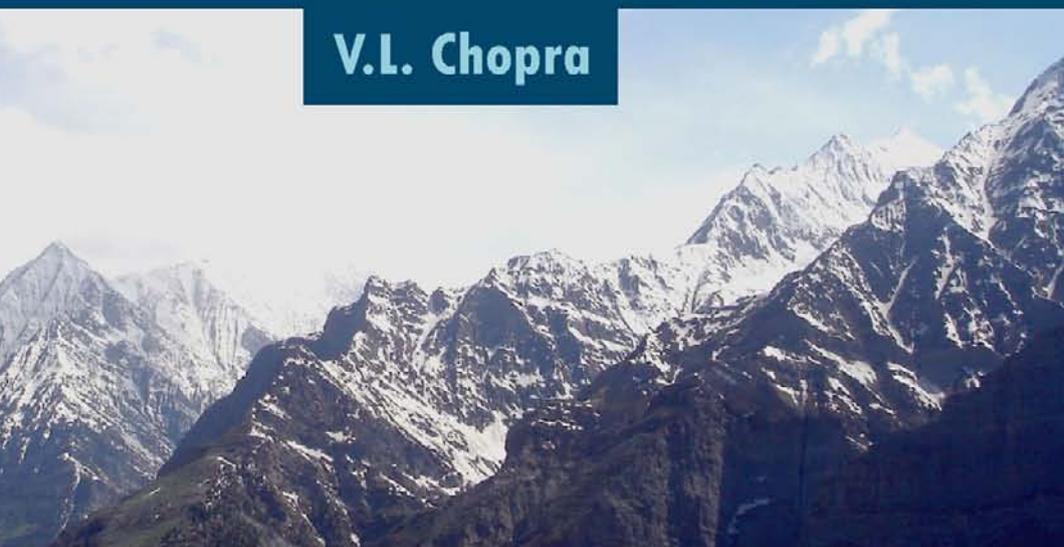




# Climate Change and its Ecological Implications for the Western Himalaya

V.L. Chopra



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*Dedication*  
*To girl children*  
*Vanshika & Priyanshika*  
*and their respective mothers,*  
*Vaishali & Priya*



## PREFACE

Inhabitants of the hill regions of developing countries face challenges and handicaps because of remoteness of their location and vulnerability resulting from fragility of environment of their ecosystems. This fragility has been further aggravated by pervasive changes in global weather. While democratic governments and enlightened civil societies wish to take proactive steps and actions which will provide protection against these weather induced perturbances as a social responsibility, the effectiveness of the steps and actions taken will manifest only when the contemplated programmes are built on policies and procedures framed on knowledge-based principles and actions. Since the required information relevant in this regard for the western Himalayan region of India is scarce and scattered, it was felt desirable to bring it together, and synthesize and evaluate it, so that it provides a sound base to build on by researchers, planners and executing development agencies. The book “Prospective weather change and its ecological implications for the western Himalayan region of India” is an attempt to fill this gap.

The contents of this volume are grouped into four sections: (1) Defining features of the area eco sub-region wise in terms of physical, biological and socio-economic attributes, (2) Ecological components most likely to be influenced by weather change, (3) Research needs for technological preparedness to face and handle weather change, and (4) Issues of policy, institutions and operational mechanisms. My reading of the analysis by the contributing authors points to the following highlights.

**Chapter 1: Physical Attributes: Soil and Landscape Characteristics of Western Himalayan Region of India** (*V.K. Suri, G.S. Sidhu and Anil Kumar*)

Soil, because it is the second largest carbon pool after the oceans, both affects and gets affected by weather change. While western Himalayan region is among the most fragile zones of the country, its

capacity to cope with the impending weather change is poorly understood because of the non-availability of information on the physical and other attributes of its varying soils. Whatever information is available is based on some random studies made at a macro scale by only one agency i.e., NBSS and LUP, Nagpur. The expectation was that State Agricultural Universities and other local organizations will fill in details for their respective areas of jurisdiction. Unfortunately this has not happened. The need therefore is to address this issue in the required depth urgently.

