ADB Climate Action SOUTH ASIA
Steering Economies Toward Low-Carbon and Climate-Resilient Development
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Addressing Climate Risks in Development Interventions

As a first step toward addressing climate change risks in development investment, a climate change risk screening system is being applied in projects in the six South Asia developing member countries of ADB. Using extensive geophysical information and downscaled high-resolution climate data, the screening system enables localized climate impact assessments by analyzing both natural hazards in the project areas and climate-related risks to the project investment.

Climate change poses a formidable threat to socioeconomic development in South Asia. Without a global deviation from a fossil fuel-intensive path (business as usual), South Asia could lose nearly 2% of its annual gross domestic product (GDP) by 2050, rising to a loss of 8.8% by 2100—and higher still if losses due to extreme weather events are added. Such risks of GDP loss can hinder the prospect for rapid economic growth of ADB's South Asia developing member countries (DMCs) and compromise efforts in poverty reduction and other Millennium Development Goals. Thus, South Asia DMCs face a huge and urgent investment challenge to adapt to climate change impacts and avoid greater damage to GDP. Average annual adaptation costs by 2050 could be as high as 0.48% of GDP under a business-as-usual scenario and 0.36% under global stabilization scenario that will keep global temperature rise below or within 2^{o}C.[1]

Climate and Development

Climate change can affect any development activity and its impact depends both on geographical location and type of activity. Development decisions and activities today must adequately consider climate change in order to avoid unnecessary costs, wasted investments, and risks to life in the future.[2] Climate change screening will ascertain potential risks of climate change through knowledge-based evaluations and/or assessments, which is the first step toward adaptation.

Climate risk screening refers to a systematic process of evaluating development projects to determine the extent to which their objectives and activities might be affected by future climate-related impacts, and to identify adaptation options to reduce any resulting adverse impacts and exploit opportunities.[3] In the absence of screening, development activities may lead to "maladaptation"—an increase in exposure and/or vulnerability to climate change—either by overlooking climate change impacts or by undertaking inadequate adaptation actions.[4]

ADB has already begun mainstreaming climate change adaptation into its operations. According to the results framework indicators, ADB will implement

[1] *Regional Economics of Climate Change in South Asia – Adaptation and Impact Assessment* Regional Synthesis Report (forthcoming).
[2] Gigli, S. and S. Agrawala. 2007. *Stocktaking of Progress on Integrating Adaptation to Climate Change into Development Cooperation Activities.* OECD, Paris. www.oecd.org/dataoecd/11/18/39575695.pdf
[3] Tanner, T., J. Xia, and I. Holman. 2008. *Screening for Climate Change Adaptation in [the People's Republic of] China: A process to assess and manage the potential impact of climate change on development projects and programmes in [the People's Republic of] China.* Institute of Development Studies. www.ids.ac.uk/files/dmfile/ChinaClimateScreeningSynthesisEnglish.pdf
[4] Olhoff, A. and C. Schaer. 2010. *Screening Tools and Guidelines to Support the Mainstreaming of Climate Change Adaptation into Development Assistance – A Stocktaking Report.* UNDP, New York.

climate change solutions in 60% of its projects for 2013–2015. ADB's South Asia Department (SARD) regards climate change adaptation as top priority and is geared toward mainstreaming climate change into all future projects and programs.

SARD is currently developing a climate risk screening framework that entails local-scale assessments using downscaled climate data. The framework has been applied to screening over 30 selected SARD projects across a number of sectors. This leaflet provides an introduction to the systematic approach to climate risk screening employed.

Climate Risk Screening System[5]

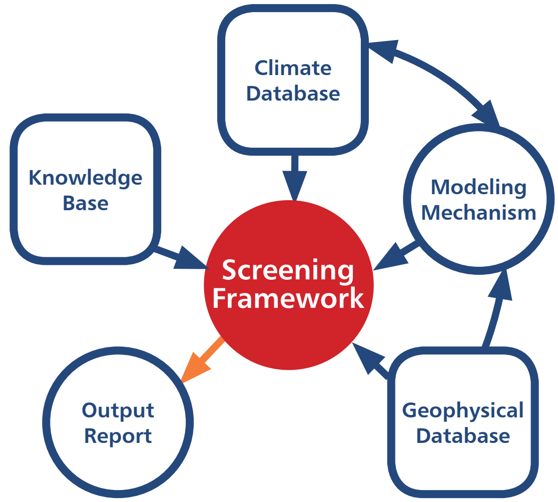
A screening tool must be able to identify the types of risks posed by climate change to a development activity and assess the potential damage. The most effective approach is through local-scale assessments by analyzing downscaled climate data supported by relevant geophysical information.

