AGENDA FOR CLIMATE ACTION

DISASTER RISK

Linking the Vulnerability and Risk Assessment for Uttarakhand with policy implications for the state

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1. OVERVIEW OF FLOODS AND LANDSLIDES IN UTTARAKHAND

Uttarakhand's unique geography and topography make it particularly vulnerable to disasters. The State is prone to earthquakes, landslides, cloudbursts, flash-floods, avalanches, as well as droughts. According to state records, there have been 20 landslides in the State over a period of 11 years between 2001 and 2012, and seven incidents of cloudbursts between 2002 and 2010.[i] The worst impacts on population and infrastructure – arguably in the last 100 years – were witnessed during the flash floods of 2013 in the Alaknanda, Mandakini and Bhagirathi Valleys, which claimed close to 6000 lives. The post-disaster reconstruction cost has been estimated at Rs. 3,964 Crore.[ii]

There is a growing recognition that a number of development factors have further exacerbated disaster risk and vulnerability in Uttarakhand: The report by the Ministry of Home Affairs on the Uttarakhand Disaster in 2013 highlights factors such as deforestation, construction of hydropower facilities, building of roads and tunnels through mountains, tourism-related construction in floodplains and hillslopes, as well as sand mining on river beds.[iii] Socio-economic considerations such as large dependence on subsistence agriculture, large scale migration, and limited economic opportunities (restricted to the plains and some tourist valleys) have also compunded this vulnerability. According to an OXFAM report, 30,000 hectares of forests have been diverted to non-forest use in Uttarakhand since the formation of the State in 2000, most of it for roads, as well as power generation and transmission in the districts of Uttarkhashi, Rudraprayag, Chamoli, and Pithoragarh.[iv]

Box 1: Observed trends linked to disaster risk

Based on Participatory Rural Appraisals (PRAs) of five sample villages in Uttarakhand

- Villagers have observed that rainfall is becoming erratic and intense, occurring over a shorter duration
- Rainfall, flooding, and landslide-related damages have been variously observed in 1993, 2000, 2010, 2011, and 2013.
- Heavy rain, and flooding have resulted in landslides, soil erosion, loss of agricultural land, and in extreme cases, damage to homes and water supply lines.
- Four out of the five villages studied were affected by the 2013 flash floods

According to the 2009 Uttarakhand Development Report, flood control projects, together with rural development and irrigation initiatives constituted 35% of the economic services-related expenditure in the State. Expenditure on flood control and drainage work – such as building roads and bridges in chronic slip zones, reconstruction of roads damaged by landslides, and floods, and construction of bridges – increased by 35% in the early to mid-2000s and constituted 0.03% of the Gross State Domestic Product.

There are a number agencies of in Uttarakhand assigned to oversee disaster prevention and preparedness in the State, as well as coordinate emergency response: The Disaster Management Department, the State Disaster Management Authority (SDMA) mandated by the Disaster management Act (2005) and chaired by the Chief Minister, the State Executive Committed led by the Chief Secretary, the Disaster Mitigation and Management Centre (DMMC),[1] various District Disaster Management Authorities (DDMAs), the State Disaster Response Force, as well as Emergency Operations Centres (EoCs) and Hazard Safety Units.

The disaster risk analysis report linked to the Vulnerability and Risk Assessment (VRA) notes that despite the presence of multiple agencies focused on disaster management, and more recently the drafting of a 'State Disaster Management Action Plan for the State of Uttarakhand' (SDMAP), implementation and financing challenges persist.

2. CLIMATE RISK TO BASIC INFRASTRUCTURE IN UTTARAKHAND

The risk analysis report[v] for Uttarakhand is focused on two major impact areas namely floods and landslides, specifically their impact on basic infrastructure such as

[1] DMMC is an autonomous institute focusing on research, documentation, policies and dialogue on disaster resilience.

roads, major bridges, hospitals, communication systems, electric lines and hydropower stations.

For the landslides analysis, the types of data used in the impact assessment are:

- Environmental parameters: Digital elevation model, slope maps, aspects of slopes, geological formations, geological faults, land cover and land use etc.
- Triggering factors: Rainfall (current and projected), built up area, earthquakes, and historical landslides.
- Elements at risk: Basic infrastructure.

The parameters for flood assessment are rainfall, district and block elevation models, and cross sections (to map runoff from river basins).

