Uttarakhand Action Plan on Climate Change




'Transforming Crisis into Opportunity'

उत्तराखण्ड शासन

Government of Uttarakhand
2014

UTTARAKHAND ACTION PLAN ON CLIMATE CHANGE

(UAPCC)

Uttarakhand is most vulnerable to climate-mediated risks. Mountainous regions are particularly vulnerable to climate change and have shown 'above average warming' in the 20th Century. It may have a huge impact on the natural resources of the region, which not only provide life supporting, provisioning, regulating and cultural 'eco-system' services to the locals, but millions of Indians living downstream. Climate change escalates the already existing vulnerabilities (social, ecological, economic and cultural) and inequities of Uttarakhand and could manifest disastrously if not addressed adequately.

The challenge for the state is to holistically converge these existing initiatives and make additional efforts to integrate climate concerns and response measures into all aspects of the development process, from policy and planning to implementation. The state has adopted this as the underlying principle in the formulation of the Uttarakhand Action Plan for Climate Change (UAPCC) and aims to become a green and carbon neutral state by 2020.

Supported by United Nations Development Programme

UNDP
Empowered lives.
Resilient nations.

Uttarakhand Action Plan on Climate Change




'Transforming Crisis into Opportunity'

उत्तराखण्ड सरकार

Government of Uttarakhand

2014

Contents

Contents iii
List of Tables viii
List of Figures ix
Foreword xii
Acknowledgements xiv
Abbreviations/Acronyms xv

Executive Summary 18

Introduction 21
Background and Context 21
The National Context 21
The Indian Himalaya Context 22
The Uttarakhand Context 24
Transforming Crisis into Opportunity 25

Process Adopted for UAPCC Preparation 26
Initial Processes and Preparation of an Initial Draft 26
Revision Process and Preparation of a Revised Draft 26

1 State Profile 31
1.1 Overview 31
1.1.1 Geographical Context—The Himalaya 31
1.1.2 Uttarakhand—Overview and Economy 32
1.1.3 Uttarakhand—Human Development 35
1.1.4 Hill Districts, Livelihoods and Vulnerabilities 35
1.2 Geological and Agro-Ecological Settings 36
1.2.1 Physiography 36
1.2.2 Agro-climatic Zones 37
1.2.3 Land-use Pattern 40
1.2.4 Forest Cover 41
1.2.5 Hydrological Setting 41
1.2.6 Major River Basins and Sub-basins 41

2 Climate Profile 43
2.1 Future Climatic Projections 43
2.1.1 Possible Future Climate Scenarios for India and the Himalayan Region 43
2.1.2 Annual Mean Temperature 43
2.1.3 Rainfall and Monsoon 44
2.2 Observed Climate Trends in Uttarakhand 45
2.3 Vulnerability Assessment of Uttarakhand 50

3 Overarching State Framework 53
3.1 State Vision and Commitment 53
3.2 Overall Approach, Principles and Strategies 53
3.2.1 Scientific Knowledge, Evidence Base and Understanding of Climate Change 54
3.2.2 Governance Mechanisms, Institutional Decision Making and Convergence 54
3.2.3 Capacity Development, Education and Awareness 56

3.2.4 Connecting Science, Practice and Policy 56
3.2.5 Integrating Poverty, Livelihoods, Gender and Equity Issues 57
3.2.6 Private Sector and Financial Institutions 58
3.2.7 Role of Civil Society 59
3.2.8 Role of International Agencies 59
3.2.9 Monitoring Framework 60
3.2.10 Knowledge Management and Dialogue across the IHR and Beyond 61

4 Sectoral Implementation Approaches 62
4.1 Overall Common Implementation Framework 62

5 Agriculture 65
5.1 Overview, Characteristics and Status 65
5.1.1 Land Holding and Land Use Pattern 65
5.1.2 Irrigation 66
5.1.3 Crop Production Scenario 66
5.2 Vulnerability to Climate Change 67
5.3 Issues, Challenges and Priorities 68
5.3.1 Main Issues and Challenges 68
5.3.2 Priorities 70
5.4 Relevant Existing Initiatives 71
5.5 Sectoral Vision and Strategies 74
5.5.1 Sectoral Vision and Commitment 74
5.5.2 Strategies 75

6 Forests and Biodiversity 77
6.1 Overview—Characteristics and Status of Forests 77
6.2 Overview—Characteristics and Status of Biological Diversity 79
6.2.1 Floral diversity 79
6.2.2 Faunal diversity 79
6.3 Vulnerability to Climate Change 80
6.4 Issues, Challenges and Priorities 80
6.5 Relevant Existing Initiatives 81
6.6 Sectoral Strategies 82
6.6.1 Sectoral Vision and Commitment 82
6.6.2 Strategies 82

7 Livestock and Animal Husbandry 89
7.1 Overview—Characteristics and Status 89
7.2 Vulnerability to Climate Change 91
7.3 Issues, Challenges and Priorities 91
7.4 Relevant Existing Initiatives 93
7.5 Sectoral Strategies 94
7.5.1 Sectoral Vision and Commitment 94
7.5.2 Strategies 94

8 Disaster Management 102
8.1 Overview—Characteristics and Status 102
8.2 Vulnerability to climate change 103
8.3 Issues, Challenges and Priorities 104

8.3.1 Issues and Challenges 104
8.3.2 Priorities 104
8.4 Relevant Existing Initiatives 106
8.5 Sectoral Strategies 108
8.5.1 Sectoral Vision and Commitment 108
8.5.2 Strategies 108