The system being implemented at SARD has six components (Figure 1): two Geographic Information System (GIS) databases to store and manage geophysical and climate data; a knowledge base to catalogue known potential risks of climate change to sector-specific projects and programs; and the screening framework, which communicates with the two GIS databases and the knowledge base through modeling that generates screening outputs. The components are described below.

Geophysical Database

The geophysical GIS database includes data necessary for climate risk assessments. Major types of geophysical data include soil, land use/

FIGURE 1: Climate Risk Screening System



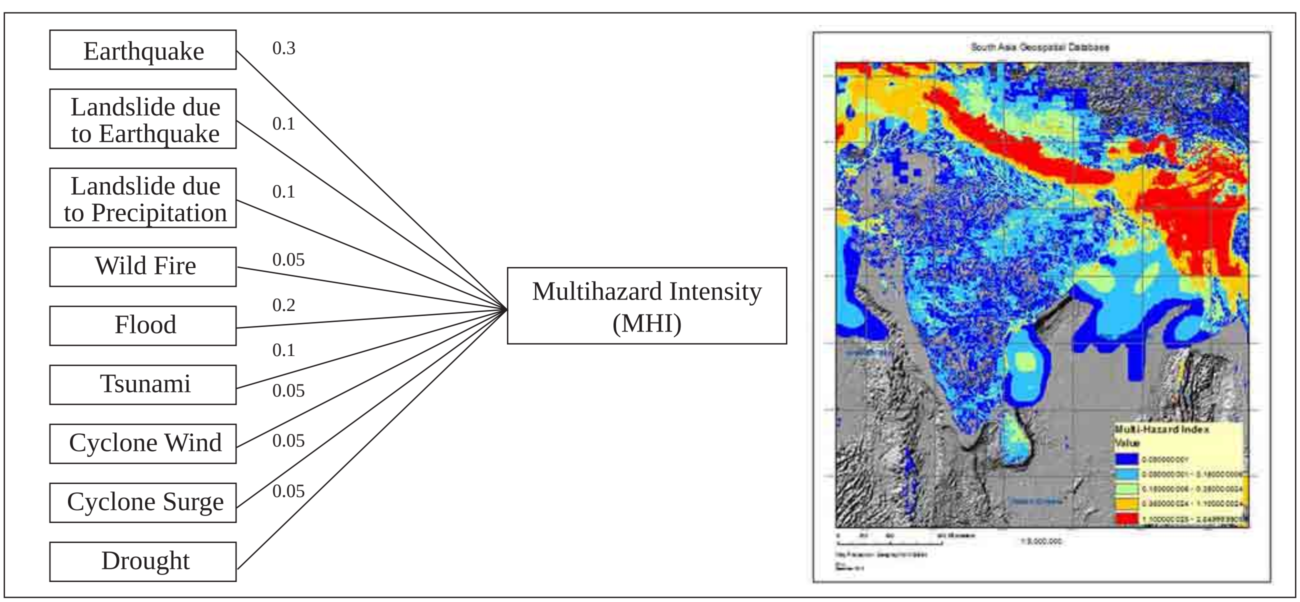
cover, vegetation cover, elevation, hydrology, and ecosystems. Global natural hazards assessment data from various sources are also stored within the database. Seven types of natural hazards are relevant to South Asia (i.e., cyclone, drought, earthquake, fire, flood, landslide, and tsunami). Although not all hazards are climate-related, risk assessment must include all natural hazards.

A multihazard index (Figure 2) that signifies the overall hazard level was created by combining the seven geoclimatic hazards, using an arbitrary weighting of potential damage to physical structures. Three risk categories of projects (low, medium, high) were formulated based on the index.