The risk of landslides and floods is projected to increase and spatially spread towards the mid and end-centuries compared to the current situation. Four districts in the upper and middle reaches of the State namely Chamoli, Pithoragarh, Tehri Garhwal and Uttarkashi are projected to have the highest combined risk index to floods and landslides across scenarios and time-lines in Uttarakhand. It is worth noting that three of these districts correspond to districts which currently have the highest number of disaster prone villages according to the State Disaster Management Plan (See Figure 1).

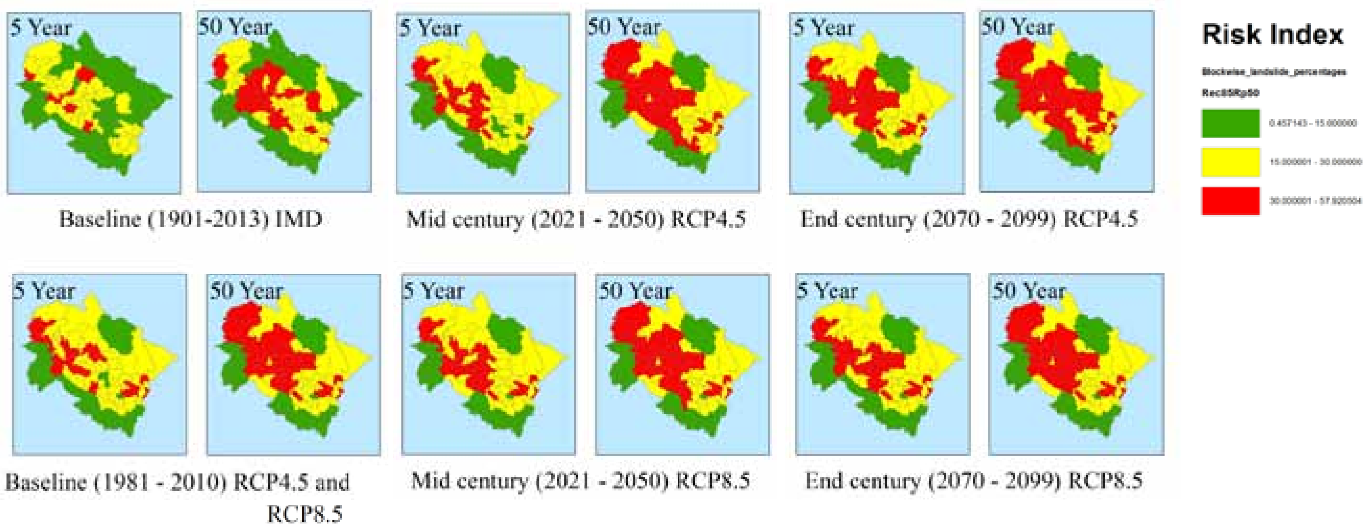
Figure 1: Mapping districts facing current and future disaster risk

CHRONICALLY DISASTER PRONE VILLAGES Source: SDMAP	HIGHEST RISK INDEX TO LANDSLIDES AND FLOODS IN THE FUTURE Source: Risk Analysis of Basic Infrastructure in Uttarakhand
PITHORAGARH: 129 villages	PITHORAGARH
CHAMOLI: 61 villages	CHAMOLI
BAGESHWAR: 42 villages	UTTARKASHI
TEHRI GARHWAL: 33 villages	TEHRI GARHWAL

2.1. Landslides

At present, parts of the middle transect of the State are at risk from landslides based on their frequency or expected rate of occurrence.[2] This trend continues in the model-based projections as the frequency and spread of hazards increase in the mid and end-centuries linked to increase in rainfall intensity. The middle transect of the State, is the most at risk. The rest of the State continues to be in the moderate risk zone across scenarios and time-lines, except for parts of the upper and lower reaches which fall in the low risk zone (See Figure 2). Eight out of the 13 districts, i.e. over 60% of the State is projected to be at high risk from the landslides in all scenarios[3] by the end century.

Figure 2: Landslide risk Index at the Block Level in Uttarakhand in the current and future scenarios



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2 A number of factors contribute to current disaster risk: Presence of major tectonic fault lines; the nature of the rocks and therefore extent of debris; the extent of development (road building and toe cutting), and presence of infrastructure in the landslide prone areas.

3 Scenarios refer to Representative Concentration Pathways or RCPs which are greenhouse gas concentration trajectories adopted by the Intergovernmental Panel on Climate Change (IPCC) to describe four possible climate futures, depending on how much greenhouse gases are emitted in the years to come.

