science, partnerships, and risk assessments to increase their adaptive capacity to climate change. Nonphysical adaptations include (i) institutional capacity building in policy making, strategy development, master planning, climate and river basin modeling, and risk assessment; (ii) monitoring of lakes, glaciers, precipitation, and rivers; (iii) disaster forecasting and warning; and (iv) institutional and community preparedness.

48. **Contribution to phase 2.** This TA activity informed two of the five projects under phase 2. First, it provided the analytical and methodological base for the $21.55 million grant for the Building Climate Resilience in the Pyanj River Basin Project. The project will be implemented in Khatlon Oblast (province), Gorno–Badakhshan Autonomous Oblast, and in 8 districts (i.e., Darvox, Iskoshim, Kulob [Kulyab], Pyanj, Rosthqala, Rushan, Vanj, and Vose) across 19 *jamoats* and 57 villages. The project covers nine flood protection projects in the Pyanj River basin, four irrigation projects, and seven water supply projects. The project will benefit almost 14,000 households. To ensure the project activities were highly relevant to people's needs, in-depth stakeholder analysis and consultations were carried out with government agencies, 16 nongovernment organizations (NGOs), and communities in the Pyanj River basin. More than 1,000 stakeholders participated in 116 meetings and focus group discussions during phase 1 preparations; 42% of consultation participants were women. The NGO Durandesh conducted a baseline survey and additional consultations with more than 200 households at the *jamoat* level.

49. The TA activity results have also informed the design of a $6 million capacity development TA project that will continue the training begun under phase 1, as well as general public awareness raising, and development of the next generation of dynamic downscaled climate models, which will address the limitations of the phase 1 statistical downscaled models. The climate science and modeling will (i) enhance Hydromet's capacity to develop and interpret downscaled climate models to guide decision making and risk management, (ii) develop a management information system for climate data, (iii) train local experts, and (iv) introduce climate science and glaciology modules in institutions of higher education.

Improving the Climate Resilience of Tajikistan's Energy Sector

Executing agency	Ministry of Energy and Industry and Barqi Tojik
Development partner	European Bank for Reconstruction and Development
Implementing consultants	Sinclair Knight Mertz and Acclimatise
Implementation period	2010–2012
Climate Investment Funds grant amount	$300,000

European Bank for Reconstruction and Development

The rehabilitation of the Kairakkum power station (pictured here with the spillway from a downstream view) will be financed through an investment package that includes a $1 million grant contribution from the Pilot Program for Climate Resilience during phase 2, which will enable climate resilience measures to be integrated.

50. Tajikistan's Poverty Reduction Strategy[7] emphasizes the importance of affordable energy and use of Tajikistan's abundant hydropower resources—the largest in Central Asia—as a platform for economic growth and development. Hydropower provides about 98% of the country's electricity, yet only about 10% of the country's total potential (i.e., 40 gigawatts) has been developed. Significant energy deficits are highest in winter when energy is often needed most for heating. In the winter of 2007–2008, major shortfalls in power generation due to insufficient water reserves in reservoirs, caused severe economic losses and extreme hardship for thousands of households.

51. Despite the potential for hydropower production, Tajikistan is a net importer of electricity, following years of underinvestment both in new generation capacity and rehabilitation of existing assets, owing to market complications from civil war, natural disasters, resource constraints, and poor management. Regional tensions over water and energy resources affect the certainty of energy imports and pose a serious threat to energy security.

52. Tajikistan's energy sector is extremely sensitive to climate change. The country's hydropower plants are highly vulnerable to the projected climate impacts on the country's river basins, which are fed by glacial meltwater and snowmelt. Most climate models predict significant changes in the dynamics of Tajik glaciers, snowmelt, and precipitation as the climate warms. The International Commission on Large Dams has already emphasized the urgent need to rehabilitate older dams, especially their spillway capacities, to cope with the new climate conditions.

[7] The Poverty Reduction Strategy of Tajikistan is available at http://www.undp.tj/files/reports/prsp2_firstdraft.pdf

53. To safeguard Tajikistan's development, the climate resilience of the hydropower sector must be improved. This TA activity analyzed the climate vulnerability of Tajikistan's hydropower sector and recommended investments for phase 2 to support a more climate-resilient hydropower sector.

54. **Methodology.** The TA activity focused on large hydropower facilities that provide more than 90% of Tajikistan's energy and are a top strategic priority for the government, specifically the Kairakkum hydropower plant on the Syr Darya River and the existing hydropower plants on the Vakhsh River cascade. Based on data availability for the hydropower plants, a more detailed analysis has been conducted for the Kairakkum hydropower plant than for those on the Vakhsh River.

55. Given the paucity of data available in Tajikistan, and the complexity of the hydropower systems involved, a conservative approach was developed for the climate risk assessment and adaptation options appraisal. A range of models was applied to understand the implications for energy production at the hydropower facilities, associated with potential future changes in climatic conditions, evaporation, and hydrology. Three future marker climate change scenarios—hot–dry, central, and warm–wet—were developed for Tajikistan from a multimodel ensemble comprising 16 climate models, 3 greenhouse gas emissions scenarios, and 3 hydrological models. Indirect impacts on the hydropower systems arising from changes in upstream river regulation or irrigation demands were assumed constant.

56. Assessments of the implications for the hydropower systems of projected future changes in inflows were undertaken by developing hydropower models, which provided continuous projections of annual energy production and firm capacity (i.e., power that is guaranteed to be available during the driest month of the driest year) during 2007–2100.

57. Based on observed natural hazards data, a preliminary analysis of hazards affecting each hydropower system was undertaken. In addition, the available literature on sedimentation in Tajikistan was reviewed, as were potential climate change impacts on sedimentation rates, as these affect reservoir storage capacity. Finally, the flood safety standards for the two hydropower systems were also reviewed, based on available information.

58. Various operational and structural modifications to optimize the performance of the facilities were appraised to evaluate the differences they may make to annual energy production and firm capacity. Measures to analyze and manage natural hazards were also identified, along with ways to manage sedimentation and recommendations on flood safety.