9 Human Health 116
9.1 Overview 116
9.2 Vulnerability to Climate Change 116
9.2.1 Direct Impacts 116
9.2.2 Indirect Impacts 116
9.3 Issues, Challenges and Priorities 117
9.3.1 Issues and Challenges 117
9.3.2 Priorities 117
9.4 Sectoral Strategies 118
9.4.1 State Vision and Commitment 118
9.4.2 Strategies 118

10 Urban Development 121
10.1 Overview—Characteristics and Status 121
10.2 Vulnerability to Climate Change 121
10.3 Issues, Challenges and Priorities 121
10.4 Relevant Existing Initiatives 122
10.5 Sectoral Strategies 122
10.5.1 Sectoral Vision and Commitment 122
10.5.2 Strategies 122

11 Water Resources 125
11.1 Overview—Characteristics and Status 125
11.2 Vulnerability to Climate Change 126
11.3 Issues, Challenges and Priorities 127
11.4 Relevant Existing Initiatives 128
11.5 Sectoral Responses 128
11.5.1 Sectoral Vision and Commitment 128
11.5.2 Strategies 129
11.6 Linkages with NAPCC 131

12 Tourism 132
12.1 Overview—Characteristics and Status 132
12.2 Vulnerability to Climate Change 133
12.3 Issues, Challenges and Priorities 133
12.3.1 Issues and Challenges 133
12.3.2 Priorities 134
12.4 Existing Initiatives 134
12.5 Sectoral Responses 135
12.5.1 Sectoral Vision and Commitment 135
12.5.2 Strategies 135

13 Energy 137

13.1 Overview—Characteristics and Status 137
13.2 Vulnerability to Climate Change 138
13.3 Issues, Challenges and Priorities 138
13.4 Existing Initiatives 138
13.5 Sectoral Strategies 139
13.5.1 Sectoral Vision and Commitment 139
13.5.2 Strategies 140

14 Roads 143
14.1 Overview—Characteristics and Status 143
14.2 Vulnerability to Climate Change 143
14.3 Issues, Challenges and Priorities 143
14.4 Sectoral Responses 144
14.4.1 Sectoral Vision and Commitment 144
14.4.2 Strategies 144

15 Industries 149
15.1 Overview—Characteristics and Status 149
15.2 Vulnerability to Climate Change 149
15.3 Issues, Challenges and Priorities 149
15.4 Relevant Existing Initiatives 150
15.5 Sectoral Strategies 151
15.5.1 Sectoral Vision and Commitment 151
15.5.2 Strategies 151

16 Transport 154
16.1 Overview—Characteristics and Status 154
16.2 Vulnerability to Climate Change 155
16.3 Issues, Challenges and Priorities 155
16.4 Sectoral Strategies 155
16.4.1 Sectoral Vision and Commitment 155
16.4.2 Strategies 155

Action Plan and Budgets 158
Agriculture 158
Forests and Biodiversity 159
Animal Husbandry and Livestock 168
Disaster Management 170
Human Health 175
Urban Development 176
Water Resources (Irrigation Department) 180
Water Resources (Uttarakhand Jal Sansthan) 181
Tourism 181
Energy (UPCL) 185
Energy (UJVN) 186
Energy (UREDA) 187
Energy (PTCUL) 188
Roads 189
Industries 190

Transport 191
Summary of Financial Outlay for Identified Sectors in UAPCC 193

Annexure 1—Brief Notes on Proceedings of Stakeholder Consultation Workshops 195

Annexure 2—Brief Notes on Findings of the WWF-India and ICIMOD-IFAD Studies 208
WWF-India study—*Facing the facts: Ganga Basin's vulnerability to climate change* 208
ICIMOD-IFAD Study 208
Gender and Uttarakhand SAPCC—Inputs from Alternative Futures, in partnership with CBGA and CHEA 215

Annexure 3 — Brief Notes on Uttarakhand Flood Disaster 2013 223

List of Tables

FIGURE 1: UAPCC REVISION PROCESS MEETING ON 19 MARCH 2012 AT THE UTTARAKHAND SECRETARIAT 27
FIGURE 2: CONSULTATIONS OF 26–27 MARCH 2012 AT DOON UNIVERSITY 27
FIGURE 3: CONSULTATIONS OF 13–14 APRIL AT GBPIHED, KOSI KATARMAL, ALMORA 28
FIGURE 4: THE HINDU KUSH HIMALAYA (HKH) AND THE INDIAN HIMALAYAN STATES 31
FIGURE 5: UTTARAKHAND AND ITS DISTRICTS 32
FIGURE 6: STATE GDP AND CONTRIBUTION OF AGRICULTURE 34
FIGURE 7: PHYSIOGRAPHIC ZONES OF UTTARAKHAND 36
FIGURE 8: TEMPERATURE REGIMES IN UTTARAKHAND (INTERPOLATED DATA) 37
FIGURE 9: DISTRIBUTION OF PRECIPITATION OVER UTTARAKHAND (INTERPOLATED DATA) 38
FIGURE 10: OVERALL CLIMATIC CONDITIONS IN UTTARAKHAND 38
FIGURE 11: UTTARAKHAND SOILS AND SOIL DEPTH MAPPING BY NBSS&LUP 39
FIGURE 12: LAND-USE PATTERN IN UTTARAKHAND 40
FIGURE 13: TEMPERATURE PROJECTION FOR INDIA FOR 2030S FOR (A) DECEMBER, JANUARY, FEBRUARY AND (B) JUNE, JULY, AUGUST—4 × 4 ASSESSMENT 43
FIGURE 14: TRENDS OF MAXIMUM AND MINIMUM TEMPERATURES, RAINFALL AND BRIGHT SUNSHINE HOURS AT PANTNAGAR OBSERVATORY, DISTRICT UDHAM SINGH NAGAR 46
FIGURE 15: VARIATION IN ANNUAL AVERAGE TEMPERATURE AND ITS TREND AT ALMORA 47
FIGURE 16: VARIATION FROM ANNUAL RAINFALL AND ITS TREND AT ALMORA 47
FIGURE 17: RAINFALL PATTERN AT HAWALBAGH, ALMORA 48
FIGURE 18: SNOW COVER AREA IN THE MONTH OF OCTOBER IN DIFFERENT YEARS IN THE WATERSHEDS OF UTTARAKHAND 49
FIGURE 19: STATUS OF SNOW COVER AREA IN OCTOBER 1990 AND OCTOBER 1999 IN THE UTTARAKHAND STATE (BASED ON OF 15TH AND 21ST OCTOBER 1990 LANDSAT TM DATA AND 15TH AND 21ST OCTOBER 1999 LANDSAT ETM+ DATA) 49
FIGURE 20: STATE-LEVEL ARCHITECTURE FOR UAPCC IMPLEMENTATION 55
FIGURE 21: TENTATIVE AND INDICATIVE MONITORING FRAMEWORK FOR UAPCC 60
FIGURE 22: COMMON FRAMEWORK ELEMENTS FOR SECTORAL IMPLEMENTATION UNDER UAPCC 62
FIGURE 23: STATISTICS RELATED TO THE PERCENTAGE OF FOREST COVER OF UTTARAKHAND 78
FIGURE 24: FOREST COVER MAP OF UTTARAKHAND (SOURCE: FOREST SURVEY OF INDIA) 78