## **Chapter 2: Land Use and Land Cover Patterns of Himachal Pradesh, India** (*Amit Kumar, Sanjay Kr. Uniyal and R.D. Singh*)

The land use and land cover patterns of a region evolve from natural events that impinge the area over time and space, and socio-economic factors that humans impose while utilizing the land for subsistence, recreation or economic activities. Natural disasters like earthquake, landslide, avalanche, flash flood, cloud burst and drought are considered stimuli to land use changes. Population growth, cropping pattern, weather conditions, variation in economic status, technological change, demography, urbanization, wanton exploitation of biological resources, invasion by exotic plants, social aspects, edaphic factors, indiscriminate mining and quarrying without accompanying land conservation measures etc. lead to change in the land use/land cover

## **Chapter 3: Water Resources of Western Himalayan Region of India** (*Kireet Kumar and Rajesh Joshi*)

Himalayan Mountains which harbour the “water tower” provide water to over 100 million living in mountains and its valleys and to billions living downstream. This chapter reviews current status of precipitation pattern and water resources, identifies critical water issues of western Himalayas, describes how these problems may worsen with possible climate change, explores the connection between water use and fresh water availability and proposes new ways of addressing these connections. Importantly, analysis of past data and PRECIS projections indicate that annual precipitation is declining in J&K and Himachal Pradesh while Utrtrakhand shows mixed trends. On seasonal scale, trend is of increasing winter and summer rainfall for western Himalaya. The annual surface flow is declining in J&K and Himachal Pradesh. Water scarcity under climate change scenario, inaccessibility of perennial water and growing water demand are current emergencies crying for immediate action. Understanding and

coping with seasonality is critical to meeting the needs of land-based activities and maintenance of societal well being.

#### **Chapter 4: Linking Climate Change with Biodiversity and Livelihoods in Indian Himalaya** (*K.G. Saxena, K.S. Rao and R.K. Maikhuri*)

The ecosystems of Himalaya are more vulnerable to climate change and are faced with serious threats to their biodiversity and livelihoods of their people. Climate change mitigation and adaptation strategies for the region will have to be evolved in the light of projected scenarios and their consequences for the region. Integrating the farmer's traditional knowledge and wisdom and aspirations of the community with scientific knowledge about climate change would be the logical way for evolving these strategies. The economy of this predominantly agrarian society is primarily based on natural resource- based livelihoods. The historical wisdom of the community about crop-environment interactions has enabled them to cope with risks associated with adverse weather conditions. The farmers have traditional ways of effectively using agro-biodiversity to face climate variability. They classify crops into groups based on the economic returns from them, their household needs as also their resilience to various kinds of stresses and adjust the crop combination according to the imminent weather conditions. There is a need for validating and enhancing such relevant local knowledge. The ongoing changes in cropping patterns have also aggravated threats to forest ecosystem services. Conservation of biodiversity and its rational deployment can provide a relevant adaptation option for coping with the changing climate conditions. The chapter discusses strategic options and actions required for conservation of agro-biodiversity and making use of it for securing livelihoods of the people of the region. It suggests that conserving biodiversity through increasing network of protected areas should be coupled with local socio-economic development. Meaningful action toward adoption of traditional crop varieties, improvement in traditional agro-forestry, water management, improving soil fertility and rehabilitation of degraded lands will secure livelihoods and also enable local people to cope with the stresses associated with climate change.

#### **Chapter 5: Weather and Climate in High Altitudes with Special Reference to the Himalayas** (*S.K. Dash*)

Mountains cover a much larger area than is common perception: globally, a fifth of total land cover. About one fourth of world's

population lives in or is closely associated with mountains. Weather and climate of high altitude mountains, besides its local effects, has far reaching consequences in distant plains also.

Weather and climate in mountain vicinities are affected at synoptic, meso and micro spatial scales through dynamic and thermodynamic processes. A variety of climate types exist along the slopes of Himalayan range. These climate types, through their influence on the quantum and quality of generated resources impact not only mountain communities but also overall water availability, food security and socio-economic welfare of the people in the plains. A focal point of current discussions is the increased occurrence, due to global warming, of weather-associated disasters such as avalanches, flash floods, snow storms, turbulences and landslides. High resolution regional atmospheric models are used for understanding and predicting local weather. The accuracy of weather forecasts for the Himalayan region depends largely on the initial atmospheric conditions such as mountain peaks along the slopes, snow and glaciers. The realistic representation of the complex Himalayan range in high resolution numerical models is a challenging task. There are also inherent problems of weather observation in the prevailing inaccessible and inhospitable terrains.

