PROJECT CLIMATE RISK ASSESSMENT AND MANAGEMENT REPORT

I. Basic Project Information

Project Title: Secondary Towns Urban Development Project (STUDP)
Project Budget: $10 million from Asian Development Bank; Royal Government of Bhutan contribution is $2 million.
Location: Three secondary towns in Bhutan. Trashigang (including Rangjung); Samdrup Jongkhar (including Dewathang); and Sarpang (including Shechamthang and Ranibagan)
Sector: Water and other urban infrastructure and services
Theme: Environmentally sustainable growth
Brief Description: The project aims to improve livability and urban services in three Bhutanese towns. These include Trashigang in the east and Samdrup Jongkhar and Sarpang in the south of Bhutan. These regions that have traditionally been lagging. These cities have high population growth rates and require the provision of adequate, reliable and sustainable urban infrastructure and services. The project will support new infrastructure development, rehabilitation of existing urban infrastructure and institutional capacity strengthening. The project outputs are: **Output 1: Urban infrastructure expanded and/or upgraded.** This includes construction of: (i) 46.8 kilometers (km) of new water transmission lines, 36.7 km of new distribution pipelines and 2.5 km of water supply pipelines upgraded and/or rehabilitated; (ii) six new ground level service reservoirs constructed with a total storage capacity of 1,300 cubic meters; (iii) two new water intake structures with 3.5 million liters per day (MLD) capacity constructed; (iv) one water treatment plant (WTP) with 1.2 MLD capacity constructed and commissioned and one WTP upgraded to 1 MLD ; (v) 800 new metered water supply connections provided; (vi) 2.5 km of sewage collection pipelines constructed with 250 new connections provided (210 households and 40 institutions) in Samdrup Jongkhar; and (vii) 9 km of new and improved drains and 3.74 km of new roads constructed in Sarpang. **Output 2: Capacity of institutions and local communities strengthened.** This includes: (i) staged water tariff framework developed; (ii) at least 3,500 people (at least 40% women) report improved knowledge on gender and public health-related issues such as water conservation, solid waste segregation and reduction, and water, sanitation, and hygiene;[a] (iii) 50 staff from project management units (PMU) and project implementation units (PIUs), and other municipal units reported improved knowledge and skills in operation and maintenance (O&M) and asset management of municipal infrastructure, of which at least 25% are women; and (iv) project gender equality results monitored through gender equality monitoring system (GEMS) of the National Commission for Women and Children. Infrastructure and associated services are the most climate change vulnerable program components and are the focus of this assessment There are seven civil infrastructure subprojects proposed under STUDP. 1. Trashigang and Rangjung (i) Trashigang water distribution network improvement (ii) Rangjung Intake WTP augmentation 2. Samdrup Jongkhar and Dewathang (i) Samdrup Jongkhar water supply system improvement project (network and household connections) (ii) Samdrup Jongkhar sewerage network and household connections (iii) Dewathang Water supply augmentation (intake) 3. Sarpang and Shechamthang (i) Development of Shechamthang local area plan (LAP) infrastructure–roads, drains, and water supply (ii) Sarpang water supply development (transmission line, intake, WTP)

[a] This target is based on observed women's participation in the consultation activities during the project preparatory period, which averaged 30%.

II. Summary of Climate Risk Screening and Assessment

A. Sensitivity of project component(s) to climate/weather conditions and sea level	
Project component	*Sensitivity to climate/weather conditions and sea level*
1. Augmentation of sewerage system (network) in Samdrup Jongkhar	1. Many sanitation facilities are located at the lowest elevation possible and are therefore vulnerable to climate change-related flooding. Although, more severe storm events can overwhelm facilities. Lower stream levels and higher temperatures can affect water quality. Climate change impacts on sanitation systems could have negative human health implications as well as damage to ecosystems. STUDP will only support the 4.5 km of sewerage network in Samdrup Jongkhar. The small and localized nature of these works do not pose a high risk from changing climate. and the loan will not support any waste water treatment facilities.
2. Strengthened water supply system or water distribution network improvement in Trashigang, Samdrup Jongkhar, Dewathang, Ranibagan, Rangjung and Sarpang (transmission line, intake, WTP)	2. Climatic patterns greatly influence both water supply and quality. Climate change can impact the availability of water supplies by increasing the severity of short- and long-term droughts, the melting of glaciers, and the intensity of storms. These effects can all necessitate additional water storage. Competing priorities for water (e.g., drinking water, hydropower, and agriculture) can further exacerbate reduced availability and increased costs of potable water. Rising temperatures can increase water demand for drinking, irrigation, and green spaces, while also causing greater evaporation from reservoirs. Increased temperatures may cause more intense storms degrading water quality by promoting algal blooms, increased sediment and pathogen concentrations and lowering dissolved oxygen levels. Changes in water quality could require significant investment in improved source water protection, water treatment, or development of new sources of water. In cities, the "urban heat island effect" can intensify temperature increases, exacerbating water quality issues.
3. Roads and Drains (Shechamthang LAP infrastructure)	3. More intense precipitation could increase flooding of roadways, soil erosion and washout of road- and tunnel-supporting culverts and drains during flash floods. This may shorten the serviceability of such infrastructure or require higher maintenance costs.
B. Climate Risk Screening	
Risk topic	Description of the risk
1. Increased intensity and frequency of heavy rainfall events	1. Increased frequency and intensity of flood events, water, sewerage, drainage and road infrastructure may be damaged due to flooding.
2. Rainfall-induced landslides	2. Precipitation induced landslide events are closely linked with flooding events and are recurrent phenomena in Bhutan. Slopes in the country are highly susceptible to landslides especially in the rainy season. This will impact water supply