List of Figures

FIGURE 1: UAPCC REVISION PROCESS MEETING ON 19 MARCH 2012 AT THE UTTARAKHAND SECRETARIAT 27
FIGURE 2: CONSULTATIONS OF 26–27 MARCH 2012 AT DOON UNIVERSITY 27
FIGURE 3: CONSULTATIONS OF 13–14 APRIL AT GBPIHED, KOSI KATARMAL, ALMORA 28
FIGURE 4: THE HINDU KUSH HIMALAYA (HKH) AND THE INDIAN HIMALAYAN STATES 31
FIGURE 5: UTTARAKHAND AND ITS DISTRICTS 32
FIGURE 6: STATE GDP AND CONTRIBUTION OF AGRICULTURE 34
FIGURE 7: PHYSIOGRAPHIC ZONES OF UTTARAKHAND 36
FIGURE 8: TEMPERATURE REGIMES IN UTTARAKHAND (INTERPOLATED DATA) 37
FIGURE 9: DISTRIBUTION OF PRECIPITATION OVER UTTARAKHAND (INTERPOLATED DATA) 38
FIGURE 10: OVERALL CLIMATIC CONDITIONS IN UTTARAKHAND 38
FIGURE 11: UTTARAKHAND SOILS AND SOIL DEPTH MAPPING BY NBSS&LUP 39
FIGURE 12: LAND-USE PATTERN IN UTTARAKHAND 40
FIGURE 13: TEMPERATURE PROJECTION FOR INDIA FOR 2030S FOR (A) DECEMBER, JANUARY, FEBRUARY AND (B) JUNE, JULY, AUGUST—4 × 4 ASSESSMENT 43
FIGURE 14: TRENDS OF MAXIMUM AND MINIMUM TEMPERATURES, RAINFALL AND BRIGHT SUNSHINE HOURS AT PANTNAGAR OBSERVATORY, DISTRICT UDHAM SINGH NAGAR 46
FIGURE 15: VARIATION IN ANNUAL AVERAGE TEMPERATURE AND ITS TREND AT ALMORA 47
FIGURE 16: VARIATION FROM ANNUAL RAINFALL AND ITS TREND AT ALMORA 47
FIGURE 17: RAINFALL PATTERN AT HAWALBAGH, ALMORA 48
FIGURE 18: SNOW COVER AREA IN THE MONTH OF OCTOBER IN DIFFERENT YEARS IN THE WATERSHEDS OF UTTARAKHAND 49
FIGURE 19: STATUS OF SNOW COVER AREA IN OCTOBER 1990 AND OCTOBER 1999 IN THE UTTARAKHAND STATE (BASED ON OF 15TH AND 21ST OCTOBER 1990 LANDSAT TM DATA AND 15TH AND 21ST OCTOBER 1999 LANDSAT ETM+ DATA) 49
FIGURE 20: STATE-LEVEL ARCHITECTURE FOR UAPCC IMPLEMENTATION 55
FIGURE 21: TENTATIVE AND INDICATIVE MONITORING FRAMEWORK FOR UAPCC 60
FIGURE 22: COMMON FRAMEWORK ELEMENTS FOR SECTORAL IMPLEMENTATION UNDER UAPCC 62
FIGURE 23: STATISTICS RELATED TO THE PERCENTAGE OF FOREST COVER OF UTTARAKHAND 78
FIGURE 24: FOREST COVER MAP OF UTTARAKHAND (SOURCE: FOREST SURVEY OF INDIA) 78

Foreword

Global Warming is perhaps the biggest challenge that the humankind is facing presently. Man has the onus of protecting not only himself but also other life forms on this planet. Globally, all nations are working on their strategies to combat climate change. On the national front, the **Prime Minister's National Action Plan for Climate Change** comprises **Eight National Missions** designed to achieve **sustainable development** as a co-benefit of addressing climate change. Indian economy is mainly dependent on land-based sectors, which are going to be severely affected by the impacts of climate change. National strategy, sub national approaches and action plans have to be developed and implemented soon. The **Uttarakhand Action Plan for Climate Change** (UAPCC) is an outcome of this. The task of preparation of this plan was assigned to the **State Forest Department**.

