Photo: Graham Crouch / World Bank

# Climate and Natural Disaster Risk Management for the Energy System in AFGHANISTAN

## OVERVIEW:

Climate and natural hazards can potentially have catastrophic impacts on the energy system of Afghanistan. The energy production in Afghanistan is dominated by hydro power generation, which is vulnerable to climate change because of the future competition for water resources between sectors and the risk of recurrent droughts. The country is also prone to natural hazards, because of its physical configuration and a degraded environment.

The major hazards impacting the energy system are long-term climate phenomena such as temperature rising, reduced terrain moisture, and water shortage; and natural hazards such as drought, flooding, landslides, avalanches, and earthquakes.

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We assess the vulnerability of the Afghani energy system to each natural hazard, and present analysis and tools to increase its resilience in view of the planned construction of new power plants, substations and transmission lines. The study assesses the potential impacts of climate change to resource availability (e.g., how climate change will impact water supply to hydropower, or availability of solar radiance to solar power production), and the system's vulnerability to natural disasters (e.g., the susceptibility to flood, or the risk of landslide, of a potential site). Climate and natural hazards projections, engineering principles, mitigation measures and a risk management framework are introduced to guide the choice and design of new power systems, and to retrofit current system components.

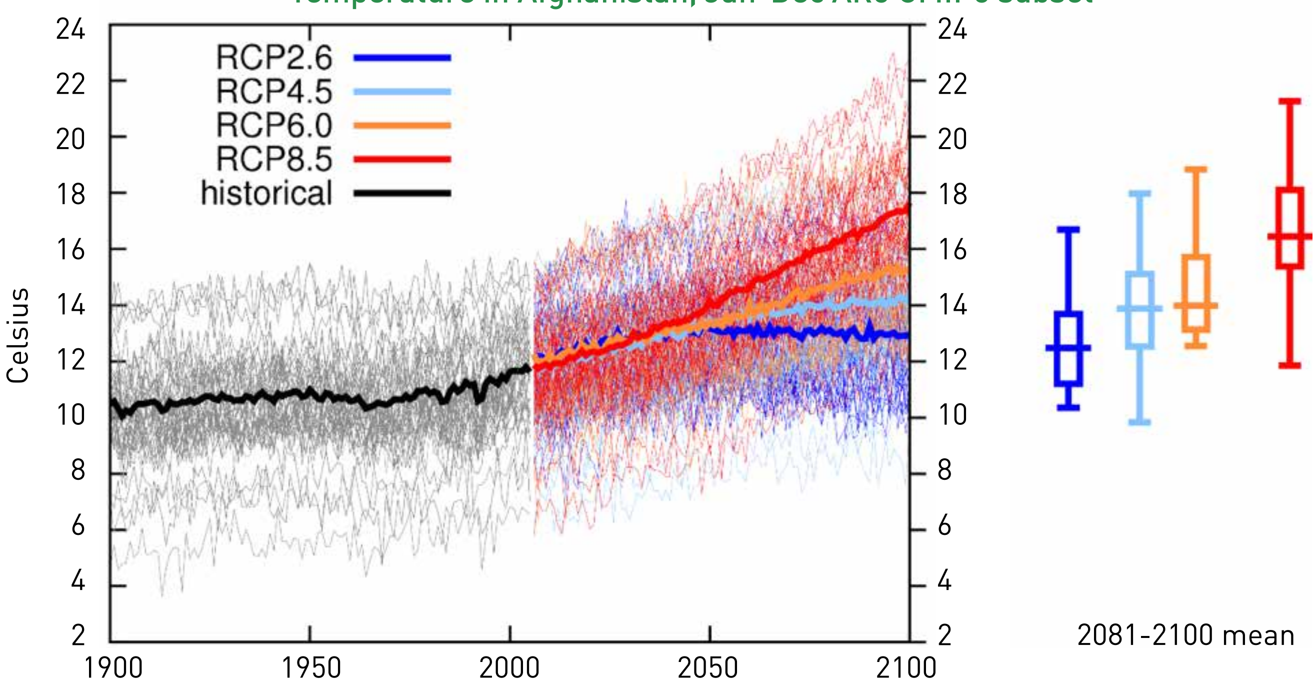
The final outcome includes: an action plan detailing the necessary actions to be performed prior to the implementation of mitigation measures, retrofitting projects and construction of new energy system components; a specific disaster risk management framework; and an adaptation policy framework.

