Supplementary Appendix

Climate Change: Project Adaptation Action Report

Part 1: Climate Change Adaptation

Basic Project Information	
Project Title: IND: Uttarakhand Emergency Assistance Project	**Sector:** Infrastructure
Location: Uttarakhand is located northern part of India in the Himalayan mountain ranges. It has international boundaries with People's Republic of China and Nepal.	**Estimated ADB Financing:** US$200 million
Brief Description	**Implementation Period**: Oct 2013-Sept 2016

The project includes four components to restore key infrastructure damaged by 2013 disaster that affected the entire State of Uttarakhand: (i) rehabilitation and reconstruction of state roads and bridges, (ii) rehabilitation and reconstruction of tourism infrastructure, (iii) rehabilitation and reconstruction of urban water supply and roads, and (iv) enhancement of project management capacity and adoption of modern road technology and disaster risk mitigation measures.

These include rehabilitation and reconstruction of: (a) about 1,800km of state highways and major district roads affected by the disaster; (b) 16 damaged bridges on state highways and major district roads; (c) about 600 km of road section on ADB assisted projects in Uttarakhand, which have been damaged by the disaster; (d) affected water supply infrastructure and urban roads in about 8-10 towns in Uttarakhand; and (e) affected tourism infrastructure in 5 districts. It will also rehabilitate and upgrade 10 trekking routes including eco-trails including construction of rest houses and public amenities. 50 helipads, heliports, and/or helidromes with passenger amenities will be constructed for emergency evacuation and relief operations in case of a future disaster, which will also provide better air connectivity for the tourists and pilgrims. The project will enhance the project management capacity of the executing agency and the implementing agencies through training workshops and handholding support through consultants for project preparation and implementation and assist in adoption of modern road technology and disaster risk mitigation measures. .

Climate Change Classification: (ADB PCS: Mitigation or Adaptation Classification)

Summary of Climate Risk Screening

According to the State Climate Change Action Plan for Uttarakhand[i], climate change induced changes are already being experienced which include: receding glaciers and upwardly moving snowline, depleting natural resources, erratic rainfall, irregular winter rains, advancing cropping seasons, fluctuations in the flowering behaviour of plants, shifting of cultivation zones of apple and other crops, reduction in snow in winter, rise in temperature, increasing intensity and frequency of flash floods, drying up of perennial streams, etc. The recent devastation in the State has largely been attributed to the incidence of flash floods resulting from heavy (64.5mm-124.4mm) to very heavy rains (124.5mm–244.4mm) experienced on 16 and 17 June 2013 in several parts of the State including cloud burst[1] in the Kedarnath area. According to the Indian Meteorological Department Uttarakhand received 324 mm of rainfall, 847% of normal (34mm) during the week 13-19 June 2013[2]. Besides the quantum of rainfall experienced, a huge quantity of water

[1] Cloudburst is the phenomenon of heavy rainfall and storms concentrated over a small area which is nothing new in an ecologically sensitive area like Uttarakhand.

[2] http://www.imdpune.gov.in/mons_monitor/mm_index.html. Dehradun, the capital of Uttarakhand, received 370 mm of rain in 24 hours on June 16-17, the highest 24-hour rainfall in city history. The June 2013 monsoon rains in Uttarakhand were highly unusual, as the monsoon came to the region two weeks earlier than normal

was probably released from melting of ice and glaciers due to high temperatures during the month of May and June. Heavy precipitation, coupled with fast melting of snow resulted in the swelling of rivers, both in the upstream as well as downstream areas. The water not only filled up the lakes and rivers that overflowed but also may have caused breaching of moraine dammed lakes in the upper reaches of the valley killing about several hundred persons, thousands missing and trapping about a hundred thousand pilgrims[3].

The rainfall fell at a time when there was still snow on the ground in upper reaches. The combination of heavy rainfall on melting snow is a significant factor causing landslides in the northern states. Heavy rainfall and toe erosion of the slopes by the high velocity and volume of water loaded with sediments, stones, rocks and sand triggered numerous landslides across the State. The landslides and toe erosion by the river caused breaching of the roads/highways at many places and washed away several bridges (steel girder bridges, beam bridges, suspension/cable bridges). The river Alaknanda and its tributary the Mandakini overflowed/breached their flood ways and started flowing along their old courses where human habitation had developed with the passage of time, destroying buildings and other infrastructure that came in its way[4].

Given the necessity for an immediate response, it is proposed that screening for the emergency assistance will be undertaken predominantly through the use of existing climate change assessment reports or databases from reputable sources and deemed appropriate in coverage. In addition, and as decided during the joint rapid damage and needs assessment conducted by ADB, World Bank and the Government in August 2013, ADB assistance, to the extend possible, will also be guided by the disaster risk management response system expected to be established with the World Bank assistance. The catastrophe in Uttarakhand, like elsewhere, underscores the importance of evolving a system that is required to help improve preparedness, minimize the damage and develop efficient mitigation measures for bringing down the losses. Actions proposed below will present a first attempt towards the development of such a system.