Climate Database

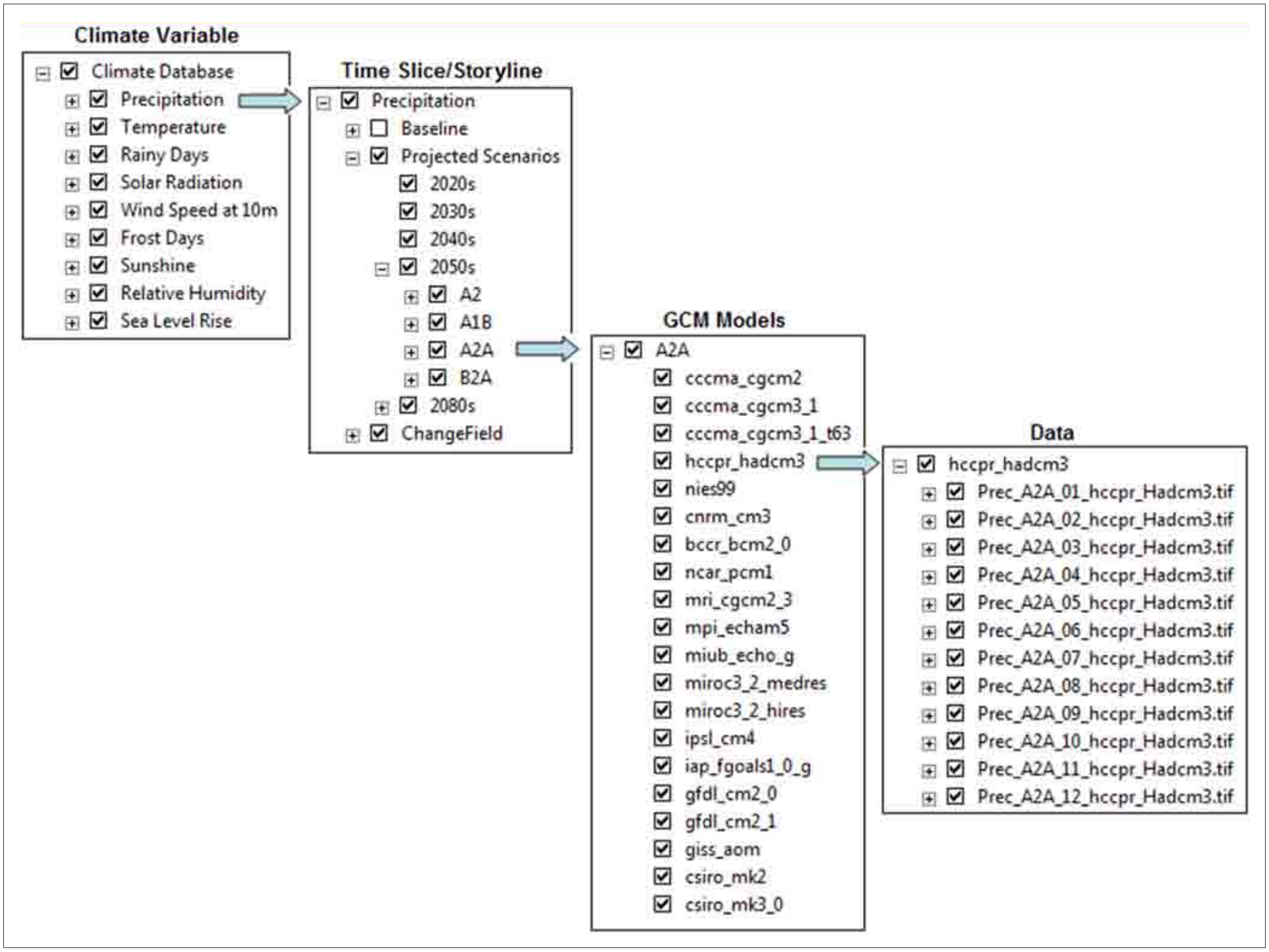
The climate database hosts the primary climate data as well as secondary and derived climate data. Primary climatic data include precipitation, temperature, rainy days, solar radiation, wind speed, frost days, sunshine hours, and relative humidity, all of which are monthly

FIGURE 2: Multihazard Index



[5] Developed with technical assistance from C.Y. Ji, Climate Change Risk Screening Specialist (consultant).

FIGURE 3: Organization of Precipitation Data within the Climate Database



based. Secondary climatic data (e.g., heat index, and water deficit) are derived from modeling. Sea level data are also stored in the climate database. Figure 3 shows the hierarchical structure of data storage for precipitation.

The baseline precipitation and temperature, obtained from the WorldClim - Global Climate Data (www.worldclim.org), are high-resolution (30 arc-seconds, or ~1 kilometer at the equator) gridded data interpolated from long-term discrete point observations from around the globe spanning the period 1960–1990. The outputs of general circulation models (GCMs) from the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (Fourth Assessment) have been statistically downscaled by the International Center for Tropical Agriculture (CIAT).[6] Monthly precipitation and temperature have been downscaled to 30 arc-seconds to align with that of the baseline.

Although statistical downscaling may introduce additional uncertainties into climate scenarios under certain circumstances, this approach has gained support in recent years because it is easily implemented and, unlike in dynamic downscaling, does not require immense computing powers. The downscaled climate datasets from CIAT are possibly one of the few, if not the only, high-resolution global datasets available at present.[7] Without downscaling, local assessments cannot be conducted.

Figure 4 shows the projected mean monthly precipitation (2050s, A2 scenario) by the GCM ensemble.

Climate Change Knowledge Base

Knowing the potential climatic risks posed to the project components is vital to the success of a screening endeavor. The climate change knowledge base will provide a complete list of potential risks to be input into the screening framework, enabling a systematic approach to be followed and avoiding omissions of any known potential risk.