## ACTION PLAN

The actions to be implemented can be defined according to a multi-phased approach. Specific actions at the first stage of the plan include: supporting enhanced policy making and investment planning; promoting capacity building and creation of expertise in relevant institutions; assessing the status of the energy system; and promoting best industry practices to upgrade or install new components. The plan then provides an operational set of actions targeted to the final implementation of the project:

- Conduct analytical studies and consultations to define and quantify the impacts of climate

Temperature in Afghanistan, Jan-Dec AR5 CMIP5 subset



The North West Substation in Kabul. Photo: © Sofie Tesson / Taimani Films / World Bank

and natural hazards on individual energy system components (power plants, substations, transmission lines);

- Identify existing components to be retrofitted and new components to be installed;
- Develop potential costs/benefits analysis, and risk assessment for a no-action option;
- Discuss options with stakeholders (government, business, civil society, multilateral institutions and potential investors) and provide recommendations;
- Conduct feasibility studies for the identified projects;
- Finalize investment program;
- Develop environmental impact assessment and stakeholder engagement plan (including gender equality approach);
- Implement project.

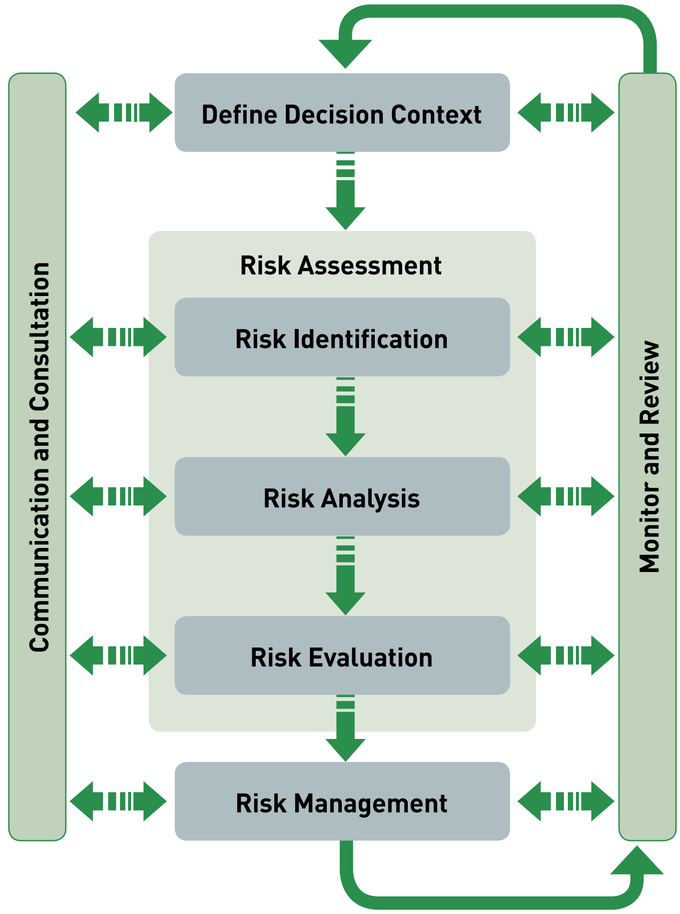
## BUILDING RESILIENCE THROUGH A RISK MANAGEMENT FRAMEWORK

- Identification of short term and long term effects of climate and natural hazards;
- Prioritization of vulnerabilities;
- Identification of interdependencies between infrastructure sectors such as energy, transport, communications, water;
- Development of network management, including smart grids and smart meters;
- Continuous monitoring to allow for adaptive management and timely maintenance;
- Development of information platform to share knowledge and coordinate between sectors;
- Investment in social and behavioral research to improve understanding of demographic and population dynamics;
- Capacity building, public engagement, and targeted knowledge transfer;
- Development of emergency management plans.