59. **Findings.** In general, the following implications for the hydropower sector are associated with trends in temperature, precipitation, and extreme events:

(i) higher winter and spring air temperatures mean that a smaller fraction of the precipitation total falls as snow;
(ii) the altitude of the snowline is increasing, changing the local albedo (i.e., reflectivity) of the landscape and amplifying regional warming;
(iii) long-term waste and reduced mass balance of glaciers, assuming no change in winter precipitation;
(iv) on average, less snow cover and snowpack storage at the end of winter, especially at lower elevations;
(v) an earlier thaw of permafrost and melting of snowpack and glacier ice;
(vi) an earlier incidence of avalanches, landslides, and flooding;

(vii) an earlier and potentially larger rainfall with snowmelt peak inflows to reservoirs;
(viii) lower summer minimum inflows to reservoirs; and
(ix) more intense summer storms, enhancing soil erosion, and conveyance of sediment.

60. The TA activity rendered additional findings described below.

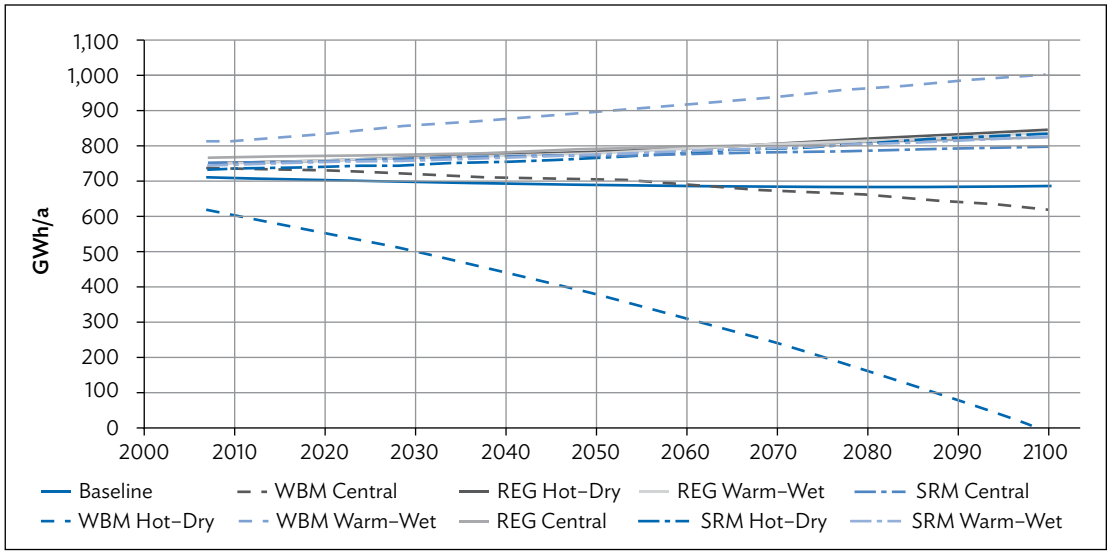
61. **Changes in reservoir inflows.** The future water balances of Kairakkum (Syr Darya River) and Nurek (Vakhsh River) reservoirs varied considerably depending on the climate change scenario and hydrological model used in the analysis. Although it is impossible to attach likelihoods to any of the climate change scenarios, according to the climate models examined in the analysis, warmer–wetter future climates are more consistent with the travel direction of regional precipitation and temperature records in Tajikistan over the last 5 decades. Overall, the annual discharges of the upper Syr Darya River appear to be more sensitive to climate change than those of the upper Vakhsh River, which is likely due to differences in the characteristics of the basin areas, such as the extent of deglaciation and basin elevation.

62. **Changes in hydropower production and firm capacity.** The discharge scenarios used in the above analysis were evaluated for their impacts on the hydropower plants using an energy production model with prescribed operating rules, refurbishment, and upgrade scenarios over the 21st century. The resultant trends in annual energy production show that for the Kairakkum hydropower plant, the spread of future projections across the nine climate change–hydrology scenario combinations is significant, ranging from about a 40% increase in annual energy production by the end of the century to a scenario in which production ceases. For the Vakhsh River cascade, projections range from a 40% increase in energy production to an 80% decrease by 2100. For both hydropower systems, under the same nine climate change–hydrology scenarios, projections for firm capacity in 2100 range from about twice the current levels to zero (Figures 3 and 4).

63. **Hazards.** Hydropower operators may have to contend with changing patterns of natural hazards due to climate change. A preliminary analysis of natural hazards affecting both hydropower plant systems reveals that some events follow a predictable annual cycle that may be susceptible to temperature and precipitation changes. Peak months of activity are (i) high winds and avalanches in February, (ii) floods and landslides in April–May, and (iii) heavy rainfall damage in May. A warmer–wetter scenario could mean that, in the future, such events may occur earlier in the year. This weather dependency can be used to develop a forecasting capability over daily to seasonal timescales if more data were available to establish the relevant relationships.

64. **Sediment yields.** About 10% of global dam storage has been lost due to sedimentation. Sedimentation rates at the Kairakkum hydropower plant are low (i.e., 8 cubic millimeters per year) compared to the remaining reservoir volume (i.e., about 3,000 millimeters per year), due to upstream reservoirs at Toktogul and Andijan trapping sediment. Sedimentation rates at Nurek reservoir are more significant, and the average annual loss of storage from 1972 to 1994 was about 115 cubic millimeters per year. If sedimentation were to continue unimpeded, dam safety and reservoir operation would be affected before the end of the century. It is not possible to be definitive about future changes in sediment yields due to climate change. It seems more likely that they would increase if Tajikistan had a warmer–wetter future climate, with deglaciation and increased frequency of heavy precipitation events. Climate change may also lead to changes in agricultural activity and crops grown, which may, in turn, affect future soil erosion and sediment yields.