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6 Ramirez-Villegas, J., and A. Jarvis. 2010. Downscaling Global Circulation Model Outputs: The Delta Method–Decision and Policy Analysis. *Working Paper No. 1*. Cali, Columbia: CIAT.

7 The CIAT statistical downscaling process assumes that climates vary only over large distances and thus is most useful for homogeneous landscapes, such as floodplains, and less so in heterogeneous areas like mountain ranges.

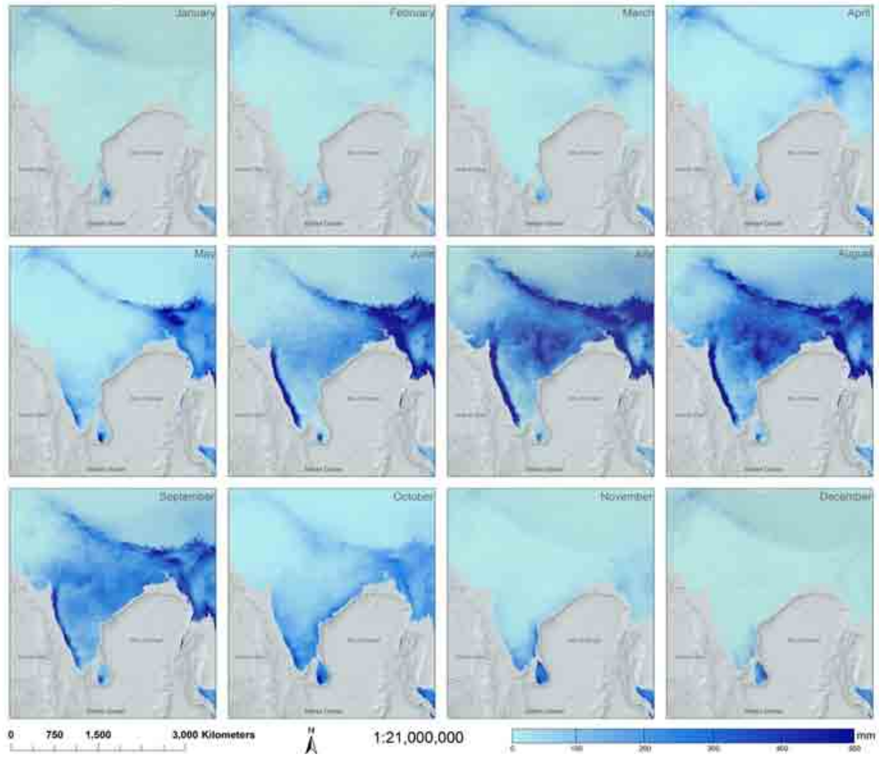
Each risk is treated as an independent entity encapsulated in terms of sector, ecological zone, climate variables, impacts, and implications.

Currently the knowledge base being developed at SARD contains limited sets of potential risks from climate change to sector projects, acquired primarily from a literature survey. As an example, Table 1 presents the climate change risks to energy projects. As more experience and expertise are gained through screening exercises, the knowledge base will become more comprehensive.

Modeling Mechanism

The essential component of the screening system is the modeling module. Windows Image Process System (WIPS)[8] is a software that offers a variety of modeling capabilities. Figure 5 shows a visualization of climate change using the system.

Figure 4: Ensemble Mean of Projected Monthly Precipitation, 2050s, IPCC A2 Scenario



Dataset: Annual Precipitation
Original Dataset: Downscaled IPCC SRES GCM Output
Storyline/TimeHorizon: A2/2050s
Data Source: CIAT
Projection: Geographic/WGS84

The most significant and harmful impacts of climate change will be experienced through alterations in the water cycle. The monthly water balance model of Thornthwaite[9] has been implemented (Figure 6). Water balance is among the empirical hydrological methods that can be used to estimate runoff characteristics for a site or drainage subbasin.

Table 1: Climate Change Risks to Energy Projects

Type	Climate Impact	Possible Implications
Fossil Fuel and Nuclear Power Generation	• Increased precipitation • More intense precipitation • Higher temperatures • Sea-level rise/storm surge • Reduced summer rainfall	• Flood risk to power plants, decommissioned nuclear sites and nuclear waste reprocessing and storage facilities • Reduced efficiency due to higher temperature • Reduced efficiency due to storminess • Reduced available water for cooling
Renewable Wind	• Increased risk in storminess • Reduced wind power	• Increased storm damage • Reduced efficiency
Solar Power Generation	• Increased cloudiness and rainy days • Increased precipitation • Decreased solar radiation • Higher temperatures	• Reduced available energy • Reduced efficiency
Hydropower Generation	• Changes in precipitation amount • Changes in precipitation patterns • Increased temperatures	• Reduced water availabililty • Reduced efficiency (seasonal)
Biomass	• Reduced precipitation/increased temperature • Changes in precipitation/temperature regime	• Reduced availability of biomass due to drought • Vegetation dynamics • Change in cropping patterns and crop types
Power Transmission and Distribution	• Higher temperature • Increased precipitation • More intense precipitation • Surface water, tidal and fluvial flooding • High winds	• Reduced network capacity • Flood risk to substations and low-lying structures • Storm damage to overhead power lines • Reduced capacity of network to distribute electricity due to high temperatures