For a hill State like Uttarakhand - which is relatively new in existence and limited in resources - **development is a necessity**. As such, **the UAPCC is committed to the overall development and inclusive growth of the State at a rapid pace**. However, Uttarakhand being environmentally fragile and a treasure of biodiversity with 71% of its geographical area under forests, the UAPCC simply aims at **reorienting our developmental strategies in an environment caring manner** so that the progress achieved is **sustainable**. The catastrophe that struck Uttarakhand during 15th to 17th June, 2013 has left several lessons to be learnt! The UAPCC is here to ***transform crisis of climate change into an opportunity of sustainable development!***

For the preparation of the plan, all the concerned Departments and Agencies were organized into 11 different sectors, each under the leadership of the concerned **Principal Secretary/Secretary** to the State Govt. Several rounds of debates and discussions were held within the sector and issues & solutions pertaining to the sector were identified and discussed at the state level in sessions chaired by the **Chief Secretary**. This resulted in the evolution of this Action Plan through various versions that were exposed to scrutiny through website, workshops, seminars etc. For a state like Uttarakhand, **adaptation** has more significance than **mitigation,** as the contribution of the State to the GHG pool is miniscule compared to the developed states in the country.

Any plan would be of no acceptability unless and until people are involved in the process of its preparation. Keeping this in view, wide consultations were held with NGO's, academia, people's representatives, civil society groups and village folks (including women) who have their own perceptions based on their experience and knowledge.

The plan has been prepared for a period of 5 years. However, certain research/studies envisaged would go beyond this period. The estimate of expenditure in the plan is to the tune of ₹ 8832.62 crores (**Roads'** component alone being ₹ 6230 crores). It is obvious that a good amount of money would be needed to implement the plan, a major component of which would be coming from the Central and the State sector schemes. However, sources outside the State would be required to finance the **additionality** of funds owing to switching over from the conventional to greener technologies. Annual working plans would be drawn from the UAPCC at the time of its implementation.

It is important to understand that this is a **dynamic** plan. This means that the plan would evolve (change) with experience and breakthrough in knowledge related to climate change. Suggestions in this regard, as and when they come, would be welcome!

Dehra Dun dated 28 May, 2014.

(Jai Raj)
I.F.S.
Addl. P.C.C.F. (Environment),
& State Nodal Officer UAPCC,
Uttarakhand.

Acknowledgements

The **Uttarakhand Action Plan for Climate Change** is an outcome of extensive and effective collaboration with many. I am thankful to **Mr. Subhash Kumar, Chief Secretary, Uttarakhand** who chaired and provided a common platform for extensive discussions! As the plan was anchored with the **State Forest Department**, **Mr. S. Ramaswamy, Principal Secretary, Forest and Environment, Govt. of Uttarakhand** and **Dr. R.B.S. Rawat, P.C.C.F., Uttarakhand** provided good support. The **Ministry of Environment and Forests, Govt. of India** had been supportive in not only providing technical assistance but also funds for the preparation of the plan. **UNDP** provided excellent technical assistance! Thanks to **Ms. Preeti Soni** and **Mr. Pramod Krishnan** from the UNDP. The **Doon University, Dehra Dun** had been the centre of many a discussions and consultations. Thanks to the **Vice Chancellors** of the University! **Dr. R.S. Tolia, NTPC Chair, Centre for Public Policy, Doon University** had been an excellent facilitator and contributor to the UAPCC. **Dr. L.M.S. Palini, Director, GBPIHED, Almorah** helped in organizing the villagers' workshop there. Several NGOs and bodies participated actively in the preparation of the UAPCC. **Climate and Development Knowledge Network (CDKN), London** took active interest in the plan and a step further to carry out vulnerability assessments in important sectors for which I am grateful to **Mrs. Elizabeth Gogoi**. **IUCN, WWF, British Deputy High Commission-Chandigarh, Alternative Futures** (an N.G.O.)**, Civil Society Groups** and many others actively participated in the plan preparation and lot of inputs came on various aspects including *gender issues*. Finally and most importantly, my thanks go to all the villagers and especially village woman who participated actively in deliberations and gave their valuable inputs.

Dehra Dun dated 28 May, 2014.

(Jai Raj)
I.F.S.
Addl. P.C.C.F. (Environment),
& State Nodal Officer, UAPCC,
Uttarakhand.