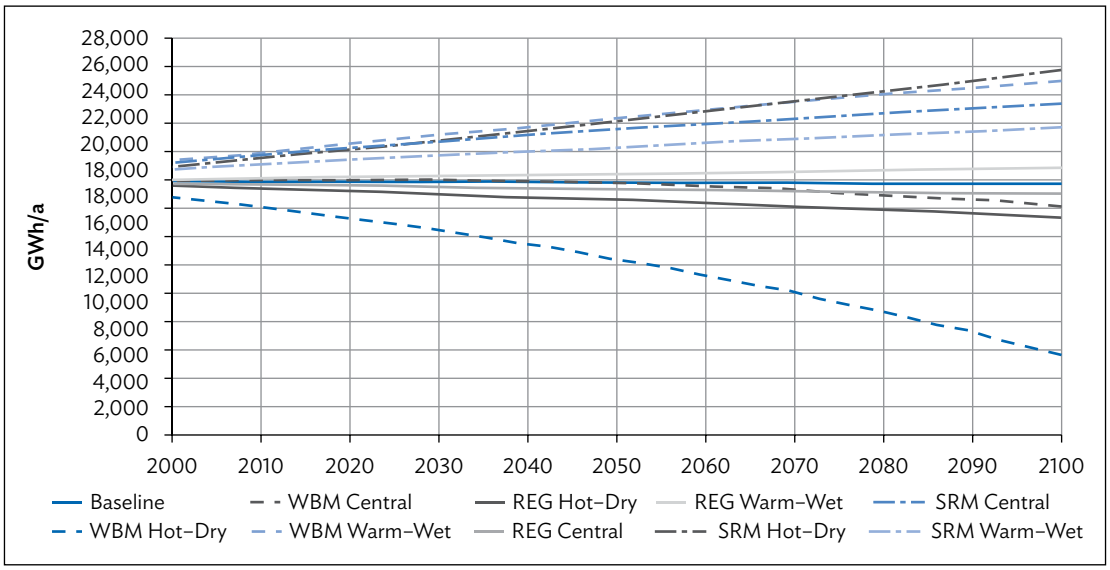
Figure 3 Model Simulations of Future Annual Energy Production, Kairakkum Hydropower Plant



GWh/a = gigawatt-hour per annum, REG = regression model, SRM = snowmelt runoff model, WBM = water balance model.

Source: Wilby, R. L. (Loughborough University), M. Friedhoff (SKM), R. Connell, B. Rabb (Acclimatise), N. Minikulov, A. Homidov, M. Shodmanov (Tajik Hydromet), and N. Leonidova (Loiha-Gidroenergo). 2011. PPCR Phase 1, Improving the Climate Resilience of Tajikistan's Hydropower Sector, Final Report, Annex 4. 14 October, Dushanbe, Tajikistan.

Figure 4 Model Simulations of Future Annual Energy Production, Vakhsh River Cascade



GWh/a = gigawatt-hour per annum, REG = regression model, SRM = snowmelt runoff model, WBM = water balance model.

Source: Wilby, R. L. (Loughborough University), M. Friedhoff (SKM), R. Connell, B. Rabb (Acclimatise), N. Minikulov, A. Homidov, M. Shodmanov (Tajik Hydromet), and N. Leonidova (Loiha-Gidroenergo). 2011. PPCR Phase 1, Improving the Climate Resilience of Tajikistan's Hydropower Sector, Final Report, Annex 4. 14 October. Dushanbe, Tajikistan.

65. **Flood safety.** It is understood that the Kairakkum and Nurek reservoirs were originally designed based on estimated peak discharges for extreme flood events, using observed discharges. It has since become international practice to apply more stringent criteria for large earth-fill dams. Furthermore, climate change is anticipated to increase the frequency and intensity of extreme flood events, although it is not possible to quantify these changes at present. It is not known if the spillway capacity and operating rules on the Vakhsh River cascade or Kairakkum hydropower plant have been reevaluated in line with current engineering practices and in the light of climate change. Flood safety at Kairakkum, however, has significantly improved since the Toktogul dam came into operation upstream in 1973.

66. **Recommendations.** Shortfalls in Tajikistan's data collection, analysis, and climate change risk assessment capacity impede the country's ability to develop its hydropower sector in a climate-resilient manner. Without a solid basis in monitoring, forecasting, and analysis, it will be difficult for experts in Barqi Tojik, informed by Hydromet, to make sound decisions on how best to optimize hydropower facilities now and in the future. The TA study offered the following recommendations for conducting further analytical work, monitoring, or capacity building:

(i) strengthen the hydrometric network for operational and long-term discharge forecasting and scenario analysis;
(ii) lengthen the period for snow cover measurement, recognizing that the onset of the melt season could already be starting earlier and continuing later into the year;
(iii) use measured spill and turbine discharge data to verify and calibrate a water balance model;
(iv) digitize and conduct quality assurance check for remaining paper-based hydrometeorological records held by Hydromet;
(v) partner with global sponsors of hydropower to establish robust protocols for evaluating low-probability, high-magnitude rainfall runoff events needed for flood safety assessment under changing conditions;
(vi) if not already done, georeference all entries within the complete Information Management and Analytical Center hazards catalog; the full dataset can then be used to determine whether any climate-driven signals are emerging in hazard frequency, timing, or location; and
(vii) assess the feasibility of seasonal forecasting of snowpack accumulation, timing of spring melt, and volume of inflows to reservoirs; where there is significant forecasting potential, operators can better manage reservoir levels to increase energy production.

67. In addition, to support investments in the Kairakkum power station, operational and structural changes to optimize energy production at the Kairakkum hydropower plant were evaluated. Several measures were identified, which would require only relatively small changes to existing structures and equipment:

(i) regarding operational changes, use some of the flood surcharge volume as live storage (i.e., increase the full supply level by up to 0.85 meters if further studies show that the flood surcharge volume is not required, as flood peaks are now attenuated by the upstream reservoirs at Toktogul and Andijan), and make changes to the operating rule curve to maximize head and minimize spill;
(ii) regarding structural measures, increase power station capacity to 147 megawatts during the planned rehabilitation by updating the generators and control system; and
(iii) increase the full supply level by 0.5 meters, and increase the power station capacity to 147 megawatts during the planned rehabilitation.

68. The results of the regional climate change and hydrology scenario in 2015 and 2100 indicate that operational changes can potentially yield about the same production increases as the structural changes examined in this TA activity. A combination of operational and structural changes brings the greatest benefits.

69. Annual energy, firm capacity, and flood safety on the Vakhsh River cascade would benefit from new upstream dams. The effect of constructing the Rogun reservoir on the existing power stations could increase annual energy production by 5%. Increasing the capacity of Nurek to 3,200 megawatts, as planned, would positively affect annual energy production.

70. For both the Kairakkum and Vakhsh River cascade hydropower plants, the TA activity also recommended various contingency measures for landslide risks, measures to manage sedimentation, and reviews needed for flood safety.

71. Toward the end of the consultancy assignment, a major stakeholder workshop was held in March 2012 in Dushanbe, organized by the PPCR secretariat and hosted by Barqi Tojik, at which the findings of the TA activity were analyzed and discussed by a wide range of Tajikistan stakeholders, and specific recommendations on PPCR phase 2 activities in the energy sector were made.