Source: Secretary of State for Environment, Food and Rural Affairs by Command of Her Majesty, 2011. *Climate Resilient Infrastructure – Preparing for a Changing Climate.*

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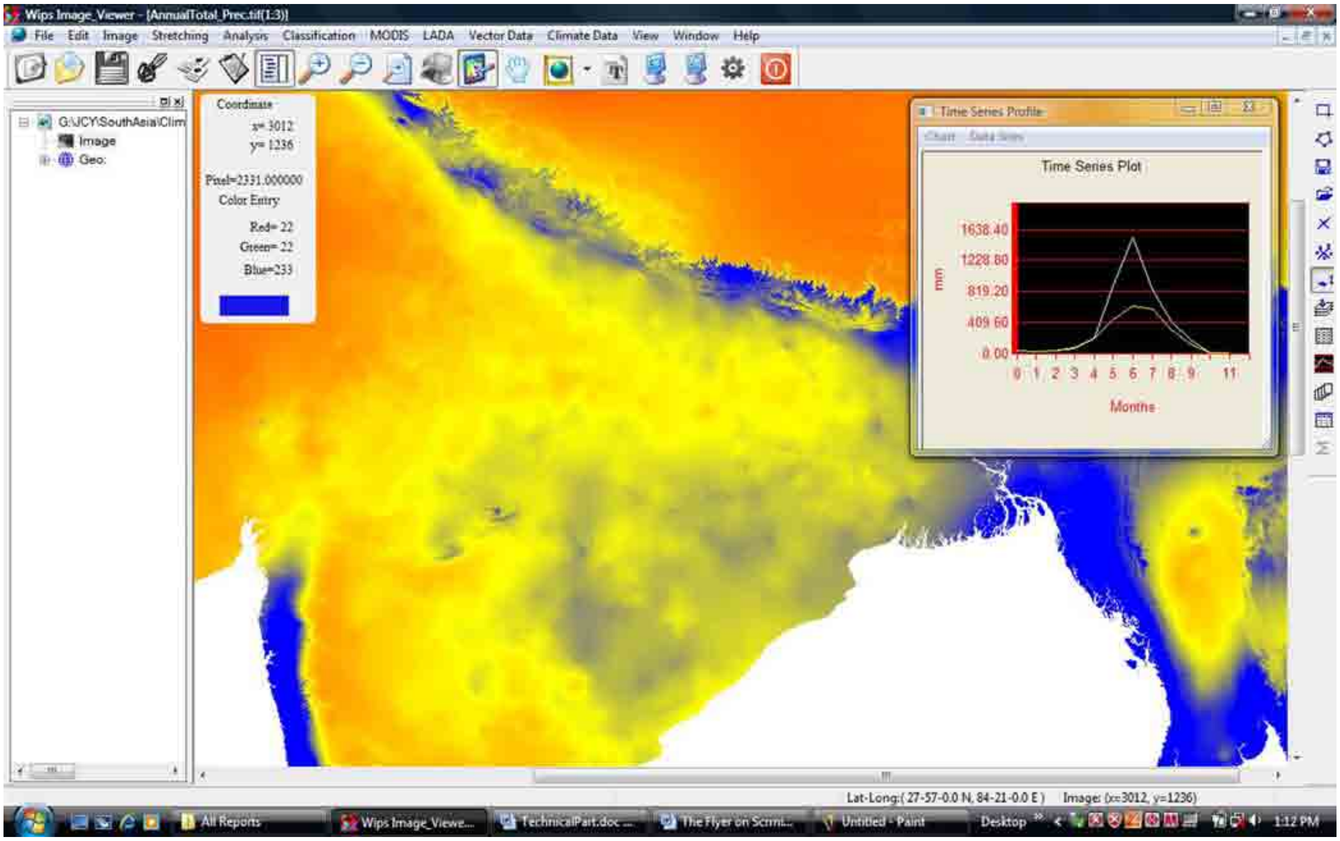
[8] Developed by C.Y. Ji, Climate Change Risk Screening Specialist (Consultant).

[9] Thornthwaite, C.W. 1948. An Approach Toward a Rational Classification of Climate. *Geographical Review.* 38. p. 55–94.