The chapter discusses some of the issues mentioned above and gives an action plan for integrated Himalayan development. A five-point action is proposed which will help understanding the present and future role of the Himalayas in influencing weather and climate of various regions of India. This action plan includes the creation of climatic knowledge base, denser network of observation points, greater use of satellite data for model building, high resolution modeling efforts and generation of scenarios for climate and impact.

## **Chapter 6: Vegetation Characteristics, Floral Diversity and Resource Use in Western Himalaya** (*Sanjay Kr. Uniyal and R.D. Singh*)

Since life in Himalayan country side revolves round forests and farming, this chapter captures the dependence of local people on forests and farming. Nearly 18% of geographical area of western Himalaya is under forests and is home to about 6000 plant species. The resources available in forests are not only the bedrock of livelihoods for the people but also provide for the forage requirements of their livestock and sustenance for the forest inhabiting faunal species. The apparent signs of forest degradation, however, raise a serious question mark on sustainability aspects and calls for urgent

interventions for halting degradation on one hand and improving productivity on the other.

**Chapter 7: Biodiversity (Plants/ Animals/ Microbes/ Birds): Status, Endemism, Threatened Species** (*S.K. Sharma and J.C. Rana*)

The chapter on biodiversity provides a glimpse of the spectrum of diversity of plants, animals, microbes and birds that occur in India in general and Indian Himalayan region in particular. It deals with the current status of biodiversity, endemism of species and vulnerability to loss from either natural or man-made interventions that include the disruption caused by climate change, creeping industrialization and intensification of agriculture. Under the influence of climate change, mountain areas are likely to experience wide ranging effects on environment, biodiversity and socioeconomic conditions. Agricultural intensification spurred by crop genetic improvement has led to loss of several traditional varieties and breeds. The chapter emphasizes the need for building complementarities among agriculture, biodiversity and conservation of genetic resources for sound and sustainable research and development, land use, and breeding approaches. While appropriate conservation approaches need to be reinforced and adequately financed, more radical changes are called for to recognize biodiversity as a global public good so that biodiversity conservation is integrated into policy and decision frameworks.

**Chapter 8: Climate-Affected Alterations in Agricultural Scenario of Western Himalayan Region: Local, Regional and National Relevance and Implications** (*Sanjay Kumar and P.K. Aggarwal*)

Agriculture is the major source of livelihood in western Himalayan region. Environment related data indicate an undeniable impact of climate change on agriculture of the region. This chapter discusses issues related to (i) loss of agricultural diversity in the region, (ii) extensive use of synthetic, specially nitrogenous, fertilizers, (iii) changes in cropping pattern, and (iv) lack of systematic data on the response of crops of western Himalayan region. It also discusses various approaches for improved agriculture and adoption of proactive measures for sustenance and improvement of agriculture to protect livelihoods in the western Himalayan region including mobilization of national and international opinion to make issues of agro-biodiversity and vulnerability of farmers central in climate change negotiations.

**Chapter 9: Resource Base and Livelihood Opportunities with Particular Reference to Perceived Climate Change in Western Himalayan Region of India** (~~Lok Man S. Palni~~, D.S. Rawat and Subrat Sharma)

Objectives such as enhancement of livelihood security, sustainable food production, environmental protection, etc., are challenging issues for mountain habitats. The Himalayan region, in particular, poses a formidable challenge for the long term sustainable development in the context of desired green economy and the likely climate change. Since natural resources (land, forests, water, etc.) are important for human survival there is an urgent need for a mountain sensitive land use policy and stringent measures to reduce environmental degradation. Strategies employed by people over the ages to cope with climate variables provide reliable leads for founding development plans. For augmenting livelihood options, industries should be in non-fragile areas and restricted to activities compatible with mountainous conditions. There is also an urgent need to change and rationalize the way we operate hill agriculture because it is a major land based activity. Energy is another sector crucial to expansion of hill economy which traditionally has been biomass based. It will be critical to ensuring that economic development in the Himalayan region is not marginalized in terms of energy use by employing standards and procedures prescribed for downstream states. Supporting adaptive approaches that build on existing strengths and knowledge for improving the resilience of mountain communities would be the logical way forward.