A. Projected changes under A2 scenario *(Khaladkhar et.al (2009)*

Temperature (^{o}C)	Precipitation (mm)	Sea Level Rise (masl):	Others:
Annual mean temperature is projected to increase by 1.65^{0}C by 2030, and 3.0^{0}C by 2050	From: To: Annual total precipitation is projected to increase by a negligible amount by 2050 under the A2 scenario	N/A	

B. Climate Risks

1. Earthquake (EQ)	Y	**Description of the risk:** Recent warmer winters in traditionally colder winter climates are resulting in more frequent freeze-thaw cycles, leading to potentially greater weathering of susceptible infrastructure materials such as concrete and pavement. Climate change may result in fewer cold days but more freeze-thaw cycles as winter temperatures rise. As such, physical structures within Uttarkashi, Chamoli, Pithoragarh, Rudraprayag, and Bageshwar are likely to be affected by the increased freeze-thaw cycles. Thawing permafrost and freeze-thaw cycle changes in the active layer of soils and may bring adverse impacts to the existing foundations
2. Landslide triggered by EQ	Y	
3. Landslide triggered by Precipitation	Y	
4. Fire	Y	
5. Flood	Y	
6. Drought	Y	
7. GLOF	Y	
8. Avalanche	Y	

(http://www.talkweather.com/forums/index.php?/topic/59493-dr-jeff-masters-indias-june-2013-flood-earths-4th-deadliest-weather-disaster-since-2000/).

[3] Brief report on Uttarakhand disaster (16 and 17 June 2013), National Institute of Disaster Management (NIDM), New Delhi based on field visit by Mr. Surya Prakash of NIDM to Alaknanda valley during 22-24 June 2013

[4] Same as footnote 3

		of all types. Under the sustained summer thermal regime with the onset of summer from May onwards, the frozen ground will start thawing. The State of Uttarakhand is vulnerable to numerous types of natural hazard including earthquakes, landslides, flooding, and fire, all of which can be extremely devastating to life as well as properties. The risks appear to be higher within the worst-hit districts during the disaster occurred in June 2013.

C. Recommendations

Activities: • A **multi-hazard mapping exercise** is recommended to be conducted based on which reconstruction of all sector projects may take place. Recovery and reconstruction of many projects may need to consider re-routing and relocation and this mapping exercise would be indispensable for project site identification/relocation etc. Based on the joint rapid damage and needs assessment and further agreements, it is expected that the Multi-hazard mapping exercise will be developed by the World Bank. ADB will seek to the extent possible to coordinate project site interventions based on the recommendations of this mapping exercise. • The design and construction **standards** for all sector projects to be raised to an appropriate level. • Slope stabilization should be implemented for projects that must traverse steep slopes. For settlements and **infrastructure** projects within low-lying flood-prone areas that cannot be relocated to a safer site, flood defense and mitigation measures should be implemented. Road projects in particular are vulnerable to flash floods, massive landslides, and erosion by heavy monsoonal rainfall. In addition, the stability of road foundations could be undermined by the increased freeze-thaw cycles, which should also be taken into account during project design. • An **early warning system** established to enhance disaster preparedness.	Requirements for TOR: Consistency to be made between the EARF and EMP as to the recommendations of the Multi-hazard exercise, Incorporation of this point to be made to project selection criteria and also in the EARF. This intervention will be developed by WB and to the extend relevant and possible, ADB will be guided by the recommendations made in the proposed emergency project.

Risk Classification: High

Due Diligence

Activities:
- Environmental assessment and review framework (EARF) was prepared and disclosed.
- Subproject selection criteria are formulated to avoid land acquisition, resettlement impacts, and social risks.
- A resettlement framework and indigenous peoples planning framework are prepared and will be disclosed in accordance with ADB's Safeguard Policy Statement.

Project Design Change or Adaptation Response

Areas vulnerable to flooding are mostly along streamlines as well as locally depressed areas. Several streams within the project area have an accumulation area greater than 4000km^2 (e.g., Bhagirathi, Yamuna, Tons, Mandakini, etc.) and numerous with that greater than 200km^2. Although a marginal increase in annual precipitation is projected under the A2 Scenario, "wet extremes are projected to

become more severe in many areas where mean precipitation is projected to increase. In the Asian monsoon region and other tropical areas there will be more flooding" (IPCC, 2007[5]). A study found that the number and intensity of extreme rainfall events have increased since 1960 especially the intensity, attributable to global and regional warming[2]. For infrastructure projects within low-lying flood-prone areas that cannot be relocated to a safer site, flood defense and mitigation measures may need to be considered. Road projects in particular are vulnerable to flash floods, massive landslides, and erosion by heavy monsoonal rainfall. In addition, the stability of road foundations could be undermined by the increased freeze-thaw cycles, which should also be taken into account during project design. For Flood Risk management aspects, the project will be guided by outputs of *TA 8089-IND: Operational Research to Support Mainstreaming of Integrated Flood Management under Climate Change*, which is currently supporting research initiatives to help better integrate non-structural and community led measures into flood management and planning.

References:

1. Government of Uttarakhand. 2012. State Action Plan on Climate Change "*Transforming Crisis into Opportunity"*
2. Government of Uttarakhand. August 2013. Uttarakhand Disaster June 2013. *Joint Rapid Damage and Needs Assessment Report.* India.
3. Khaladkar, R. M. P. N. Mahajan, and J. R. Kulkarni, 2009. Alarming Rise in the Number and Intensity of Extreme Point Rainfall Events over the Indian Region under Climate Change Scenario. ISSN 0252-1075 Contribution from IITM. Research Report No. RR-123
4. Subrat Sharma. G. B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263 643, India. *Catastrophic hydrological event of 18 and 19 September 2010 in Uttarakhand, Indian Central Himalaya – an analysis of rainfall and slope failure*

[i] Report yet to be approved.

[5] http://www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-10-1.html.