	transmission lines in particular.

Climate Risk Classification: Medium for flooding and rainfall-induced landslides. Although Bhutan is a high-risk country to the impacts of climate change, the project location and scope will not be highly sensitive to climate impacts.

C. Climate risk assessment

A preliminary climate risk and vulnerability assessment (CRVA) was carried out for the project, which reviewed climate change prediction methodologies used in the Himalayan region and considered their application to the project. Climate change projections have been derived from sources such as Bhutan's National Environment Commission's technical paper of Vulnerability and Adaptation assessment (2011),[a] ADB's technical assistance report on Adapting to climate change through Integrated water resources management (2016),[b] International Centre for Integrated Mountain Development's (ICOMOD's) Technical report 4 (2009),[c] Bhutan Second National Communication to UNFCCC (2015.),[d] and data from meteorological stations of the Department of Hydro Met Services.

1. Considering the geographical spread of the sub-projects outlined in the STUDP, a tactical approach to addressing the issues of precipitation was through regionalization approaches where regional frequency analysis (RFA) was used to transfer information from a group of homogeneous gauged sites and applied over target sites within that homogeneous region. The RFA consisted of two main steps: (1) grouping stations with similar hydrological behavior (or delineation of hydrological homogeneous regions) and (2) regional estimation within each homogenous region at the site of interest.
2. A stationary extreme value analysis of precipitation was carried out which established a relationship between the extreme precipitation magnitude (X) and recurrence interval or return period (T) whereby estimates of extreme precipitation magnitudes for various return periods were derived.
3. To account for climate change, a non-stationarity analysis was carried out by introducing a linear trend in the location parameter by a 7% increase in monsoon precipitation by mid-century, and a simulation exercise carried out. The % increases in precipitation for various T-year return levels were determined for an uncertain future climate.

Projections

Landslides and flooding. Flash floods and landslides are a recurrent threat to human lives, properties and livelihoods—especially in the southern and eastern foothill belt where the terrain is steep and rocks underlying the soil cover are highly fractured, allowing easy seepage of water. Contributing factors are the undercutting of slopes by high-energy rivers and streams during a period of heavy rainfall. Most flood events are flash floods, which are local floods of great volume and short duration. In 2004, flashfloods affected six eastern Dzongkhags (districts), of which Trashigang, Tashi Yangtse and Samdrup Jongkhar were the most affected areas. Landslides affect most areas in the eastern and southern parts of Bhutan.

Bhutan where the projects are located. Earthquake induced landslides also pose a risk.

Temperature changes. Generally increasing at around 2 degrees for the period 2040 to 2069, but slightly higher during winter season. Geographically, higher warming occurs in the northern parts of Bhutan (such as in Thimphu) than in the south and east where the project sites are located.

Precipitation changes. The ECHAM5/A1B scenario projects an increase in mean total annual precipitation of ~ 25 % for the 2040-2069 period, with generally higher increases in the monsoon season compared to the winter season for all Dzongkhags project sites.

Extreme weather events. More frequent and intense flash floods, cyclones and glacial lake outburst floods were reported during the previous decade (~ 2000 to 2009), but not in the project sites.

Key climate change risks include: (i) increased frequency and intensity of flood events, and (ii) increased frequency and intensity of precipitation events leading to frequent landslides.

[a] National Environment Commission. 2011. *Bhutan. Vulnerability and Adaptation Assessment Volume I, Technical Paper*. Thimphu.

[b] National Environment Commission and Department of Agriculture, Royal Government of Bhutan; ADB. 2016. *Climate Change Modeling and Assessment, Revised Report: Adapting to Climate Change through Integrated Water Resources Management: (CDTA 8623 BHU)*. Thimphu.