72. Contribution to phase 2. The analysis and recommendations from this PPCR phase 1 TA activity and the stakeholder workshop were then used to inform a major European Bank for Reconstruction and Development (EBRD)-managed feasibility study of the rehabilitation of the Kairakkum hydropower plant, enabling the phase 1 TA activity to have a significant transformative impact on the design of a major investment program. In addition, the feasibility study and environmental and social impact assessment will build on the analytical work of this TA activity, leading to additional climate-resilience features being incorporated into the plant's rehabilitation. This investment offers a valuable opportunity to pilot the integration of climate change analysis and climate-resilience measures into investment planning in hydropower, with potential transferable lessons for other hydropower plants in Tajikistan and beyond. The investment will also improve the enabling environment for climate-resilient energy security and strengthen institutional capacities for climate-resilient hydropower operations.

Sustainable Land Management Approaches for Climate Resilience

Executing agency	Ministry of Agriculture
Development partner	World Bank
Implementing consultants	Centre for Development and Environment
Implementation period	March–September 2011
Climate Investment Funds grant amount	$200,000

73. Widespread land degradation in Tajikistan is increasing the sensitivity of land resources to climate change impacts. Over 62% of pastures, meadows, natural forests, and areas along roads and canals and 22% of agroforestry areas are considered heavily degraded. Despite impressive agricultural growth, rural households are typically ill-equipped to change their farming practices

or sources of income to address the impacts of the changing climate, mainly because income levels remain low due to the generally small size of family farms, low levels of technology used, and interference of local authorities in farm-level production and marketing decisions.

74. The vulnerabilities of present and future agricultural populations reinforce the need to follow the principles of sustainable land management (SLM). SLM is the use of land resources (e.g., soil, water, animals, and plants) for the production of goods to meet changing human needs without jeopardizing the long-term productive potential of these resources and their environmental functions.[8] This TA activity provided the country with baseline data and an analysis of existing SLM practices, which inform how phase 2 investments can best improve rural livelihoods and resilience to climate change.

75. **Methodology.** Using the knowledge management system of the World Overview of Conservation Approaches and Technologies, 13 government agencies and nongovernment organizations (NGOs) working on SLM in Tajikistan collaborated to document current SLM technologies and approaches being used in the country. The documentation included traditional practices found in the hilly and mountainous regions of Tajikistan, land management practices introduced in Soviet times, practices implemented by international NGOs over the past 15 years, and practices of individual farmers. Different types of land use, regions, and actors in Tajikistan are represented in case studies showing potential practices for scaling up.

76. **Findings.** The SLM documentation team found 46 technologies and 24 approaches currently being used in the country. The technologies were analyzed for their potential to address climate change impacts and then grouped according to their functionality (Table 3 and Appendix).

77. Likewise, the 24 SLM approaches found across the country were grouped according to the ways in which they used the above technologies, that is, through SLM planning, individual and community initiatives, government partnerships, user associations, financial support, and knowledge transfer.

78. To strengthen the analysis of the correlation between SLM technologies and approaches and their potential to address climate change, the World Overview of Conservation Approaches and Technologies developed a new questionnaire to identify the protection a technology provided against different types of climate change impacts. Through additional desk study, the assessment also determined reasonable levels of exposure, land sensitivity, and adaptive capacity.

79. **Recommendations.** The assessment was valuable particularly for gathering and analyzing data with village-level government and NGO staff, demonstrating that the village level is appropriate for planning and implementing programs. The analysis proposed activities for three interactive zones: in-village, near-village, and off-village. Although the three-zone concept is applicable to all villages in all agro-climatic conditions of Tajikistan, each zone presents unique opportunities for addressing climate change risks (Figure 5).

80. The in-village zone has many private kitchen gardens that are essential for food security, especially for female-headed households with limited access to good-quality arable land. The near-village zone is a narrow belt around the village that requires costly rehabilitation, because its communal grazing areas are severely overused. This belt also includes riverbeds, valleys, and gullies

[8] World Overview of Conservation Approaches and Technologies (WOCAT). 2007. *World Overview of Conservation Approaches and Technologies*. Bern: Center for Development and Environment.

Table 3 Sustainable Land Management Technologies Currently Practiced in Tajikistan

Technology by Functionality Group	Number of Cases Documented	Issues of Climate Change Impacts, Land Degradation Addressed
Agroforestry	9	Crop failure in monoculture systems
Irrigation infrastructure management	8	Irregular rainfall patterns, water shortage
Land productivity enhancement	5	Soil fertility decline, cold spells, pests
Cross-slope measures: on-site protection	4	Heavy rainfall, water erosion
Improved grazing land	4	Decreased precipitation, degraded vegetation and soil
Indirect sustainable land management measures	4	Desertification, vegetation degradation
Tree belts	4	Wind erosion, microclimate changes, evaporation
Cross-slope measures: off-site protection	3	Disaster risk prevention (e.g., mudslides)
Water harvesting	3	Decreased precipitation, concentration of rainfall on fewer days
Planted and natural forest	2	Riverbank erosion, decreased biomass

Source: World Bank.

Figure 5 Illustration of the Three-Village Zonal Approach

Source: Wolfgramm, B., S. Stevenson, Z. Lerman, J. Zähringer, and H. Liniger. 2011. Pilot Program for Climate Resilience Tajikistan, Phase 1 Agriculture & Sustainable Land Management, Final report, 15 December. Dushanbe, Tajikistan.

that threaten villages with floods and landslides. Private user rights would help rehabilitate the belt with vegetation that would improve the microclimate and protect villages. Beyond this belt is the off-village zone—rain-fed and irrigated cropland and large grazing and forestlands, which are the main production areas of Tajikistan, yet most show signs of soil erosion, salinization, and vegetation degradation. Mitigation measures are required in this zone to prevent further degradation and increase productivity.

81. The findings and recommendations from the activity were disseminated among PPCR stakeholders, who were encouraged to give feedback in writing or during a feedback meeting in Dushanbe. Valuable feedback was collected from the World Bank team, the NGO Forum on ADB in Tajikistan, the Tajik Climate Change Network, the Ministry of Water Resources and Land Reclamation, and consultants. Their feedback was incorporated into the final report and design of phase 2.