# DISASTER RISK MANAGEMENT FRAMEWORK UNDER DEEP UNCERTAINTY

The factors guiding the design of infrastructure do not account only for forecast of demand, but also for the impact of long term climate change and natural hazards. Clearly, an evident difficulty is the uncertainty concerning the spatial and temporal distribution of natural impacts during the projected lifetime of the infrastructure. Traditional engineering methods account for future uncertainties based on statistical methods, which are typically based on empirical probability distributions of past events. However, because of the time scale of climate change, and the introduction of additional uncertainties and potential changes in user demand, urbanization, land use, resource availability, and economic development in general, the requirement that the infrastructure will keep meeting future needs cannot be satisfied based on deterministic projections.

In order to address decision makers needs in conditions of deep uncertainties, more flexible approaches are necessary: adaptable designs and plans should be defined by the range of possible future scenarios, along with probabilistic risk




## Future Plans

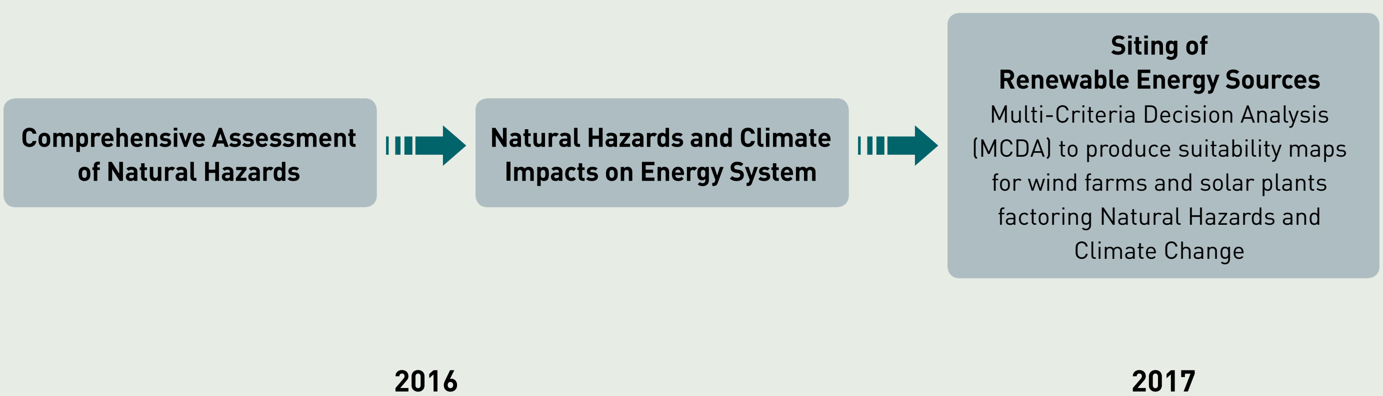


Photo: © Sofie Tesson / Taimani Films / World Bank

hazard assessments. The observational method is an effective risk management tool, which allows modifications to be implemented during the phases of design, construction, and operation. This approach consists in identifying the most probable climate and hazard conditions, and devise in advance the necessary modifications or actions to be implemented for all possible deviations from the assumed climate and hazard conditions.

## STRATEGIC PLANNING

The limited reach of regional grids in Afghanistan implies that smaller scale off-grid renewable energy technologies such as small hydro, wind, solar photovoltaic, and concentrated solar power can be major factors in a development program by providing access to energy, particularly in rural areas.

With climate projections emphasizing the vulnerability of water resources, identification of sites for new hydro power plants is a critical area: future potential sites may not be suitable for hydropower, and current sites may be losing productivity.

Consistently declining costs and increasing availability, along with relative insensitivity to climate change make solar and wind renewable resources a viable option. In particular, the elevated resilience to climate change of solar photovoltaic installations, their penetration potential in off-grid rural areas, scalability to different local stakeholder arrangements, along with Afghanistan's elevated solar radiation, may give photovoltaic resources a competitive advantage.

