AGENDA FOR CLIMATE ACTION

AGRICULTURE

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

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1. OVERVIEW OF AGRICULTURE SECTOR IN UTTARAKHAND

As is the case for much of India, agriculture[1] is a substantial contributor to Uttarakhand's Gross State Domestic Product (11% in 2011-12[i]). It is the source of livelihood for over 70% of the State's population.[ii] Uttarakhand has four agro-climatic zones covering six altitudinal farming approaches, which means there is potential to grow a wide variety of crops. Despite being a predominantly agricultural State, however, Uttarakhand struggles with low agricultural yields. A number of factors contribute to this problem including small and scattered land holdings, difficult terrain, high dependence on rain-fed agriculture, lack of access to improved inputs, and poor trade conditions.

Out of the total reported land area of 53.48 lakh hectares, only 14% is under cultivation; the rest is under forest and wasteland. As of 1995-96 almost 72% of the land holdings were less than 1 hectare in size.[iii] Small farm holdings do not enjoy economies of scale available to larger land holdings, and this has impeded investment in the sector. Increasing urbanisation has led to farmland being converted to non-farm use, and because of the perceived lack of opportunity in agriculture, many men have been migrating to urban areas. To improve commercial opportunities and gains for farmers, the Uttarakhand Agriculture Produce (Development and Marketing) Act was established in 2011 to regulate the sale and purchase of agricultural produce, establish better marketing systems and, encourage private investment in the sector. Uttarakhand was also one of the first States to set up Special Agricultural Zones (SAZs) to promote an integrated approach to farming.

Agriculture in the State is primarily rain-fed, which means there is a high dependence on rainfall. Only 14% of cultivated land is irrigated, and mostly confined to the plains. There is a stark difference in productivity between the hills and plains; districts of Udham Singh Nagar, Haridwar, Nainital and Dehradun have high agricultural productivity, while hill districts have very low productivity. Apart from climatic and soil conditions, this is largely due to the lack of access to improved technologies (e.g. machinery, quality seeds, information technology services) which were brought to the plains by the Green Revolution. One of the positive outcomes of hill farming, however, is that it is largely organic and is based on mixed cropping, which is more resilient to environmental uncertainty.[iv]

Box 1: Observed trends linked to vulnerability in the agriculture sector

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

- All villages but one (in the district of Haridwar) are characterised by small and scattered land holdings.
- Several villages have no irrigation facilities and are entirely dependent on rainfall.
- Most villages (4 out of 5) face a serious wildlife menace that leads to the destruction of crops.
- Most villages (4 out of 5) have observed the problem of soil erosion, which damages agricultural land and has worsened in some villages because of increased episodes of heavy rainfall.
- Most villages (4 out of 5) do not use chemical inputs for agriculture and horticulture, which provides an opportunity to certify and sell organic produce.
- Two villages have benefited from the introduction of improved agricultural inputs and technology due to government and donor-funded programmes.