82. **Contribution to phase 2.** An $11.45 million project financed by the Climate Investment Funds, and an additional $5.4 million from the Global Environment Facility, has been prepared for phase 2. As recommended in the phase 1 assessment, the proposed Environmental Land Management and Rural Livelihoods Project will be implemented over 5 years in select climate-vulnerable districts—Baljuvan, Farkhor, Jirgatol, Khovaling, Kulob, and Tavildara—that span the three different agro-ecological zones of Tajikistan.

83. The project aims to improve rural production and land resources management in villages, and supports larger-scale initiatives in sustainable community land management. In villages, the project will support rural production and land management investments and related small-scale infrastructure investments that aim to reduce land degradation, improve livelihoods, and increase resilience to climate change impacts. On a larger scale, the project will introduce sustainable community-managed pasture and livestock production systems in selected *jamoats* and sustainable on-farm water management practices in irrigated croplands, primarily in lowland districts. The project also supports knowledge management, technical and institutional support, and project coordination to ensure capacity building of government and communities.

Measuring Institutional Adaptive Capacity and Climate Change Awareness

Executing agency	Committee of Environmental Protection
Development partner	World Bank
Implementing partner	United Nations Development Programme, Tajikistan
Implementation period	2011
Climate Investment Funds grant amount	$250,000 total: $150,000 to review Tajikistan's institutional arrangements and capacity needs for climate policy; $100,000 to raise awareness of climate change

84. This TA activity looked systematically at the adaptive capacity of national laws and policy, national and subnational government institutions, and civil society to lead adaptation activities, specifically in response to risks within the water, agriculture, energy, and health sectors. This TA

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Crop diversification will be one of several resiliency measures implemented during phase 2 that will support sustainable land management and improve the income of farmers.

WORLD BANK

An estimated $18.88 million investment in phase 2 for sustainable land management will build the resilience of individual farmers and community land resources such as grazing pastures.

activity also assessed how the education, awareness levels, and the public opinion of stakeholders reflect their general understanding of the cause–effect relationships of climate change in the four key sectors and their knowledge and demonstrated ability to adapt.

85. The implementation of recommendations in phase 2 to address various gaps is crucial in supporting the effectiveness of the entire phase 2 investment program, which aims to build broad resilience in hydropower production, SLM, and river basin management. Ultimately, the capacity developed through the PPCR process in Tajikistan is essential to replicating the investments piloted by the program.

86. **Methodology.** The baseline capacity assessment is based partly on the CARE Climate Vulnerability and Capacity Analysis, the climate smart investment framework[9] by the Department for International Development of the United Kingdom, and with proprietary modules on knowledge, information, and education. The gap analysis and recommendations drew upon the *Practical Guide to Capacity Development in a Sector Context,* which focuses mostly on capacity development within a single institution, and the United Nations Development Programme 2007 and 2010 guides on capacity development.[10]

87. Data collection methods involved (i) a desk review of all phase 1 project documentation to incorporate findings and recommendations on sector-specific capacity strengths and needs; (ii) institutional mapping; (iii) stakeholder group consultation that included prioritization exercises and partial strengths, weaknesses, opportunities, and threats (SWOT) analysis of priority sectors; (iv) semi-structured and structured interviews and survey questionnaires to measure baseline capacities and needs; and (v) follow-up consultations with independent experts on findings and recommendations. More than 30 government agencies and educational institutions and more than 30 NGOs were involved in data collection and analysis.

88. **Findings and recommendations.** The TA activity identified six key findings and offered corresponding recommendations for their implementation in phase 2. Specific road maps were developed for each, which are sensitive to the country's limited resources and use existing capacity and relationships to meet implementation challenges.

89. **Finding 1: The government is funding work on climate change, both directly and indirectly, and there is an opportunity to prioritize and publicize this work.** Currently, the country has no framework that considers its climate portfolio as a whole. This leads to a lack of policy-based budgeting, efficient resource allocation, and oversight. While additional policies supporting climate resilience should be introduced, the government could make substantial progress toward improved adaptive capacity simply by effectively implementing policies that have already been approved. Other recommendations are as follows: (i) treating the climate-resilience portfolio as a whole in government policy making and resource allocation; (ii) developing clear priorities and performance targets for spending on climate-related issues; (iii) establishing priorities and performance targets; (iv) undertaking a public expenditure review focused on climate resiliency; and (v) monitoring the climate portfolio, and using it as a tool for raising awareness and preparing for a post-phase 2 strategy.

[9] The handbook on the methodology is available at http://www.careclimatechange.org/cvca/CARE_CVCAHandbook.pdf

[10] The practical guide is available at http://www.adb.org/sites/default/files/cd-guide-sector-context.pdf. All United Nations Development Programme guides in Tajikistan are available at http://www.undp.tj/site/index.php/en/publications

90. **Finding 2: The government should endorse a national action plan on climate change and update related legislation.** While a national action plan will be an important step forward, it is only one part of a larger policy package of legislation that must promote climate resiliency. Related recommendations would be to (i) develop clear targets and courses of funding for the national action plan, (ii) mainstream climate change adaptation into the national development strategy and the poverty reduction strategy, and (iii) update all key sector legislation to enable funding for climate adaptation.

91. **Finding 3: While public awareness of climate change may be greater than anticipated and continues to grow, information and outreach should now focus on specific adaptation activities.** A national survey of households taken from a random sample revealed that 57% of respondents considered themselves well informed or very well informed about the consequences of climate change, yet responses revealed that they did not connect climate change adaptation to other key concerns, such as infectious diseases or water availability. A survey of awareness-raising campaigns revealed that many national campaigns lacked a unified message that was easily understandable by the public. This indicates a need to raise awareness to link climate change to key issues such as water resources, energy, disaster risk reduction, health, and, more importantly, adaptation responses.

92. The following recommendations were made to raise public awareness: (i) target regions and districts where awareness is particularly low;[11] (ii) for every awareness campaign, develop a media plan on how best to reach audiences rather than randomly use one media outlet or spread money across many, which is the standard practice; and (iii) consider women's unique capacities, knowledge needs, and participation factors in designing activities (household surveys revealed that awareness of climate change issues was somewhat lower for women than men in Tajikistan).