Abbreviations/Acronyms

Acronym	Expanded Form
ADB	Asian Development Bank
AEZ	Agri-Export Zones
AIS	Agriculture Information System
APCCF	Additional Principal Chief Conservator of Forests
APIB	Agro-Climatic Planning and Information Bank
ATMA	Agriculture Technology Management Agency
BOT	Build–Operate–Transfer
BSI	Botanical Survey of India
CA	Conservation Agriculture
CBDM	Community-Based Disaster Management
CBO	Community-Based Organization
CBR	Crude Birth Rate
CBRI	Central Building Research Institute
CDKN	Climate and Development Knowledge Network
CDM	Clean Development Mechanism
CDR	Crude Death Rate
CEIA	Cumulative Environmental Impact Assessment
CFL	Compact Fluorescent Lamp
CHC	Community Health Centre
CPMU	Central Project Management Unit
CSR	Corporate Social Responsibility
CSWCRI	Central Soil and Water Conservation Research and Training Institute, Dehradun
DIVPMU	Divisional Project Management Unit
DMMC	Disaster Mitigation and Management Centre
DPIU	District Project Implementation Units
DRR	Disaster Risk Reduction
ECBC	Energy Conservation Building Code
EIA	Environment Impact Assessment
EMP	Environment Management Plan
EOP	Environmental Operating Plans
ESCO	Energy Service Company
FAO	Food and Agriculture Organization of the United Nations
GBPIHED	Govind Ballabh Pant Institute of Himalayan Environment and Development, Almora
GBPUA&T	Govind Ballabh Pant University of Agriculture and Technology, Pantnagar
GDP	Gross Domestic Product
GER	Gross Enrolment Ratio
GHG	Green House Gas
GIS	Geographical Information System
GLOF	Glacial Lake Outburst Floods
GMVN	Garhwal Mandal Vikas Nigam
GoI	Government of India
GPS	Geographical Positioning System
GRIHA	Green Rating for Integrated Habitat Assessment
GSDP	Gross State Domestic Product
HDI	Human Development Index
HEP	Hydro-electric Project

Acronym	Expanded Form
HKH	Hindu Kush Himalaya
HRDI	Herbal Research and Development Institute, Gopeshwar
HYV	High-Yielding Varieties
ICAR	Indian Council for Agriculture Research, New Delhi
ICFRE	Indian Council for Forestry Research and Education, Dehradun
ICIMOD	International Centre for Integrated Mountain Development, Kathmandu
ICT	Information and Communication Technology
IDWR:	Indian Daily Weather Reports
IFAD	International Fund for Agricultural Development
IHDI	Inequality Adjusted Human Development Index
IHR	Indian Himalayan Region
IIRS	Indian Institute of Remote Sensing, Dehradun
IIT	Indian Institute of Technology
ILRI	International Livestock Research Institute
IMD	India Meteorological Department
IMR	Infant Mortality Rate
INCCA	Indian Network for Climate Change Assessment
IPCC	Intergovernmental Panel on Climate Change
ITK	Indigenous Technical Knowledge
KfW	Kreditanstalt für Wiederaufbau
KMVN	Kumaon Mandal Vikas Nigam
KVK	Krishi Vikas Kendra
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
LANDSAT MSS	LANDSAT Multi Spectral Scanner
LAPA	Local Action Plan on Adaptation
LBSNAA	Lal Bahadur Shastri National Academy of Administration, Mussoorie
LED	Light Emitting Diode
LHP	Large Hydro-electric Project
LSD	Land Survey Directorate
MAPs	Medicinal and Aromatic Plants
MoEF	Ministry of Environment and Forest
MPP	Multi-purpose Project
NAARM	National Academy of Agricultural Research Management
NABARD	National Bank for Agricultural and Rural Development
NADRS	National Animal Disease Reporting System
NAP	National Agriculture Policy
NAPCC	National Action Plan for Climate Change
NBSS&LUP	National Bureau of Soil Survey and Land Use Planning
NGO	Non-Governmental Organization
NH	National Highway
NIC	National Informatics Centre
NIH	National Institute of Hydrology
NPP	Net Primary Productivity
NTFP	Non-Timber Forest Produce
PRI:	Panchayati Raj Institution
PHC	Primary Health Centre
PMRY	Pradhan Mantri Rozgar Yojna
PPP	Private–Public Partnership
PRI	Panchayati Raj Institutions
PTCUL	Power Transmission Corporation of Uttarakhand Limited
PWD:	Public Works Department

Acronym	Expanded Form
R&D	Research and Development
R&R	Rehabilitation and Resettlement
REDD	Reducing Emissions from Deforestation and Forest Degradation
RKBY	Rashtriya Krishi Bima Yojna
RKVY	Rashtriya Krishi Vikas Yojna
RS-GIS	Remote Sensing and Geographical Information System
SAC	Space Applications Centre
SAMETI	State Agricultural Extension Management and Training Institute
SAPCC	State Action Plan on Climate Change
SCCC	State Council for Climate Change
SDMA	State Disaster Management Agency
SED	State Environment Directorate
SGWB	State Ground Water Board
SHP	Small Hydro-electric Project
SIDCUL	State Infrastructure and Industrial Development Corporation of Uttarakhand Limited
SOP	Standard Operating Procedure
SSI	Small-Scale Industries
SWM	Solid Waste Management
TDC	Tarai Development Corporation
TERI	The Energy and Research Institute
THI	Temperature–Humidity Index
UAPCC	Uttarakhand Action Plan for Climate Change
UCCC	Uttarakhand Centre on Climate Change
UCOST	Uttarakhand State Council for Science and Technology
UDD	Urban Development Directorate
UDWDP	Uttarakhand Decentralized Watershed Development Project
UED	Uttarakhand Environment Directorate
UELP	Uttarakhand Efficient Lighting Project
UJVN	Uttarakhand Jal Vidyut Nigam
ULB	Urban Local Bodies
ULDB	Uttarakhand Livestock Development Board
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UOCB	Uttarakhand Organic Commodity Board
UP	Uttar Pradesh
UPCL	Uttarakhand Power Corporation Limited
UREDA	Uttarakhand Renewable Energy Development Agency
URP	Uniform Recall Period
USWDB	Uttarakhand Sheep and Wool Development Board
UTC	Uttarakhand Transport Corporation
UUSDIP	Uttarakhand Urban Sector Development Investment Programme
VKC	Village Knowledge Centre
VPKAS	Vivekananda Parvatiya Krishi Anusandhan Sansthan
WIHG	Wadia Institute of Himalayan Geology
WMD	Watershed Management Directorate
WWF	World Wide Fund for Nature
ZSI	Zoological Survey of India

Executive Summary

The Uttarakhand Action Plan on Climate Change (UAPCC) has been formulated in accordance with the principles and guidelines of the National Action Plan on Climate Change (NAPCC). The UAPCC integrates the action plan of Uttarakhand with the ongoing and proposed developmental programmes in the state, and in tandem with the eight national missions along with the principles and guidelines listed out in the NAPCC.