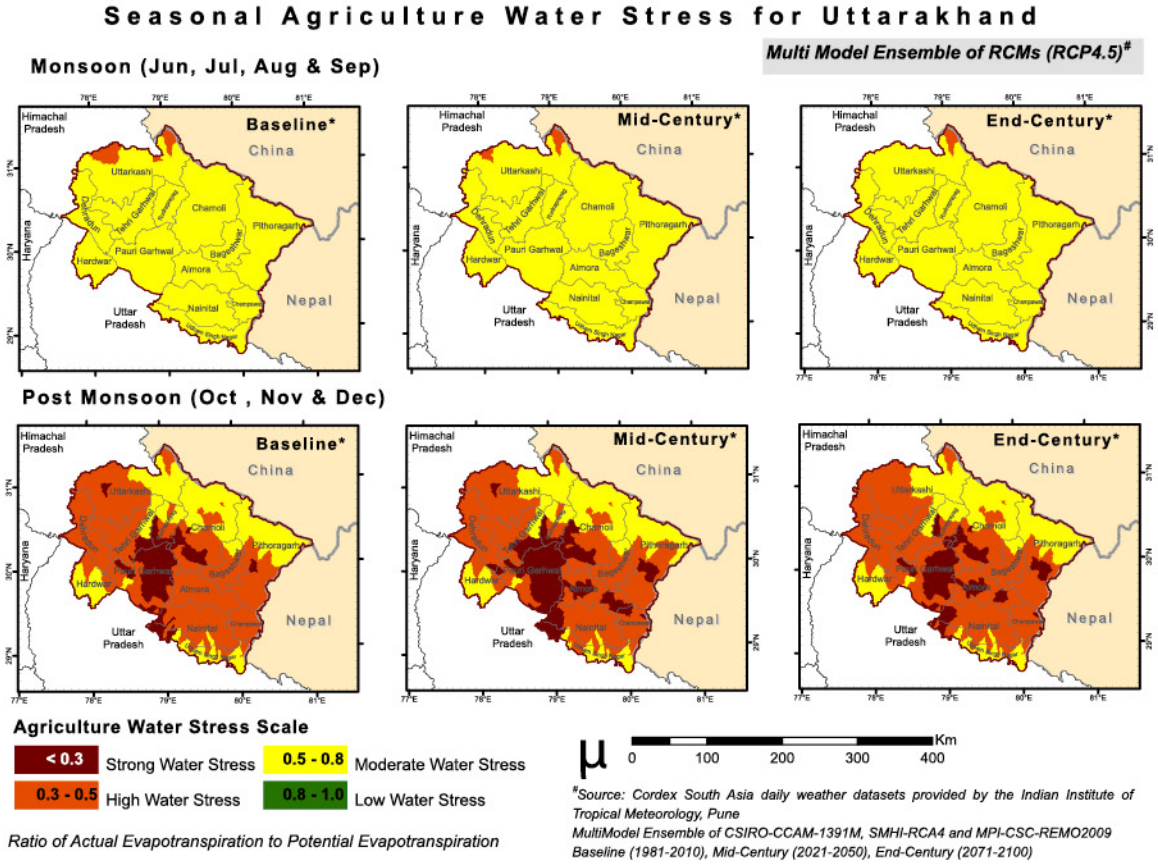
2. CLIMATE VULNERABILITY OF THE AGRICULTURAL SECTOR IN UTTARAKHAND

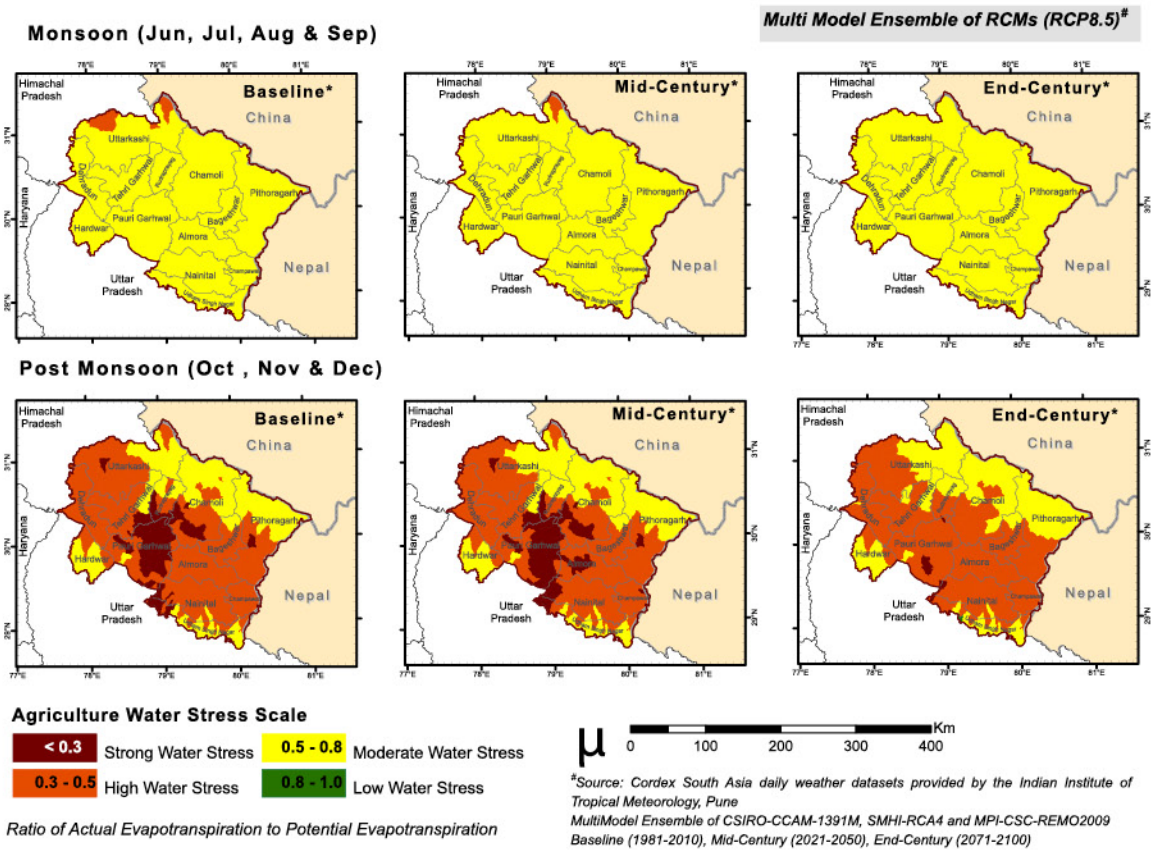
Agriculture is inherently vulnerable to climate variability and change due to the natural connections and dependencies that exist between climatic conditions such as temperature and rainfall, and plant development. This vulnerability is exacerbated in Uttarakhand by a number of developmental issues as outlined above, which increase the exposure and sensitivity of the sector to climate impacts.