**Interdependencies in infrastructure and cascade failure**

Assess infrastructure's vulnerabilities to climate and natural hazards across sectors and impacts on the infrastructure system as a whole

| | Energy | Transportation | Water | Communication |
|---|---|---|---|---|
| **Energy** | | | Electricity for pumps and treatment | Transmission equipment |
| **Transportation** | Fuel, supplies and workers | | Supplies and workers | Supplies and workers |
| **Water** | Cooling and production | | | Equipment maintenance |
| **Communication** | Emergency detection and maintenance | Emergency detection and maintenance | Water supply and quality detection and control | |

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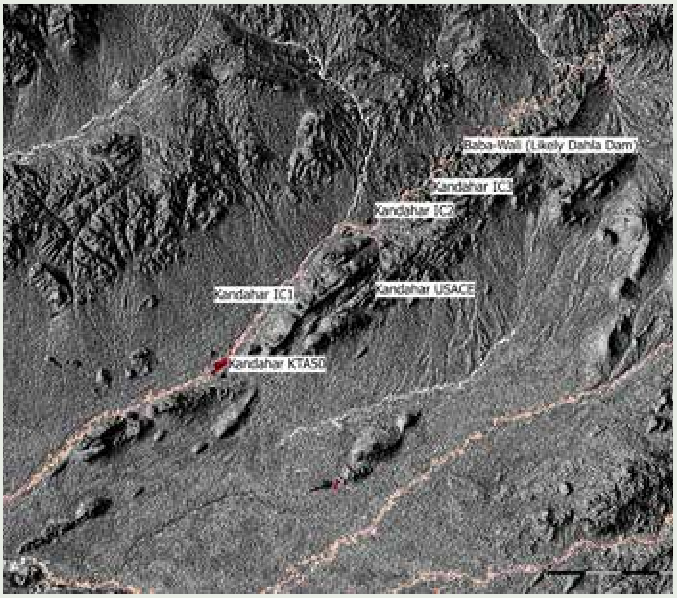
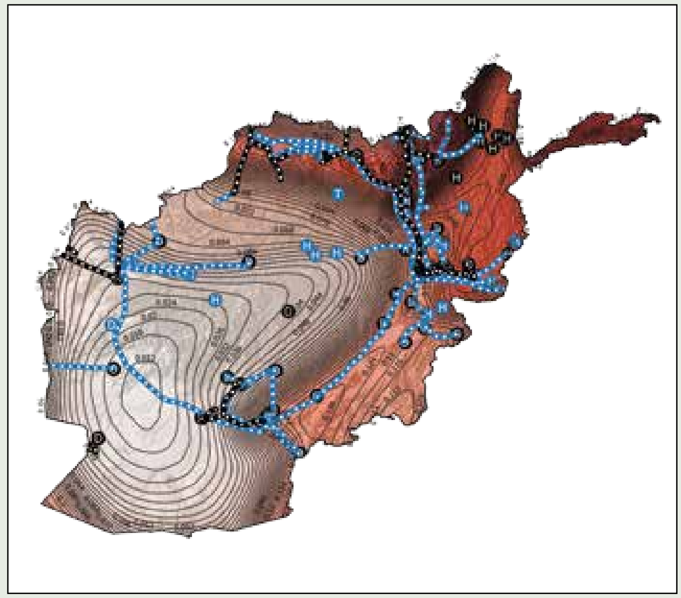
## Hazards and Mitigation