**Chapter 10: Ecosystem Services of the Western Himalaya: Management Implications** (G.S. Rawat)

The western Himalayan region bestows numerous ecosystem services that include material goods from biodiversity, biosphere carbon storage, carbon sequestration, climate regulation and regular flow of fresh water for people living within as well as outside. Ever-mounting anthropogenic pressures that result from lack of adequate livelihood opportunities and mismatch between conservation and 'development' are major causes of environmental degradation and disruption of ecosystem functioning of the region. In this chapter, Dr Rawat discusses various ecosystem services flowing from the region and management strategies that will ensure human well being. He underscores various policy directives for the region such as valuation and payment for ecosystem services, restoration of degraded ecosystems, strategic environmental assessment and planning for all the

river basins, minimizing conflicts between protected areas and the people living therein and participatory natural resource management.

### **Chapter 11: Ecological Components Most Likely to be Influenced by Climate Change** (*S.K. Vats and P.S. Ahuja*)

There is paucity of research data on responses of plant species and microbes to changing environmental variables in Himalaya. Issues of significance include understanding vulnerability of specific ecosystems and species to climate change, their adaptive capacity to face emerging competitive interactions and changing profile of secondary metabolites of commercial plants, to quote a few. The ecological and biological implications of climate change in mountains are large, and offer high research opportunities and challenge alike.

### **Chapter 12: Research Needs for Technological Preparedness** (*P.S. Ahuja and Amit Chawla*)

The challenge of changing climate in the Western Himalayan Region (WHR) requires high level of preparedness in our research and technological capacity. This region has warmed more than the global average over the last century and the rate of warming in the next decades has also been predicted to be higher. As a result, the glaciers are shrinking and the monsoon system is weakening resulting in reduced precipitation. There are convincing reports of the vulnerability of ecosystems *viz.*, glacier recession, range shift of wild and cultivated plant species, decreased crop production, changes in habitats of animal species, changes in plant and crop phenology, and spread of invasive species. Greater long-term observations and regional climate modeling studies are required over the region to establish the impacts of future global warming. The authors suggest a modular approach where by the vulnerability of different sectors and domains are taken into account for acquiring the requisite capacity and preparedness for facing the challenge of climate change in the region.

### **Chapter 13: Policy Considerations** (*V.L. Chopra, Indrani Chandrashekar and Amit Chawla*)

The debate on global climate change has fortunately shifted now from whether it is occurring at all to how it should be faced to blunt its negative impact. For the western Himalayan region, the issue is particularly relevant because of the severity of likely impact and its pervasive influence over numerous sectors ranging all the way from natural resources (e.g., land, water, biodiversity), to livelihoods, to

economic development of the region, to society and social fabric, and to the complex web of inter-sector interactions. From time to time, policy formulations have been framed and both legal and administrative mechanisms have been prescribed for implementing these policies at the central and state levels. The extent of success achieved has been variable and leaves much to be desired. For the future, areas that will need serious attention include sound national research programmes and relevant infrastructure to generate locally and nationally relevant data bases, science and technology capacity building for generating ameliorating solutions and public participation in the formulation and implementation of programmes aimed at social inclusion.

This book therefore, is very rich in contents, timely in relevance and relevant in the prevailing context. Each topic has been dealt with comprehensively by experts in the area and bears the required mark of authenticity. It is our hope that the book will be a reliable source of information and meet the needs of a wide variety of users that includes students, teachers and researchers; administrators and development planners and members of the civil society. In the labour of love of putting this volume together, I have received support and help from many sources and would like to record gratitude to the following in particular: P.S. Ahuja for solid support, help and advice in innumerable ways; Sanjay Kumar for being a reliable comrade-in arms and Surender Vats and J.K. Prashar for facilitating my survival at Palampur. To the contributing authors, I owe a debt of gratitude for their time, commitment and patience.

**V.L. Chopra**

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