Figure 3: District-level landslide risk Index

RISK INDEX	DISTRICTS
HIGH	Almora, Bageshwar, Chamoli, Pauri Garwal, Pithoragarh, Rudraprayag, Tehri Garwal, Uttarkashi
MEDIUM	Champawat, Dehradun, Nainital
LOW	Udham Singh Nagar, Haridwar

Figure 3 categorises districts as having high, medium, and low risk both in the mid and end-centuries.

2.2. Floods

The current flood prone areas in Uttarakhand are the banks of six major rivers – Yamuna, Ganga, Alaknanda, Ramaganga, Goriganga, Kaliganga and Sarda. The VRA projects an increase in the intensity of rainfall in all scenarios and timelines, and as a consequence, these rivers are expected to experience increased run-off leading to floods. Floods are expected to further exacerbate soil erosion in turn compounding flood events.

An increase in flood risk is projected in areas of dense infrastructure such as road networks and hotels (not just in the plains of Haridwar but, also rapidly developing northern districts such as Uttarkashi).

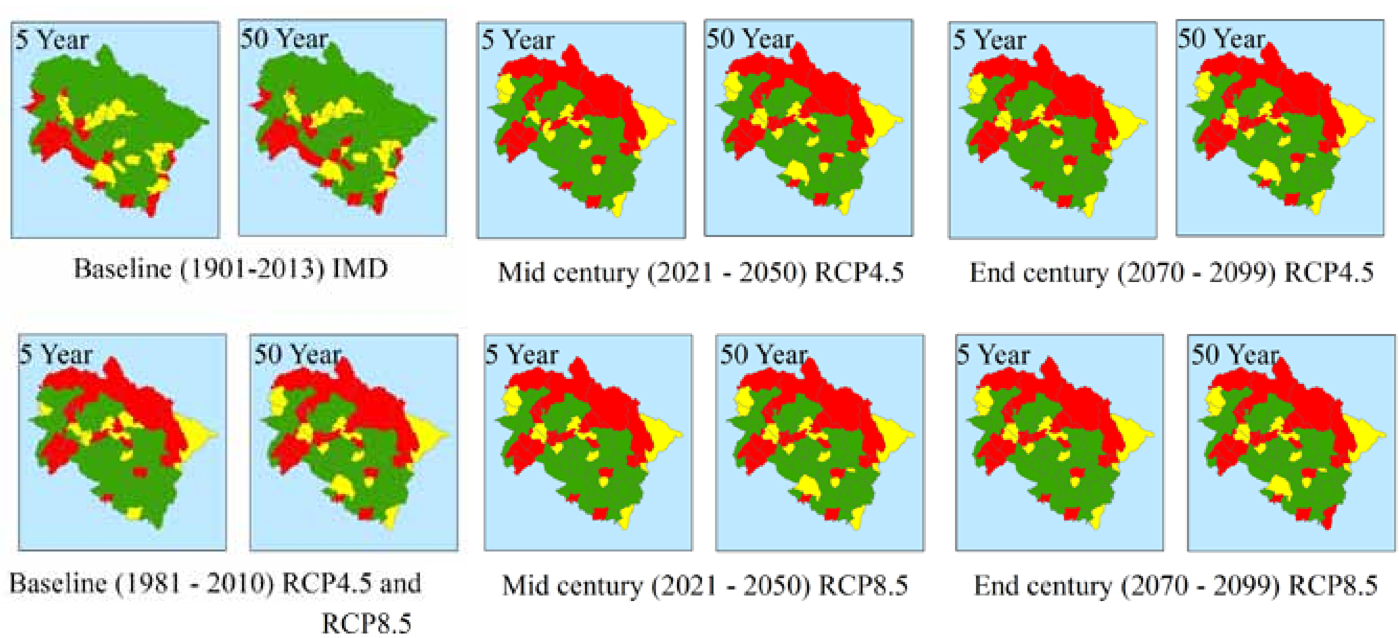
Figure 5: District-level flood risk Index

RISK INDEX	DISTRICTS
HIGH	Chamoli, Haridwar, Pithoragarh, Uttarkashi
MEDIUM	Dehradun, Tehri Garwal, Pauri Garwal, Udham Singh Nagar
LOW	Champawat, Nainital, Almora, Bageshwar, Rudraprayag

Based on the modelled simulations, four districts are projected to be at high risk from landslides in all scenarios by the end-century. Figure 5 categorises the 13 districts as having high, medium and low risk in both mid and end-centuries.