At the same time, climate change may in some scenarios present new opportunities which, if managed

[1] In this document agriculture refers to arable, cropped land and does not include livestock.

Figure 1: Seasonal agriculture water stress under two scenarios (RCP 4.5 and RCP 8.5)





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appropriately, may contribute to an overall increase in the productivity of the agricultural sector. It is worth noting though that there is a degree of uncertainly linked to all model-based projections, particularly on precipitation, making it necessary to focus on policy options that are robust against multiple scenarios.

The Vulnerability and Risk Assessment (VRA) points to three specific areas of future impact on agriculture:

1. Increase in water stress and implications for irrigation
2. Increased risk of flooding
3. Potential increase in some crop yields

2.1. Increase in water stress and implications for irrigation

Increase in temperature extremes can cause additional evaporation and evapotranspiration losses leading to water stress.[2] This has two main implications for agriculture. First, this limits growth, which in turn results in decreased yields and makes plants more susceptible to disease and pests. Second, water stress can result in additional surface or groundwater irrigation requirement for crops during their critical growth period. Figure 1 indicates seasonal agriculture water stress in the monsoon and post-monsoon periods under both climate scenarios for the mid and end-centuries.

There is projected to be low or moderate water stress in the monsoon season for most of Uttarakhand and high water stress in the post monsoon season in many parts of the State's basins toward the 2050s. However, under the moderate scenario (RCP 4.5) (Figure 8 - top), the situation is projected to improve toward the end of the century.[3] Under the extreme scenario (Figure 8 - bottom), agricultural water stress is likely to reduce during monsoon months and be moderate during winter. The districts of Almora, Champawat, Pauri Garhwal, and Tehri Garhwal are likely to experience higher agricultural water stress.

Furthermore, analysis of rainfall, land-use, and soil properties indicate that future drought conditions are likely to increase in hilly regions of the State and improve in the mid and lower transects of Uttarakhand.

2.2. Increased risk of flooding

Increased intensity of rainfall events, particularly an increase in precipitation in the summer monsoon, can lead to flooding, resulting in soil erosion and crop loss as well as disruption of transport routes and access to markets. Uttarakhand is highly dependent on rain-fed agriculture, which makes it susceptible to changes in rainfall. These projected changes may in turn pose a threat to rural farming livelihoods and overall food security, as well as agricultural revenues.