Figure 5: Climate Data Visualization using Windows Image Processing System (WIPS)



Central to the modeling processes is the choice of general circulation model. In most cases, the ensemble average is used, a common practice in climate impact assessments. In the near future, both the maximum and the minimum will be added to the screening process to provide more information for handling uncertainties. When a specific set of GCM models is found more robust to simulate past climate within a designated region, this specific set will be used for subsequent tasks.

Reporting Module

The output of a screening exercise consists primarily of a screening report and a set of maps. The report template has five sections, each corresponding to a step (described below) of the framework. The present template is subject to modification according to the results of trials.

The Screening Framework

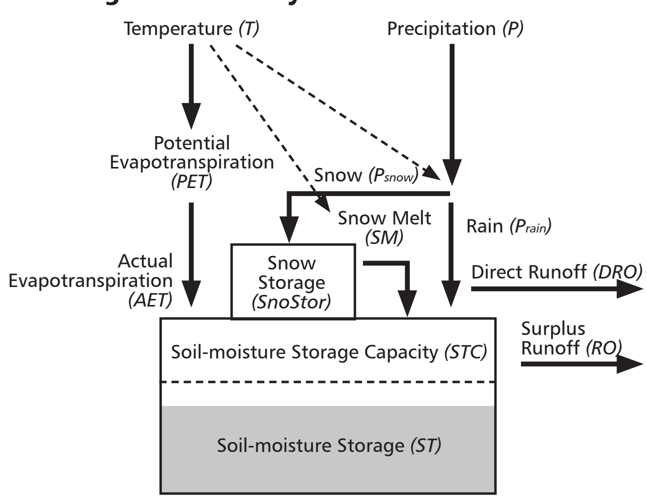
The center of the system is the screening framework through which both natural hazards and climate-related risks to a development activity are evaluated. The five steps of the screening framework are as follows.

1. Preparation of Project Information. Preparation includes digitization of project areas from high-resolution satellite images, getting the databases ready, examination of and familiarization with the project area, and formulating a list of potential risks.

2. Screening Natural Hazards. It is important that both climate and non-climate risks—for example, earthquakes and their secondary hazards (tsunami, landslides)—be included in the screening process.

For hazards that are of geological origin (i.e., not climate-related), risk screening ends at this stage. For climate-related hazards found relevant to the project, a semiquantitative analysis is conducted to infer the level of future risks.

Figure 6: Monthly Water Balance Model



Source: McCabe, G. J., and S.L. Markstrom. 2007. A Monthly Water-Balance Model Driven by a Graphical User Interface. *US Geological Survey Open-File Report* 2007-1088.

3. Screening Climate-Sensitive Project Components. Components of a project sensitive to climate change are listed in the knowledge base. A project component can be either physical, such as a dam, or conceptual (i.e., the service that the project is designed to provide), such as water availability. Visualization of changes of climate variables over time against the baseline serves as the first step in analysis. Modeling is commonly employed in the semiquantitative analyses.

4. Screening Indirect Impacts. Modeling may also be required for possible indirect impacts that the development project might bring to the project area and could result in maladaptation. For instance, a storage-type power generation project could increase the risk of flood and inundation upstream and both water shortage and flooding downstream.

5. Recommendations. Once all potential risks have been identified, actions that are required are recommended. If climate risks are high and warrant detailed assessments, generic terms of references are included for project consultants in terms of the expertise required and major assessment tasks that they should perform.

Challenges and Opportunities

Scarce Data and Information

The first and biggest challenge in climate risk screening is the scarcity of required data and information, which contribute significantly to the difficulty of identifying options for adaptation. For example, global databases necessary for geohazard screening are often of low spatial resolution, whereas project screening requires the use of "best" data available, such as data downscaled to 1-kilometer resolution and local-scale assessments based on site-specific data and information.

Limited Capacity in Developing Member Countries

A second challenge is the lack of human and technical capacity in concerned institutions to properly conduct climate risk screening. To many national stakeholders the concept itself may still be new and the process complicated. Human and institutional capacity development will be a major tool in addressing the risks posed by changing climates.

Application

The potential applications in ADB alone are many. As an example, SARD has 118 projects across several sectors in the pipeline for 2013–2015. Through the 3-year period, SARD expects that about 74 (60%) of these pipeline projects will have adaptation and/or mitigation components for addressing climate change issues.[10] These 74 projects are expected to follow a basic climate risk screening process as depicted in Figure 7.

Given the basic project information, potential climate change components, issues, and concerns can be identified and considered in the project design. The draft concept paper is reviewed and finalized, constantly keeping in mind the climate risk screening framework, with recommended actions and/or options for due diligence.