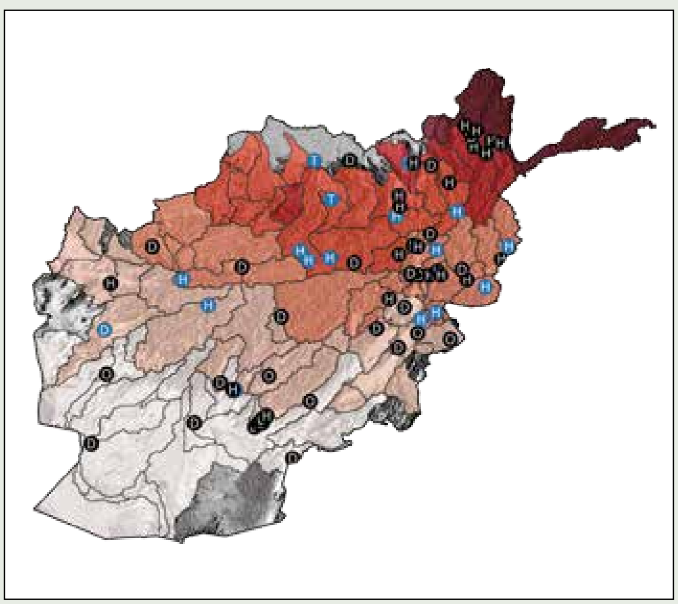

### Floods

- Relocation of equipment
- Geotechnical flood defenses at river level – Dams, dikes
- Flood abatement solutions at the building line – Walls, tanking, sealing, pumps



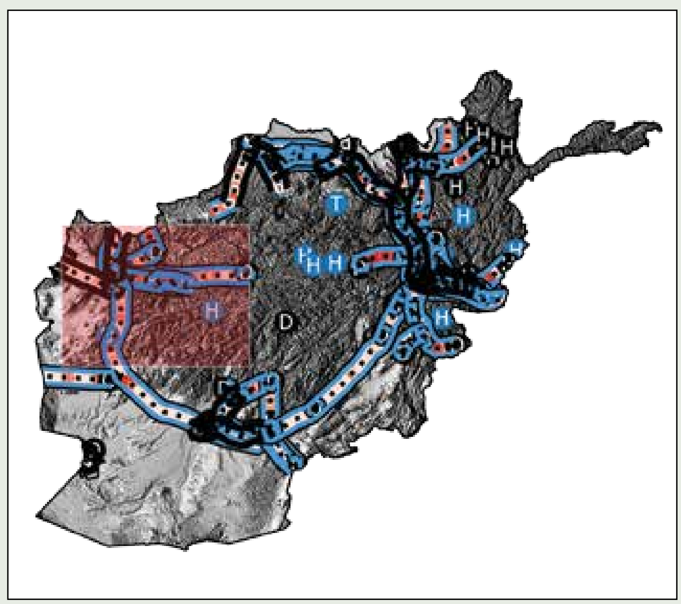
### Earthquakes

- Seismic design practices on new structures
- Retrofitting existing components – Base insulation, damping systems



### Drought

- Risk Management Plan
- Modeling and forecasting
- Geophysical monitoring
- Impact assessment
- Resource management



### Landslide

- Correct siting of towers
- Relocation of unstable towers
- Stabilization of foundations
- Stabilization of soil

Photo: Lysogor / Thinkstock.com

**Avalanche**

- Avalanche mapping
- Forced release of avalanches
- Diversion structures
- Snow supporting structures

## IMPACTS OF A CHANGING CLIMATE

In Afghanistan, the average annual temperature is projected to increase between 1.4 °C and 4.0 °C by the 2060s, and between 2.0 °C and 6.2 °C by the 2090s. Since 1960, the frequency of hot days and nights in Afghanistan has increased in each season, while the frequency of cold days and nights has decreased.

In the Eastern Hindu Kush Range of Afghanistan and Pakistan, Landsat and Remote Sensing imagery acquired in 1976, 1992, 2001 and 2007 on Alpine glaciers of various sizes, altitudes and orientations show that 76% of the sampled glaciers retreated, 16% advanced and 8% exhibited relatively stable terminus conditions; in the Wakhan region of Afghanistan 93% of the sampled glaciers retreated; in the Hindu Raj of Pakistan 74% of the sampled glaciers retreated.

The forecasted increased glacial melt would lead to a temporary increase of summer river flows for a few decades, followed by a reduction in flow as the glaciers disappear. Loss of glacier mass and snow cover are projected to accelerate throughout the twenty-first century, reducing water supplies and hydropower potential

## RENEWABLE SOURCES AND ENERGY SYSTEM RESILIENCE

Increasing energy production from renewable sources strengthens the resilience of the energy system, because of:

- Reduced dependence on fuel import and transportation, which are vulnerable to climate and natural disasters;
- Enhanced grid management practices, which reduce cascade failures and vulnerability of the transmission network;
- Increased off-grid micro generation of electric power, which reduces infrastructure interdependencies.

Photo: Betul Ozenc

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