2.3. Changes in crop yields

A number of climate related factors, including changes in temperature and rainfall, have the potential to affect crop water demand and productivity, and thus yields, both negatively and positively. Overall, an increase in wheat yield (15-20%) and rice yield (2-5%) is expected. However, a decline in production of rice and wheat is likely in the districts of Uttarkashi, Rudraprayag, Chamoli and Pauri Garhwal under both scenarios. Changes in climate may lead to better growing conditions in certain districts. This also means there may be opportunities to increase production and productivity of different types of crops; for example, higher temperatures allow seasonally longer plant growth for crops in cool and mountainous areas that remain at low temperatures for most of the year.[v] In contrast, in already warm areas, climate change can cause reduction in productivity.

3. LIMITATIONS OF THE VRA

It is important to note that crop models are not available for all crops, therefore only wheat and rice crops have been analysed. Examining the impacts of climate change on other important crops, particularly horticultural crops such as fruits and flowers, which have the potential to bring larger revenues to the State, is an area for future research. Furthermore, crop models cannot simulate intercropping, which is a dominant practice in the hill districts.

Impact models do not account for several factors which also impact agricultural productivity including terrain and slope quality (e.g. hilly or rocky terrain) and have a limited response to extreme events (e.g. they cannot account for flooding due to cloudbursts). The VRA also does not take

[2] Water stress is determined as the ratio of actual water uptake and potential transpiration.

[3] Representative concentration pathways (RCP) scenarios 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. In RCP 4.5 emissions peak around 2040, then decline. In RCP 8.5, emissions continue to rise throughout the 21st century.

into account the links between agricultural water stress and crop yields; this requires an integrated assessment model, and no such model exists globally that can link the two. These limitations point to the need for further, targeted research into specific sub-sectors and at the community level to ground-truth and refine the VRA's broad messages.

3.1. On-ground vulnerability and coping strategies

The PRA results indicate a number of factors that can increase community-level vulnerability to climate change, as outlined in Box 1. Villagers' observations correspond with the three projected impact areas generated in the VRA, namely increase in water stress, increased risk of flooding and changes in crop yields, highlighting that these are already current stressors. First, several villages have no irrigation facilities and are entirely dependent on rainfall which increases their sensitivity to changes in precipitation patterns and increases the risk of water stress. Villagers in Majuli (Nainital) and Kharni Guth (Champawat) have observed dry periods increasing in duration. Second, most villages have noted the problem of soil erosion damaging agricultural land, due to increased incidence in heavy rainfall. Residents of Bhikkampur (Haridwar) state that every year, agricultural land is washed away in the monsoon rains. Third, villagers note that increasing temperatures are shifting cultivation zones. Apple production has declined in Kantari (Uttarkashi) and Majuli due to a reduction in the required chilling period. Some villages are already adapting to warmer temperatures by growing different crops. For example in Kharni Guth and Chameli (Tehri Garwhal), villagers have begun growing mango and banana crops. Most villages (4 out of 5) do not use chemical inputs for agriculture and horticulture, which presents an opportunity to certify and sell organic produce at better prices. This requires third party certification and good access to markets, and indicates the value of undertaking market analysis to better understand current and future risks and opportunities for new agricultural enterprises.

4. CLIMATE POLICY LANDSCAPE

The key document linked to climate change and the agricultural sector in Uttarakhand is the Uttarakhand Action Plan on Climate Change (UAPCC).

At the national level, the agricultural sector is guided by the National Mission for Sustainable Agriculture (NMSA), one of the eight missions under the National Action Plan on Climate Change (NAPCC), which primarily aims to enhance agricultural productivity especially in rain-fed areas focusing on integrated farming, water use efficiency, soil health management, and synergizing resource conservation.