93. **Finding 4: While capacity building in organizations is important, activities should be varied to avoid "training fatigue."** Lack of qualified personnel emerged as a key gap in the analysis, and more than 90% of regional and national officials contacted requested additional information on climate change issues. The TA study recommended (i) not limiting capacity building to training, but considering mentoring and coaching programs, institutional twinning, and consultant exchanges; (ii) utilizing existing training institutions, resources, and relationships for civil servants, government officials, and communities; (iii) giving special attention to training programs that link climate change adaptation and health, as phase 2 activities will not directly address this relationship; and (iv) taking steps to ensure women's participation to avoid their underrepresentation due to few women in leadership positions.[12]

94. **Finding 5: Bringing climate change issues into school curricula can increase knowledge quickly, but longer-term considerations are also important.** An effective long-term strategy will consider awareness raising, applied knowledge for sector specialists, postgraduate professional support, and a clear mechanism for implementing this strategy in Tajikistan. Recommendations are to (i) revise the draft state environmental education program and the law on environmental education to include climate change and its issues, a clear delegation of authority for implementation, and specific tasks and timelines; (ii) develop curriculum modules

[11] For example, 81% of respondents in Dushanbe considered themselves informed or well informed about climate change, while only half as many respondents in the Districts of Republican Subordination gave those answers.

[12] Less than one-third of *jamoat* leaders or mayors, less than 10% of executive branch leaders, and less than 20% of people's deputies are female. Mezentseva, E. 2007. *Increased Gender Equality at the Decision-Making Level.* Dushanbe: United Nations Development Fund for Women, p. 7.

on climate change and its impacts and responses for environmental and sector disciplines as well as economics, business, medicine, and energy engineering; and (iii) develop a long-term plan to address research and postgraduate needs in climate disciplines.

95. **Finding 6: Nongovernment organizations and community-based organizations should be leveraged as significant contributors to phase 2 activities, particularly in capacity building and training.** NGOs already provide training on climate change and adaptive measures at the national and local levels and have strong links in communities. To increase their participation in phase 2, the TA study recommended (i) strengthening the people's ability to experiment and innovate, establishing a small grants program for community-level organizations to undertake community-based adaptation projects; and (ii) including NGOs in developing, implementing, and monitoring of the recommended national action plan on climate change.

96. **Contribution to phase 2.** Based on the recommendations and implementation road maps produced from the phase 1 assessment,[13] a $6 million capacity-building TA, Building Capacity for Climate Resilience in Tajikistan, administered by the Asian Development Bank (ADB), has been designed and approved for phase 2. While capacity building is mainstreamed in all PPCR components, a concentrated and substantial effort is made under the new TA in phase 2.

97. Climate science modeling and institutional capacity building will be advanced during phase 2 of the PPCR implementation. The climate science and modeling component will (i) enhance the capacity of Hydromet to develop and interpret downscaled climate models to inform decision making and risk management, (ii) develop a management information system for climate data, (iii) train local experts, and (iv) introduce climate science and glaciology modules in institutions of higher education.

98. The component for building capacity for climate resilience will (i) strengthen climate risk management practices and awareness of climate change among various stakeholders, and (ii) institutionalize the PPCR secretariat to ensure the effective implementation of climate change projects beyond the duration of the PPCR.[14]

[13] The implementation road map was produced as a result of PPCR phase I, component A1—Stocktaking Report and Gap Analysis.
[14] Under one of the five outputs of the capacity development TA, the project will aim to develop the PPCR secretariat into a national implementing entity to ensure that Tajikistan can use and leverage additional financial support and implement climate change projects beyond the life of the PPCR.

PHASE 2 INVESTMENTS

99. Since the conclusion of phase 1 activities and the comprehensive review of results, the government, the multilateral development banks (MDBs), and teams of consultants had been preparing the investment package for phase 2. The status of each project varies monthly as the teams proceed through the milestones of gaining stakeholders' approval. Phase 2 consists of four grant-based sector investments and one crosscutting capacity development TA activity. The framework of phase 2 is summarized in Table 4. Most of the projects are expected to be implemented over 5 years, with completion around 2018–2019 or before.

Table 4 Phase 2 Investment Framework

Project	Financing Amount	Government Executing Agency and Multilateral Development Bank Administering Funds	Description
Improvement of Weather, Climate, and Hydrological Service Delivery	$7,000,000	Committee of Environmental Protection (Hydromet) and the World Bank	The project, begun in 2012, is strengthening the national capacity to collect, analyze, and present to the government and the public, data on weather, climate, and hydrology.
Building Capacity for Climate Resilience	$6,000,000	Committee of Environmental Protection and the Asian Development Bank	The project will build the capacity of Hydromet to develop and analyze dynamic downscaled climate models and its general capacity through results management, knowledge management, and awareness raising.
Enhancing the Climate Resilience of the Energy Sector	$11,000,000	Ministry of Energy, Barqi Tojik, and European Bank for Reconstruction and Development	This project will improve the enabling environment for climate-resilient energy security, strengthen institutional capacities for climate-resilient hydropower operations, and implement the climate-resilient upgrade of the Kairakkum hydropower plant as a groundbreaking demonstration project.
Environmental Land Management and Rural Livelihoods	$11,450,000	Committee of Environmental Protection and the World Bank	The project will enable people in rural areas to increase their productive assets through ways (e.g., through community-based funding for improved crop yield, diversity, efficiency, market access, and small-scale infrastructure) that also improve management of natural resources and resilience to climate change.
Building Climate Resilience in the Pyanj River Basin	$22,700,000	Ministry of Land Reclamation and Water Resources, Ministry of Finance, Statue Unitary Enterprise for Housing and Communal Services (Khochagii Manzilii Kommunali, or KMK), and the Asian Development Bank	The project will improve the livelihoods of 59 climate-vulnerable villages in 19 *jamoats* by climate-proofing flood, irrigation, and water supply infrastructure and offering microcredit or microdeposits for adaptation activities.

Source: Author.