It is worth noting that as part of the VRA of the water sector, return period analyses (or the estimate of the likelihood of a flood recurrence) for two major structures, namely the Tehri and Kalagarh dams have been carried out. The analysis indicates that for the Tehri dam, the probability of a high magnitude once in 100-year event, will become a once in 50-year period event in the future, and for the Kalagarh dam, the probability of once in-100-year event is likely to increase to once in 70-year period event in the mid-century, and once in 55-year period event by the end-century. The overall implication is that additional stress is likely to be placed on the dam infrastructure, causing structural damage along with overflow of capacity, leading to flooding.

Figure 4: Flood risk Index at the Block Level in Uttarakhand in the current and future scenarios



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3. LIMITATIONS OF THE RISK ANALYSIS

One of the limitations of the risk analysis report has been the lack of availability of detailed information pertaining to exact locations, durations, and specific damages in the State as a result of disasters, as well as the lack of high resolution spatial layers like land use and land cover maps.

Moreover, the infrastructure maps are of a coarse granularity and do not focus on the type and quality of infrastructure present. For instance flood resistant buildings as well as critical infrastructure such as hospitals and road connectivity may have a net positive impact on disaster events.

The impact assessment does not factor temperature changes over time which can lead to snowmelt and Glacial Lake Outburst Floods (GLOFs), further exacerbating floods and landslides.

Figure 6: Observations of heavy rain years and the villages affected

1993 → **Majuli, Karni Guth**
1994
1995
1996
1997
1998
1999
2000 → **Bikkampur**
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010 → **Majuli Kantari**
2011 → **Karni Guth, Kantari**
2012
2013 → **Karni Guth, Chameli, Kantari, Bikkampur**

4. ON-GROUND VULNERABILITY AND COPING STRATEGIES

> *"Forest fires can worsen landslides, we need to initiate further studies on this."*
>
> *- Climate Action Group, SCCC* [4]

The PRA analysis indicates a number of factors that determine on-ground disaster risk in the State (See Box 1). Residents across villages note that five to ten years ago, there was a trend of receiving continuous showers for seven to eight days, this has been replaced by abrupt high and heavy rain fall over fewer hours. The earlier pattern of rains were more beneficial for agriculture as they helped recharge the ground water, as well as springs and other water bodies. With the current trend of shorter higher intensity rains, there is a tendency towards increased run-off and heavy soil erosion leading to flash floods and landslides. Majuli (Nainital) seems least prone to flooding compared to the other villages studied. However in Chameli (Tehri Garhwal), villagers endure varying degrees of landslides and soil erosion every five years. In Bikkampur (Haridwar) every year during the monsoons, the land located at the extreme east of the village is submerged under water and valuable agricultural land is washed out. Figure 6 lists the years when heavy rain was observed and the villages that were affected. It is worth noting that four out of five villages sampled were affected by the 2013 flash floods.

Given that locals are already observing changes in temperature, rainfall and snowfall, there is urgent need to strengthen community-led disaster management approaches and integrate climate risk in planning processes. Villages will benefit from efforts to build early warning systems, establish measures to climate proof agricultural and housing infrastructure, and incorporate landslide management techniques.

5. CLIMATE CHANGE AND DISASTER MANAGEMENT POLICY LANDSCAPE

The key document linked to disaster risk management and climate change in Uttarakhand is the Uttarakhand Action

4 The SCCC or the State Climate Change Centre is a semi-autonomous body led by the Uttarakhand Forest Department. The Climate Action Group is a cross-sectoral group of department officials meant to contribute to the climate agenda in the state through coordination and interaction with the SCCC.

Plan on Climate Change (UAPCC) which was updated following the 2013 flash floods.

Nationally, disaster management efforts in the country are guided by the overarching Disaster Management Act (2005). Following the 2013 flash floods in Uttarakhand, the State set up a State Disaster Management Authority as mandated by the Act and drafted the State Disaster Management Plan. It is a comprehensive document detailing objectives and policy recommendations, available disaster management infrastructure and resources, institutional structures, as well as key coordinating officers and personnel to ensure comprehensive disaster preparedness and management in the State. Climate change however is not considered in any detail in the document except to note that extreme rainfall events could be attributed to climate change.

At the sub-national level, District Disaster Management Plans have also been drafted, although it is unclear if they are well-fleshed out and if they have been mainstreamed into the annual district plans. All the aforementioned plans and policies in Uttarakhand need to be reviewed in light of the findings of the risk analysis, specifically:

- The State Disaster Management Plan
- District and Village disaster management plans
- Uttarakhand's five year Plan
- State level policies on agriculture, water, tourism, infrastructure, health, forestry and industries (because disaster risk resilience is a cross-cutting concern).