According to the IPCC 5th Assessment Report, human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise and in changes in some climate extremes. This evidence for human influence has grown since AR4. It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century. The atmospheric concentrations of the greenhouse gases {carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)} have all increased since 1750 due to human activity. The deep interconnections between the vulnerability of natural and human systems to climate change calls for expeditious coping strategies and response measures. Climate proofing of vulnerable sectors, programmes, natural systems and communities by integrating adaptation and mitigation options into planning processes and interventions are increasingly becoming an integral part of the development/environment lexicon and action worldwide.

Need for Climate Change Action Plan for Uttarakhand

On a geographical level, the sub-national entities, the state acts as the 'ground zero' of climate change battle. Preparation and implementation of State Action Plans on Climate Change (SAPCC) thus forms a crucial clog in the strategy to address climate change, as most of the interventions aimed at improving the climate resilience/ adaptation ability of the communities, public or private infrastructures and preserving the eco-systems are undertaken and implemented at the state level. Besides, technology improvements in production, consumption and other related sectors at the state level are also critical in enhancing the effectiveness of national policies for mitigation. The process of preparation of Climate Change Action Plan for Uttarakhand stems from these imperatives. The government has therefore identified the State Forest Department (SFD) as the Lead Agency to coordinate preparation and implementation of the UAPCC in consultation with various line departments and other relevant stakeholders. For the preparation of the plan, all the concerned Departments and

Livelihood dependencies in Uttarakhand Himalaya

Agencies were organized into 11 different sectors, each under the leadership of the concerned Principal Secretary/Secretary to the State Govt. Several rounds of debates and discussions were held within the sector and issues & solutions pertaining to the sector were identified and discussed at the state level in sessions chaired by the Chief Secretary. This resulted in the evolution of this Action Plan through various versions that were exposed to scrutiny through website, workshops, seminars etc. For a state like Uttarakhand, adaptation has more significance than mitigation, as the contribution of the State to the GHG pool is miniscule compared to the developed states in the country. State wide consultations were also held with NGO's, academia, people's representatives, civil society groups and village folks (including women) who have their own perceptions based on their experience and knowledge.

Uttarakhand is most vulnerable to climate mediated risks. Mountainous regions are vulnerable to climate change and have shown "above average warming" in the 20th century. Studies conducted by MoEF have shown an increase in annual temperature in the Himalayan region, a net increase in rainfall in the 2030s with respect to the simulated rainfall of the 1970s in the Himalayan region. Impacts are expected to range from reduced genetic diversity of species to erratic rainfall leading to flash floods to glacial melt in the Himalayas leading to increased flooding that will affect water resources within the next few decades.

The natural resources of the region provide life supporting, provisioning, regulating, and cultural 'eco-system' services to millions of locals as well as people living downstream. The economy of the state as a whole is characterized by low economic growth combined with high rates of population growth. The livelihoods are almost totally based on natural resources - water, forest, agriculture, etc. About three-fourth of state's population is rural and virtually all depend on agriculture. Tourism and Animal husbandry are other sources of income. With over 15 important rivers and over a dozen of major glaciers, Uttarakhand is a valuable freshwater reserve. Hydel power continues to be a prime resource base for state's economy (with more than 200 large and medium sized hydro-projects). A large portion of the state is under forests with several forest based industries. Climate change will have direct impacts on livelihoods as most of the economic and livelihood sectors are dependent on the biodiversity and natural resources of the state which are vulnerable to the impacts of climate change.

Some of the reported climate change induced changes in the Uttarakhand Himalayas include: receding glaciers and upwardly moving snowline, depleting natural resources, erratic rainfall (leading to flash floods as seen in June 2013 disaster), irregular winter rains, advancing cropping seasons, fluctuations in the flowering behaviour of plants (e.g. Renwartia spp), shifting of cultivation zones of apple (the zone has moved by 1000 m to 2000 m), reduction in snow in winter, rise in temperature, increasing intensity and frequency of flash floods, drying up of perennial streams, etc.

Transforming Crises to Opportunities

The climate response strategy of Uttarakhand has key elements such as accelerating inclusive economic growth, promoting sustainable development, securing and diversifying livelihoods,

and safeguarding ecosystem services. Further, the strategy envisaged should not be viewed as a standalone action; instead it should be integrated into the regular developmental planning process. Similarly, while it is important to pursue both mitigation and adaptation measures, considering the overall socio-economic and ecological contexts and vulnerabilities, it would be of importance to give priority to adaptation options including Disaster Risk Reduction.

In accordance to the sector wise strategies identified for the state, the state over a period of five years has estimated an expenditure of ₹ 8832.62 crores in the plan. The sectoral breakdown of the expenditure outlay has been given below:

S.No.	Sector	₹. in lakhs
1.	Agriculture	7,991.75
2.	Forests and Biodiversity	97,101.65
3.	Animal Husbandry and Livestock	19,274.73
4.	Disaster Management	37,125.00
5.	Human Health	10,400.00
6.	Urban Development	41,465.70
7.	Water Resources	9,825.00
8.	Tourism	4,100.00
9.	Energy	15,838.50
10.	Roads	6,23,000.00
11.	Industries	4,260.00
12.	Transport	12,880.00
Total		**8,83,262.33**

Climate change also offers some unique opportunities for the state. It will allow the state to examine and address the climate change impacts separately in the 'hills' and 'plains' using exclusive 'viewing tools' and adjust for any regional disparities/ imbalances in terms resource allocation, setting of priorities, etc. It also gives Uttarakhand an opportunity for having a relook into the developmental paradigm and make on-course corrections while keeping 'inclusive growth' and 'building resilience' at the centre of this philosophy.