Similarly, during project preparation, the screening framework ensures that climate change concerns and issues are adequately reflected in the project design documents (e.g., physical and financial plans). A detailed climate risk-screening report can be included as a supplementary appendix of the final documents for approval within ADB.

Lastly, during implementation, the project's performance and actual climate change risks and/or impacts that it encountered should be closely monitored and properly documented in order to contribute updated scientific information for the region concerned.

As an example, the Box summarizes the risk profile analysis and recommendations from the application of the framework and risk-screening process to the 140-megawatt Tanahu Hydropower Plant Project in the West Region (Pashchimanchal) of Nepal.

Ways Forward

The climate risk screening framework described above can be applied to all location-specific projects and programs in South Asia DMCs. The databases (e.g., geophysical, climate, and knowledge databases) used for screening will provide improved data and information that will raise public awareness of climate change risks.

The implementation of climate change risk screening will need a central facility with technical specialists and appropriate hardware, at least until the next generation of projects for which climate-related risks are better known well ahead of their conception.

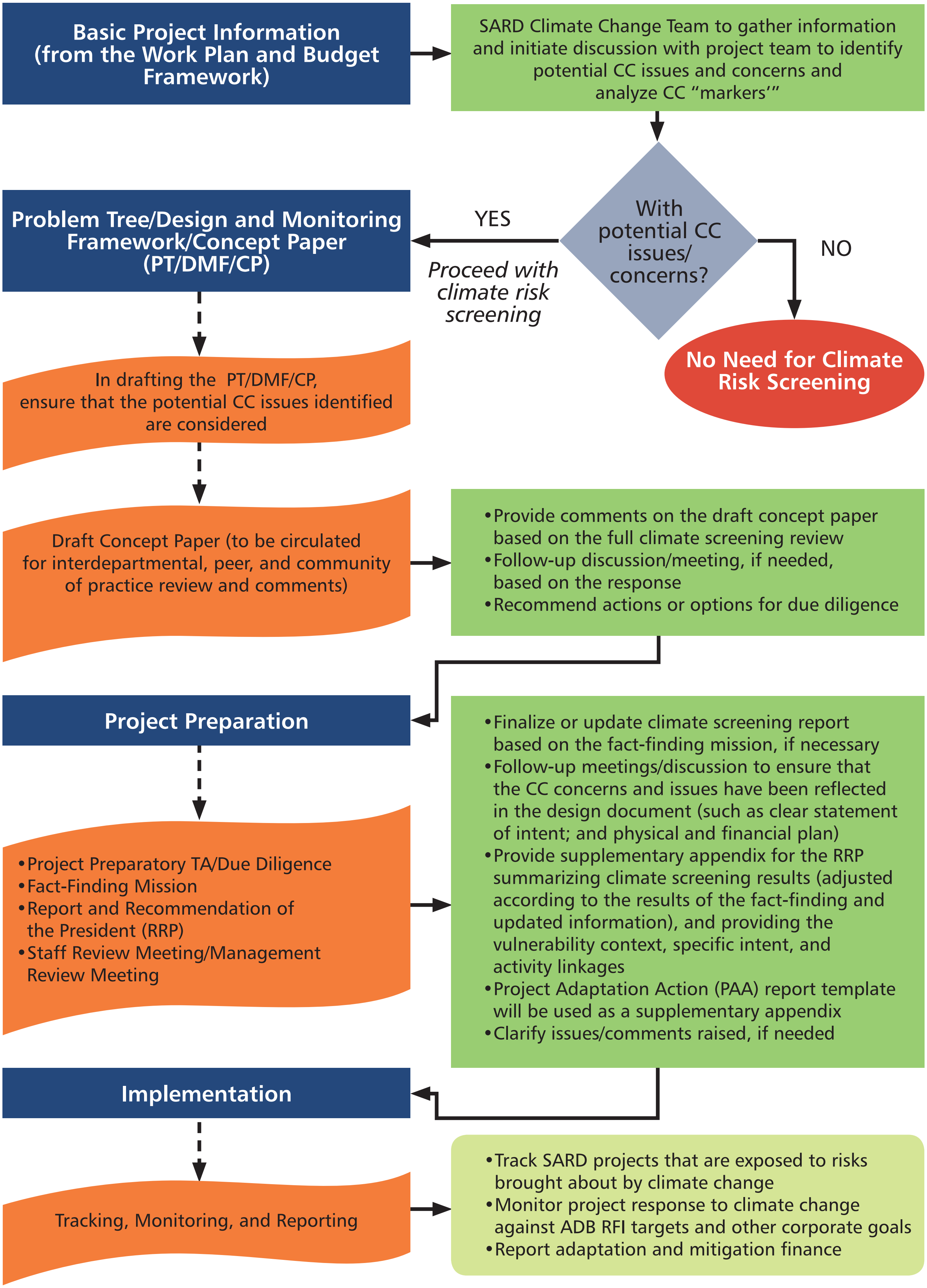
For cost efficiency and sustainability, the databases of the risk-screening framework can be linked to similar regional and/or global efforts, such as the ADB Asia-Pacific Regional Climate Projections Consortium and Data Facility.[11]

SARD will promote regional information and knowledge exchange on, and encourage the replication of, best practices and lessons learned from climate change risk screening and adaptation activities and strategies.