APPENDIX

Recommended Sustainable Land Management Approaches per Village Zone

	Land-Use Type		Exposure to Climate Change	Sensitivity of Land and Livelihoods	Adaptive Capacity[a]	Targeted Stake-holders
I.	**In-Village**					
	Cultivation of small household plots	Intensified and diversified cultivation of small household plots	Lack of precipitation and drought periods resulting in water stress	Highest importance regarding food security Increased exposure to pests and diseases	Very limited finances and agricultural inputs Limited access to knowledge and advisory support Limited workforce	Vulnerable households with household plots only Female-headed households
	Indirect SLM measures targeting degraded forest areas and cultivated land	Better-preserved forests and increased fertility of cultivated land	Increase in high rainfall events Extended drought periods Reduced precipitation	Forests are degraded and under continuous high pressure from fuelwood collectors. Cultivated land is degraded because organic material is burned instead of used as fertilizer.	Rural households have limited alternatives regarding fuel sources and consumption. They are highly reliant upon wood, bush, and dried dung.	Vulnerable households with household plots only Female-headed households

Technology Groups and WOCAT Codes[b]	Approach Groups[c] and WOCAT Codes	Policy Implications	Opportunities for Phase 2	Threats for Phase 2
LPE: TAJ109, TAJ350, TAJ375, TAJ380, TAJ393, TAJ398 WH: TAJ104, TAJ348	Knowledge transfer: TAJ018 (field schools) Targeting women: TAJ036 Public women's organization, Zam Zam: TAJ038	Improved farm services and inputs required Experts in greenhouse construction to be trained Market chain for greenhouse products to be developed Certification processes for organically produced products to be established	A range of low-cost interventions can be integrated to provide substantial short-term benefits. Greenhouses can increase the growing season, encourage crop diversification, increase yields, and improve the food security situation of the household. Tenure rights on household plots are clear and taxes limited to the land tax, which are important preconditions for the implementation of SLM practices.	Greenhouses might require a large initial investment and expertise, depending on the construction. Sanitation and health threads of water tanks need to be taken into account.
ISM: TAJ102, TAJ354, TAJ551	Financial support: TAJ031 Targeting women: TAJ038 (women's affairs officer) TAJ026 (participatory cost–benefit analysis)	Experts in house insulation and energy-efficient stoves to be trained A market for energy-efficient construction to be developed These would have to become registered businesses, subject to taxes.	Energy-efficient technologies are well established in Tajikistan. There is already significant expertise, experience, and geographic spread that can be further supported. There are cheap solutions to promote community interest. Through implementation of energy-efficient technologies in the in-village zone, forests from the off-village zones would be better protected.	Indoor stoves and insulation require substantial initial investment. Many households would require financial support or a microloan.

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	Land-Use Type		Exposure to Climate Change	Sensitivity of Land and Livelihoods	Adaptive Capacity[a]	Targeted Stake-holders
II.	**Near-Village**					
	Degraded cultivated land	Intensified and diversified Haymaking and agroforestry areas	Increase in high rainfall events and extended drought periods, leading to water shortages	Degraded land has low productivity and thus affects food security. Cultivated land on slopes is increasingly susceptible to degradation processes that can result in landslides and mudflows, pests, and disease.	Limited knowledge of applicable technologies Limited finances Lack of clear land-use rights, possibly no land-use certificates issued	*Dehkan* farms Individual households
	Degraded pasture land	Intensified and diversified Haymaking and agroforestry areas	Extreme rainfall and droughts Decrease of snow cover and therefore less soil humidity in spring, leading to reduced pasture productivity	Severely degraded pastures are sensitive to drought and erosion processes, which is exacerbated by uncontrolled grazing. Rural households are highly dependent upon livestock for food security and livelihoods.	Missing governance of commonly managed resources No pasture law Weak institutional setup Poor livestock-breeding practices Lack of quality veterinary services Poor access to markets Limited knowledge of applicable technologies	*Jamoats* *Dehkan* farms Individual households

Technology Groups and WOCAT Codes[b]	Approach Groups[c] and WOCAT Codes	Policy Implications	Opportunities for Phase 2	Threats for Phase 2
AF: TAJ004, TAJ008, TAJ111, TAJ113, TAJ365, TAJ370, TAJ103 TB, CSM-ON, IIM: TAJ376, TAJ362, TAJ107, TAJ108, TAJ397	Individual initiative: TAJ03, TAJ04, TAJ05 SLM planning: TAJ020, TAJ046, TAJ047 Knowledge transfer: TAJ018, TAJ037 Financial support: TAJ044	Allocation of marginal land to active land users Potential registered change in land use and tax implications Tax payable on new trees after 5 years Legal support in securing land-user certificates Access to credit for covering establishment costs	Intensification, diversification, expansion, and protection are all applicable. The community has many technologies to implement using several established or new approaches. Additional agroforestry plots near villages will provide year-round work to the rural population.	Equitable reallocation of land needs to be assured. Compensation for lost communal grazing land must be given. Sufficient water resources and adequate distribution networks must ensure all implementation can be sustained. Tax regulations give preference to quick-growing trees.
AF: TAJ004, TAJ008, TAJ111, TAJ113, TAJ365, TAJ370, TAJ103 CSM-ON, IIM: TAJ376, TAJ362, TAJ107, TAJ108, TAJ397	Individual initiative: TAJ03, TAJ04, TAJ05 SLM planning: TAJ020, TAJ046, TAJ047 Knowledge transfer: TAJ018, TAJ037 Financial support: TAJ044	Allocation of marginal land to active land users Potential registered change in land use and tax implications Tax payable on new trees after 5 years Legal support in securing land-user certificates Access to credit for covering establishment costs	Active land users are provided with more land, turning unproductive land into highly productive land with higher crop yields. If coupled with stall feeding and better livestock breeds, higher livestock productivity and potential for farm diversification (e.g., milk) are expected. Such measures will also reduce pressure on off-village pastures.	The area of common grazing lands will be reduced. Stall feeding requires more work. Legal guidance is lacking, i.e., there is no pasture law. A lengthy process exists when allocating land to individuals through local government. The near-village grazing land may be owned by one inactive farmer.