Agricultural policies and plans for Uttarakhand should be reviewed in light of the VRA, in order to manage areas of current and emerging risk due to climate change, as well as opportunities. At present, there is no overarching agricultural policy document in Uttarakhand, which poses a challenge to (climate resilient) decision making. Some of the relevant agricultural policies and schemes that need to be examined in light of the VRA are:

- Uttarakhand Agriculture Produce (Development and Marketing) Act
- Plans related to Uttarakhand's Agricultural Export Zone (AEZ) projects (lychee, basmati rice, flowers, medicinal and aromatic plants)
- Uttarakhand's Annual Action Plan under the National Mission for Integrated Development of Horticulture (MIDH)
- District level irrigation plans
- National Weather Based Crop Insurance Scheme (WBCIS)
- Seb Bima Yojana (apple insurance) developed by Uttarakhand government and Agriculture Insurance Company of India (AIC)
- Pradhan Mantri Krishi Sinchayee Yojana (PMKSY): National mission to improve farm productivity and ensure better utilization of the resources in the country, focusing on irrigation.[4]

Furthermore, the agricultural sector is an important component of India's Nationally Determined Contributions (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC), which aims to better adapt to climate change by enhancing investments in development programmes in a number of areas including agriculture, water resources, and the Himalayan region. Interventions that implement and deliver NDC objectives are likely to be eligible for international finance from multilateral and bilateral development partners.

[4] Further programme areas are listed in the UAPCC

5. AGENDA FOR CLIMATE ACTION IN AGRICULTURE

The following table provides suggested areas of action to be undertaken in agriculture 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
Increase in water stress	• Assess irrigation strategies alongside studies on crop yields in line with the VRA findings to evaluate further investments in irrigation in certain areas. For e.g. in specific blocks/ districts where increased drought is projected).	**Strengthening existing programmes**
	• Re-evaluate guidelines for irrigation practices specifically for district irrigation plans as guided by the VRA (and as a priority in the vulnerable districts).[5]	**Strengthening existing programmes**
	• Promote climate smart agricultural technologies and techniques in the vulnerable regions as guided by the VRA (e.g. drip irrigation and sprinklers, adoption of climate resilient seed types, integrated pest management).	**Strengthening existing programmes**
Increased risk of flooding	• Raise awareness at the farm level of climate risk insurance schemes against climate-related crop failures.	**Capacity Building**
	• Use VRA findings to target further areas of research that can enrich the information used by the Agricultural Insurance Company of India (AIC) to develop weather based index insurance (e.g. through CGIAR CCAFS), which the State can avail.	**Information and research**
	• Assess viability of climate-resilient seeds and switching to alternative – more resilient – crops.	**Information and research**
Changes in crop yields	• Use VRA results to guide targeted impact assessments on how a range of crops will respond to simultaneous climate-related changes (For e.g. increase in temperatures, water stress, flooding, increase in pests and diseases etc.) and the full range of possible stressors as identified by the VRA.[6] Particularly, focus on areas of interest/investment, including hill crops and Uttarakhand's AEZ projects, in order to design appropriate interventions.	**Information and research**
	• Undertake analysis of markets and supply chains to better understand current and future vulnerabilities and opportunities for development of new agricultural enterprises, such as agri-business initiatives and food processing.	**Information and research**
	• Examine the viability of organic agriculture as a climate resilient measure.	**Information and research**

[5] For e.g. assess increase or decrease in water yield, in which districts/blocks, and what periods

[6] Impact models do not account for terrain and slope quality (eg. hilly or rocky terrain) which also affects agricultural productivity

CLIMATE IMPACT AREA	ACTION	TYPE OF INTERVENTION
Climate change can undermine development objectives	• Ensure that the State's sectoral vision and objectives are drawn up in a single agriculture policy document, which will serve as a guide to climate-resilient decision making in line with state priorities.	**Policy review and mainstreaming**
	• Include climate data (from VRA and subsequent sectoral or district-level studies) in Uttarakhand's Agro-Climatic Planning and Information Bank (APIB).	**Information and research**
	• Build capacity of agriculture extension teams to provide regular training to farmers at village level to help them understand climate change impacts and to take appropriate measures to protect crops and improve productivity.	**Capacity building**

6. DEVELOPMENT CO-BENEFITS

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

- Improve water management.
- Increase agricultural production and productivity and enhance farm income.
- Increase food and nutritional security for an increasing population in the State, as per the Department of Agriculture's objectives.
- Reduce crop losses.
- Increase food security.

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[iii] UAPCC, 2014

[iv] Ibid

[v] Ibid

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