Uttarakhand Action Plan for Climate Change (UAPCC) is only the beginning. As the knowledge base broadens and as more data and evidence become available, UAPCC shall undergo revisions and updates. As a result, UAPCC has to be perceived as an evolving document, with ample flexibility to internalize changes and developments happening at the national, regional and local levels over time.

*****

Introduction

Background and Context

Climate change is a major global environmental and developmental problem. Though all the possible consequences of climate change are yet to be understood, it is now established that adverse impacts are likely from an increased frequency of extreme weather, floods and droughts, submergence of coastal areas due to sea level rise and extreme climate variability. Impacts of climate change are also likely to be iniquitous—the poor, women, the aged and the very young, especially in underdeveloped or developing area contexts—are relatively more vulnerable due to their greater dependence on climate-sensitive sectors such as agriculture, fisheries and forestry for their livelihoods or their limited adaptive capacity. The poor status of infrastructure and essential services in most of the poverty-affected areas also limits their ability to cope with adverse impacts of climate change.

Climate change no longer remains a distant theoretical possibility or an academic rhetoric; it is an unconcealed reality. According to the IPCC 5th Assessment Report, human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise and in changes in some climate extremes. This evidence for human influence has grown since AR4. It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century. The atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) have all increased since 1750 due to human activity. The deep interconnections between the vulnerability of natural and human systems to climate change calls for expeditious coping strategies and response measures. Climate proofing of vulnerable sectors, programmes, natural systems and communities by integrating adaptation and mitigation options into planning processes and interventions are increasingly becoming an integral part of the development/environment lexicon and action worldwide.

The National Context

Climate change is expected to manifest quite significantly in India.[1] India is considered highly vulnerable to climate change, not only because of high physical exposure to climate-related disasters (65% of India is drought-prone, 12% flood-prone and 8% susceptible to cyclones) but also because of the dependency of its economy and majority of population on climate-sensitive sectors (e.g. agriculture, forests, tourism, animal husbandry and fisheries). Climate change will induce changes in the complexion, distribution, quality and functionality of the natural resource base. Further, it will result in 'insecure livelihoods' due to disruptions in the social, cultural, economic and ecological systems, physical infrastructure and human assets, increasing health risks and crippling or even negating the developmental gains and opportunities.

Addressing climate change calls for a wide array of policy responses and strategic actions at local, sub-national, national and global levels. Recognizing that climate change is a global challenge, India has engaged actively in multilateral negotiations in the United Nations Framework Convention on Climate Change (UNFCCC). The objective is to establish an effective, cooperative and equitable global approach based on the principle of 'common but differentiated responsibilities and respective capabilities'. India's immense geographic diversity adds to the complexity of developing and implementing a climate response strategy.

[1] A framework for preparation of the State Level Action Plans on Climate Change, MoEF, 2010.

As the impacts will vary across states, sectors, locations and populations, there can be no 'one-size-fits-all' climate change strategy. Approaches will need to be tailored to fit specific sub-national contexts and conditions.

India's National Action Plan on Climate Change, 2008 (NAPCC), with its eight national missions, is designed to achieve sustainable development as a co-benefit of addressing climate change. The focus of NAPCC is on promoting understanding of climate change, adaptation, mitigation, energy efficiency and natural resource conservation while pursuing overall economic growth—i.e. measures that promote development objectives which also result in co-benefits for addressing climate change. There are eight national missions (see box below), which form the core of NAPCC, representing 'multi-pronged, long-term and integrated strategies for achieving key goals in the context of climate change'.

- **Jawaharlal Nehru National Solar Mission** aims to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar energy competitive with fossil-based energy options.
- **National Mission for Enhanced Energy Efficiency** recommends mandating specific energy consumption decreases in large energy consuming industries. It also recommends financing for public-private participants to reduce energy consumption through demand-side management programmes.
- **National Mission on Sustainable Habitat** aims to promote energy efficiency as a core component for urban planning. The plan calls for a greater emphasis on urban waste management and recycling including production of power from waste.
- **National Water Mission** sets a goal of 20 percent improvement in water use efficiency through pricing and other measures.
- **National Mission for Sustaining the Himalayan Ecosystem** aims to conserve biodiversity, forest cover and other ecological values in the Himalayan region.
- **National Mission for a Green India** aims at Increased forest/tree cover on 5 million hectares of forest/non-forest lands, improved quality of forest cover on another 5 million hectares (a total of 10 million hectares) and improved ecosystem services, including biodiversity, hydrological services and carbon sequestration, as a result of treatment of 10 million hectares.
- **National Mission for Sustainable Agriculture** aims to support climate adaptation in agriculture through the development of climate-resilient crops and appropriate agricultural practices.
- **National Mission on Strategic Knowledge for Climate Change** is for gaining a better understanding of climate science, impacts and challenges. It envisions improved climate modelling and increased international collaboration to develop adaptation and mitigation technologies.