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	Land-Use Type		Exposure to Climate Change	Sensitivity of Land and Livelihoods	Adaptive Capacity[a]	Targeted Stake-holders
	Gullies, landslide- and mudflow-prone areas, and riverbanks	Productive gullies Stabilized land for cultivation	Extreme heavy rainfall events	Severely degraded land, threatening infrastructure, agricultural land, homes, and livelihoods	Limited finance and understanding of the causes of disaster risks Limited knowledge of applicable technologies	*Jamoats* *Dehkan* farms Individual households
III.	**Off-Village**					
	Rain-fed annual cultivated land	Intensification and diversification of rain-fed annual cultivated land	Heat waves Droughts Extreme weather events	Reliance on a restricted crop selection increases the sensitivity of land use to climate extremes due to the higher risk of production failure Pests and diseases	Poor seed stock Lack of quality agricultural inputs Technologies unknown to land users (e.g., minimum tillage and irrigation techniques)	Risk-taking individuals and innovative farmers *Dehkan* farms
	Irrigated annual cultivated land	Intensified and diversified irrigated cultivated land, and agroforestry	Heat waves Droughts Limited number of rainfall days	Reliance on a restricted crop selection increases the sensitivity of the land use to climate extremes due to the higher risk of production failure. Limited and untimely irrigation water Pests and disease	Lack of operational control of water distribution, use, and payments Limited finances for rehabilitation of irrigation infra-structure Lack of monitoring of irrigated water and dissemination of critical information	Risk-taking individuals and innovative farmers *Dehkan* farms Local government

Technology Groups and WOCAT Codes[b]	Approach Groups[c] and WOCAT Codes	Policy Implications	Opportunities for Phase 2	Threats for Phase 2
CSM-OFF: TAJ353, TAJ356, TAJ403	Individual initiative: TAJ006 (joint land user initiative) SLM implementation: TAJ022 (village school involvement), TAJ029	Lack of clear understanding of who is responsible for protecting the village, community, or government Land ownership issues Community agreement and demarking land for rehabilitation (e.g., fencing) Land tax implications	Increase protection of infrastructure and land from disaster risks not only in the near- but also in the in-village zone Potential to rehabilitate unproductive land for future cultivation	Legal guidance is lacking, i.e., there is no pasture law. Fencing costs are high due to lack of natural resources to construct a fence. There is potential for conflict over land ownership after rehabilitation.
Conservation agriculture: AUS02, SPA01, MOR10, KEN30, ZIM001, RSA43	KEN13, RSA43	Providing improved access to agricultural inputs Ability to follow freedom to farm with no outside interference Access to attractive finance packages for investment in land Simplification of land taxes	No change in land category needed Increase in intensification and diversification of the land, more resilient to climate change impacts Long-term benefits leading to increased commercialization Once conservation agriculture is established in the off-village zone, it might also spread to the near-village zone.	Expert knowledge is required for implementing such a system. Suitable machinery is required. This technology has so far not been tested in Tajikistan. It requires entrepreneurial farmers to implement these measures.
IIM: TAJ112, AF: TAJ113	Knowledge transfer: TAJ018 User associations: TAJ024	Providing improved access to agricultural inputs The ability to follow freedom to farm with no outside interference Access to attractive finance packages, including insurance packages Simplification of land taxes Establishment of water user associations, a water monitoring strategy, and implementation structure	Increased diversification and intensification opportunities Increase in existing yields Potential for structured land-use planning based on water monitoring Prevention of conflict between water users Long-term benefits leading to increased commercialization	Large-scale investment in the irrigated plains may be required. If not well managed, the overexploitation of water resources might hinder intensification activities in the near-village zone.

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Land-Use Type		Exposure to Climate Change	Sensitivity of Land and Livelihoods	Adaptive Capacity[a]	Targeted Stakeholders
Extensive pasture land	Highly productive extensive pasture land	Droughts Less snow Less precipitation	Severely degraded pastures sensitive to drought and erosion processes, exacerbated by uncontrolled grazing Rural households highly dependent upon livestock for food security and livelihoods	No pasture law Weak institutional setup Poor livestock breeding Lack of quality veterinary services Poor access to markets Limited knowledge of applicable technologies	Households *Dehkan* farms Local government State forestry departments
Forest	Sustainably managed forests	Extreme rainfall Glacier and snowmelt Drought and hot days Lack of precipitation	Forests exploited extensively for fuel and construction materials Increasingly prone to forest fires, pests, and diseases	Limited capacity and resources of state forestry departments to manage vast forest areas High dependence on wood for fuel Lack of a strong forestry code	Households *Dehkan* farms Local government State forestry departments

SLM = sustainable land management, WOCAT = World Overview of Conservation Approaches and Technologies.

[a] Such as finance and access to finance, land ownership, freedom-to-farm knowledge, support from the community, and access to materials.

[b] Technology groups as characterized on page 22. AF = agroforestry; CSM-OFF = cross-slope measures: off-site protection; CSM-ON = cross-slope measures: on-site protection; IGL = improved grazing land; IIM = irrigation infrastructure management; ISM = indirect sustainable land management measures; LPE = land productivity enhancement; PNF = planted and natural forest; TB = tree belts; WH = water harvesting. Each technology and each approach documented in the WOCAT database is assigned a unique code consisting of a three-letter country code and a three-digit number.

[c] Approach groups are characterized starting from page 22.

Source: World Bank.

Technology Groups and WOCAT Codes[b]	Approach Groups[c] and WOCAT Codes	Policy Implications	Opportunities for Phase 2	Threats for Phase 2
IGL: TAJ009, TAJ100, TAJ103, TAJ368	User associations: TAJ013, TAJ040	Support and registration of water user associations Support of state veterinary services Completion of pasture law Legal support of allocation of livestock routes to pasture lands	Improvement in pasture yields Improvement in livestock health due to watering points and shade Improved meat and dairy production Less degraded pastures will reduce negative off-site effects such as sediment loads in rivers and irrigation systems	An established level of control is needed to prevent other livestock farmers from exploiting new initiatives.
PNF: TAJ114, TAJ342, TAJ366 TB: TAJ106 (wind forest strips)	SLM implementation: TAJ015, TAJ025 Financial support: TAJ030	Government approval of the new forest code Forest agency at district level must be trained in elaborating management plans and long-term contracts with land users	No change in land category needed Higher forest productivity Increased biodiversity and natural protection against climate change impacts Potential to plant climate-resilient trees for the future Intact forest in the off-village zone protects the near- and in-village zones from disaster risks.	Potential large initial investment The quality of tree nurseries needs to be tightly controlled before saplings are sold and distributed.

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Building the Analytical Base

A Summary of Results from Phase 1 of the Pilot Program for Climate Resilience in Tajikistan

The Pilot Program for Climate Resilience is a global initiative in nine countries and two regional programs in several countries—including Tajikistan—that face exceptional risks to climate change. The program helps put countries on a climate-resilient development path consistent with their poverty reduction and sustainable development goals. Tajikistan's program is administered by the Asian Development Bank, the European Bank for Reconstruction and Development, and the World Bank. It is being implemented in two phases and covers six priority investment areas. This report provides an overview of the technical assistance under PPCR's phase 1 completed in 2010.

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