A key institutional imperative is the need for better coordination between multiple institutional structures responsible for disaster management in the State such as DMMC, SDMA, DDMAs, SECs, the State Disaster Response Force etc.

"Village Disaster Management plans are currently being prepared. In each Tehsil, an NGO has been designated to do a three-day PRA assessment and undertake these plans."

- Member, State Council on Climate Change

"World Bank (under its Uttarakhand Disaster Recovery Project) has set up a soil balance, slope stabilisation and a landslide management committee with experts... (their) findings will be shared with the highest policy making body in the State"

- Member, State Council on Climate Change

Finally, it is worth noting that India's Nationally Determined Contributions (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC) reiterates the importance of linking disaster risk reduction, adaptation, and loss and damage. At the international policy level, loss and damage refers to the fact that there are limits to our efforts to adapt to climate change, and that residual impacts are likely. The NDC notes that there is, "an urgent need for finance to undertake activities for early warning system, disaster risk reduction, loss and damage and capacity building at all levels."[vi] Linking disaster risk resilience and adaptation can help build a more holistic picture of climate risk, including risks from both short-term extreme events (flash floods, landslides) and longer-term slow onset events (e.g. droughts), as well as measures that move from responding to disasters to preventing their occurrence in the first place. The document also suggests that indigenous, locally appropriate knowledge and technology be considered in developing disaster management strategies.

6. AGENDA FOR CLIMATE ACTION IN DISASTER RISK

The following table provides suggested areas of action to be undertaken under disaster management over the next five years based on findings of the top-down VRA, a bottom-up review of community trends, and a review of existing state and national priorities.

CLIMATE IMPACT AREA	ACTION	TYPE OF INTERVENTION
Increased risk of soil erosion and landslides	• Incorporate landslide management techniques in all infrastructure development, with emphasis on road construction. (Measures such as no habitation on quaternary deposits, little or no use of explosives in the hills and slope stabilization measures aligned with all slope modification works).	**Policy review and mainstreaming**
	• Forest conservation and avoided deforestation measures in disaster prone regions guided by the VRA.	**Cross sectoral planning**
	• Further research on linkages between forest fires and landslides in the State.	**Information and research**
Climate change not integrated with current disaster management policies	• Review and update state, district and village disaster management plans guided by the VRA findings.	**Policy review and mainstreaming**
	• Re-examine critical infrastructure inventory (such as police resources, hospitals, primary and community health care centres, helipads etc.) as detailed in the State Disaster Management Plan for vulnerable districts and blocks guided by the VRA findings.	**Strengthening existing programmes**
	• Align VRA findings with the World Bank supported 'Uttarakhand Disaster Recovery' project.	**Policy review and mainstreaming**
Increase in the vulnerability of local communities	• Community based disaster management: Strengthening capacity of local self- government entities to understand risk, disaster preparedness and response though participatory initiatives.	**Capacity building**
	• Aggregate research on available indigenous, locally appropriate knowledge and technology to improve disaster risk resilience.	**Information and research**
	• Map infrastructure facilities either as disaster assets (hospitals, or disaster proofed buildings at an elevation) or liabilities (brick and mud houses, roads built on old landslide debris) to further categorise disaster-linked vulnerability.	**Information and research**
Risk of snow melt and GLOFs resulting in flash floods	• Initiate research on rising temperatures and resultant impacts on snowmelt and glacial lake outburst floods (GLOFs) as the VRA does not examine the link between temperature changes and disaster risk.	**Information and research**
Development and economic goals compromised	• Mainstream disaster management and climate resilience in development programmes by ensuring programmes are sanctioned after conducting comprehensive climate and disaster risk assessments.	**Policy review and mainstreaming**
	• Ensure each selected project or initiative has factored sufficient funds to deal with extreme events.	**Policy review and mainstreaming**
	• Comprehensive risk analysis as well as safety audits for all existing infrastructure (hydro power projects, reservoirs, building design and construction, roads) based on the VRA.	**Policy review and mainstreaming**
	• Ensure incorporation of disaster resistant features in all new constructions as stipulated by national building codes and other Bureau of Indian Standards codes.	**Policy review and mainstreaming**

7. DEVELOPMENT CO-BENEFITS

The suggested areas of climate action would lead to the following development co-benefits:

- Reduce disaster related mortality and morbidity.
- Help contain disaster induced economic losses.
- Help the State avail incentives for forestry sector based on the Government of India's 14th Finance Commission as well as revenue generation through the national REDD+ and Agro-forestry schemes outlined in India's NDC.
- Unlock finance for activities that reduce climate-related loss and damage as outlined in the NDC.

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