[c] ICIMOD. 2009.*Climate Change Impact and Vulnerability in the Eastern Himalayas–Technical Report 4, Nepal*.
[d] National Environment Commission, Royal Government of Bhutan. Second National Communication to the UNFCCC. On account of data availability problems, the 1980-2009 period from the PRECIS simulations (22 km resolution) is used. For the future (A1B) scenarios, two-time slices are used, namely a short-term time period (2010–2039) and a long-term time period (2040–2069). These future short term (2010-2039) and long term (2040–2069) scenarios of daily maximum and minimum air temperature, daily precipitation and daily solar radiation, at minimum, were prepared using the PRECIS regional climate model.

III. Climate Risk Management Response within the Project

1. For use by the design team, intensity-duration-frequency (IDF) curves were developed for short duration precipitation intensities under both stationary and non-stationary scenarios, with the recommendation to use the outputs of the non-stationary analysis which project higher magnitudes of rainfall. These have been used for design of drainage and water supply networks.
2. Locating wastewater facilities to higher elevations, separating storm and wastewater sewers, and improving treatment to produce a higher quality effluent can help reduce climate risks.[a]
3. Vigilant management of sediment deposition is vital to maintain conveyance capacity of the natural and engineered channels. Intake structures have been designed with protection bunds and access roads for maintenance to minimize sediment depositions and enable clearing of debris/ sediments in the monsoon season.
4. Infrastructure operation and maintenance planning. Implement regular and detailed monitoring of channels and structures, particularly prior to and during the monsoon season when flood risk is highest.
5. Changes in maintenance needs and schedules must be monitored over time as adaptation actions are implemented. Likewise, changing environmental conditions affected by climate (e.g., land erosion patterns, frequency and severity of inundation events) should be monitored and evaluated to understand evolving adaptation needs.
6. In places where erosion is expected to be high, gullies which make the water run faster down the slopes should be controlled. This recommendation has been used for the preparation of the detailed engineering design of the Ranibagan LAP drainage.
7. Suitable slope stabilization and pipe anchorage measures have been incorporated into the detailed designs to increase resilience of water transmission pipes traversing through landslide prone slopes.
8. The project is supporting the relocation of the commercial center of Sarpang (erstwhile Sarpang Bazaar-which got washed away in 2016 Sarpang river flood) from flood plain of Sarpang river to an elevated area away from the flood hazard zone (Shechamthangn LAP). For drainage system design of LAP refer point 6.

Further, the Royal Government of Bhutan, through its policies has the necessary guidance and safeguards for water use and management (Annex 1) but needs some efforts to increase capacity on both technical skills and database management. Also, inadequate observation platforms for weather and climate information may have to be addressed. Suitable management actions are recommended below:

1. A thorough precipitation - flooding relationships and analysis of the changes in return periods should be done.
2. The concerns on "much water at the wrong time and wrong place" can be stabilized by coordinating with the local authorities and promoting the retention of water through watersheds and other water conservation measures (water demand side) and maintaining forest and/or ground cover to intercept rainfall, hold the water and promote infiltration.
3. Mainstreaming climate considerations into careful planning processes will ensure that the facilities (water supply—storage, treatment, intake and distribution) maintain their value in the long-term.

[a] STUDP is only funding wastewater networks. The government (through its own funds) is installing compact waste water treatment plant in Samdrup Jongkhar. The site is selected according to the recommendations and plant plinth level is to be raised as an adaptation mechanism to flooding.

Royal Government of Bhutan's Policies for Enhancing Adaptive Capacity

Policies

The Water Act of Bhutan 2011 and Water Regulation of Bhutan 2014 are basically sound and in harmony with other water-related legislations. Guidelines have been prepared to supplement the Water Regulation particularly for the registration of Water Users Associations. There is, however, scope for fine-tuning the legal framework. Planning, implementation and monitoring water security is built around the concept of the Bhutan Water Security Index, which is comprised of five key dimensions: (i) Rural drinking water supply and sanitation; (ii) Economic water security; (iii) Urban drinking water supply, sanitation and drainage; (iv) Environmental water security; and (v) Resilience to disaster and climate change. Integrated Water Resources Management is currently on planning stage and a provisional plan was already prepared.[1]

Water resources: Bhutan's high per capita water availability includes the aspect of "much water at the wrong time and wrong place (footnote a). Management actions and capacity should be put in place to address this condition.

Human Capital: As a matter of generalization, Bhutan has limited technical and database management capacity. It has been established from numerous studies and assessments in the region that results and findings were quite tentative because of inadequate data. The overall adaptive capacity of the country is medium to high.

[1] NEC-Royal Government of Bhutan, 2016: National Integrated Water Resources Management Plan. Thimphu.