[10] SARD database of pipeline projects.

[11] ADB. 2013. *TA-8359 (REG): Regional Climate Projections Consortium and Data Facility in Asia and the Pacific.* Manila.

Figure 7: Schematic Flow Diagram of Climate Change Risk Screening SARD Projects



ADB = Asian Development Bank, CC = climate change, RFI = results framework indicator, SARD = South Asia Department, TA = technical assistance.
Source: ADB South Asia Department Portfolio, Results and Quality Control Unit

Climate Change Risk Screening in the Tanahu Hydropower Plant Project, Nepal[a]

The Project. The Tanahu Hydropower Project in the West Region of Nepal is a hydropower generation and transmission project, based on a reservoir to be formed on the Seti River. The project aims to expand Nepal's access to clean and sustainable energy through increased efficiency and supply of reliable hydropower energy. It will be the country's first reservoir hydropower plant, with a 140-meter high concrete gravity dam and total water storage capacity of 295 million cubic meters. The project will (i) design and operationalize a 140-megawatt hydropower plant and related 37-kilometer, 220-kilovolt transmission system; (ii) expand the rural electrification area (covering 17,636 households); (iii) implement relevant community development programs; (iv) review and restructure the Nepal Electricity Authority; (v) undertake other sector reforms; and (vi) initiate an equity sale scheme for hydropower development.

Climate Change Risks Screening. The main task of the screening preparation step was to delineate the watershed upstream from the dam site using digital elevation data. By overlaying the watershed boundary onto natural hazard intensity maps, the relevant hazards were found to be earthquake, landslides triggered by precipitation, and flooding. As landslides and flooding are climate change related, the risks they pose were assessed by comparing baseline precipitation against that projected under the Intergovernmental Panel on Climate Change A2 scenario for the 2050s. Modeling results showed that precipitation would increase by about 8%, and would likely increase the risk of landslides, flooding (including fluvial flooding of the Seti River), flash flooding, and glacial lake outburst flood (GLOF).

Analysis of Climate Change Risks (Vulnerability Context). Water availability and sedimentation are two project aspects identified as being sensitive to climate variability and change. Although precipitation is projected to increase, the projected rise in annual mean temperature (as much as 3°C) will increase evapotranspiration, which will be partially offset by accelerated melting of glaciers. Overall, the net availability of water under changing climate may not change substantially. However, greater precipitation will worsen soil erosion, leading to increased sediment load in the reservoir, reduced water storage, and more frequent need for sediment flushing. The project's hydrological risk was found to consist of (i) a flood risk to dam safety and (ii) a drought risk to energy generation in the power plant.

Actions to Address the Climate Change Risks. To mitigate the risks posed by sedimentation, the project will adopt a modern and tested sediment flushing system, whose operational risks will be minimized by proper early warning systems, adequate technical inputs, and immediate actions. To reduce the risk of an unexpected increase in sedimentation, and based on the erosion hazard map, riverbank protection will be conducted and an early warning system (i.e., sirens) will be implemented along with a public awareness program.

Overall, the climate change-related hazards identified (landslides, flooding, runoff, soil erosion, sedimentation, seismic hazard, etc.) warrant further assessments that should consider all projected climate change scenarios. The tasks include (i) detailed assessment of risks posed by earthquakes, avalanches, landslides, and floods (including GLOF), and setting design standards for all project structures (dam, tunnel, power transmission lines); (ii) assessment of runoff characteristics of the Seti River within the watershed of the project's 7.26-square kilometer reservoir, under both current climate and future scenarios; and (iii) assessment of runoff due to melting of glaciers at the headwaters within the watershed over time. Based on the assessments, an early warning system to prevent dam overflow should be devised, and a large-scale (e.g., 1:50,000) map of projected soil erosion and sedimentation should be made in order to guide the design of measures to control the erosion of curbs and embankments of the Seti River. Climate change risk screening also showed the need to conduct a comprehensive assessment of water availability for the 2030s, 2050s, and beyond.

[a] ADB. 2013. *Report and Recommendation of the President to the Board of Directors: Nepal Tanahu Hydropower Project*. Manila.

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See also: http://www.adb.org/climate-action-south-asia

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