The Indian Himalaya Context

The Indian Himalayan Region (IHR) stretches across states in the western and eastern Himalaya and provides critical ecosystem services for communities in mountains and downstream plains. The IHR region covers vast areas, with about 17% of the region being under permanent snow cover and glaciers and about 30–40% under seasonal snow cover, forming a unique water reservoir. This feeds important perennial rivers that provide water for drinking, irrigation and hydropower. Every year, about 1,200,000 million m^3 of water flows from Himalayan rivers. The IHR is home to nearly 4% of the country's population and provides directly or indirectly for their livelihoods. The average land holdings are very small and less than a hectare per family. Most agriculture is of the subsistence type and depends on suitable weather for good yields. Animal husbandry is another source of income. Owing to the very small land holdings, families rely heavily on natural fodder resources, including the

forest areas, to feed their livestock. Economically vulnerable groups including the scheduled tribes and castes have high dependence on the forest resources including collection of fodder, medicinal plants and firewood. These ecosystem services are highly climate sensitive and the regional economy is thus more vulnerable.

The economy of the IHR is predominantly rural and highly dependent on climate-sensitive sectors such as the agri-horticultural and livestock sectors. Here, for example, increasing variations in precipitation (both rainfall and snow) and temperature can change the soil moisture availability, plant phenology, viable altitudinal range of plants and pest susceptibility. Eventually, these changes impact growth and yields from agriculture, horticulture and forest species. Rain-fed agriculture, horticulture and livestock are particularly impacted. An example is the falling apple yields; especially in lower altitudinal ranges in the western Himalaya, such as in Himachal Pradesh. Similarly, drying of natural springs, together with increase in pests, has impacted cardamom cultivation in the eastern Himalaya, for example, in South Sikkim District.[2]

The Himalaya have become highly vulnerable due to geological reasons, additional stress caused by exploitation of natural resources, increased population pressures and other related challenges. These effects are likely to be exacerbated due to the impact of climate change, which may adversely impact the Himalayan ecosystem through increased temperature, altered precipitation patterns, more recurrent episodes of drought and negative biotic influences. If average temperatures increase as predicted (increases in average temperatures and variations in rainfall patterns have already been observed in the region), all aspects of human and natural life will be affected. Locally, the ability of people to cope with will be challenged; further away, changes in the Himalaya—extreme rainfall events and glacier melt—could affect the lives and livelihoods of around millions of people living in the river basins downstream. Irrigation, livestock and rural drinking water supply depend heavily on springs as source. These are drying up and turning seasonal. On a broader regional perspective, a huge majority of Himalayan glaciers, the largest ice pack outside the poles, are retreating.[3] Yet, knowledge on the state of Himalayan glaciers and their evolution is still fragmentary due to their remoteness and as a result of a lack of long-term series for glacier area, length or mass balance changes.[4]

The IHR, over the last few years, has seen a rapid increase in the incidence and intensity of extreme weather events. Deaths and morbidity associated with extreme climate variability are also likely to increase. Climate change will have differentiated impacts, which will be more severe for women, children and for poor and marginalized groups in hill communities. As such, livelihood activities in the IHR have a higher level of sensitivity and a disproportionate exposure to climate change. Mountains have smaller farms and mostly rain-fed farming, leading to low productivities and income levels. Adoption of commercial farming (vegetables, fruit) has provided significant cash income in rural areas. Agriculture and livestock are at high risk from rainfall variability and extreme weather events. Women have high levels of labour responsibility for fuel wood, fodder and water, as well as in agriculture. Historically, migration has been an important element of an adaptive livelihood strategy, which, while obtaining cash income, leads to functionally women-headed households for much of the year. Connectivity adds an additional component of risk. In addition, climate change can adversely impact infrastructure—for example, extreme weather events can cause landslides, damage roads, critically impair connectivity, damage basic service installations

[2] Climate Change and India, A 4x4 Assessment, Indian Network for Climate Change Assessment, November 2010.

[3] Snow and glaciers of the Himalayas, Report, Space Application Centre, Ahmedabad, May 2011.

[4] Bolch *et. al*. (2012), The state and fate of Himalayan glaciers. *Science* (in review).

such as the water supply and drainage, etc. Likewise, many infrastructure or developmental projects may have adverse impacts on the climate.

Many of the above changes are already becoming visible in the IHR. While communities are trying to cope with these changes (autonomous as well as at collective levels), the interactions between different sectors, stressors, climate change, development, adaptation and mitigation are particularly complex in the IHR. Good data and information are needed to assess the current situation and to make reliable predictions that can be used as a basis for planning. At the same time, a good data and information base will enhance climate resilience for the future and also the improve quality of life in the present. On a geographical level, the sub-national entity, the state, acts as the focal point of climate change response. Preparation and implementation of SAPCCs thus forms a crucial cog in the strategy to address climate change, as most of the interventions aimed at improving the climate resilience/adaptation ability of the communities and public or private infrastructure and preserving the ecosystems are undertaken and implemented at the state level. Besides, technology improvements in production, consumption and other related sectors at the state level are also critical in enhancing the effectiveness of national policies for mitigation.

The Uttarakhand Context

Uttarakhand is most vulnerable to climate-mediated risks. Mountainous regions are particularly vulnerable to climate change and have shown 'above average warming' in the 20th Century. According to the Intergovernmental Panel on Climate Change (IPCC), impacts are expected to range from reduced genetic diversity of species to glacial melt in the Himalaya, leading to increased flooding, which will affect water resources within the next few decades.

The natural resources of the region provide life supporting, provisioning, regulating and cultural 'eco-system' services to millions of local as well as downstream people. The economy as a whole was characterized by low economic growth combined with high rates of population growth in the past. However, in recent times, the state has shown rapid economic growth (2.9% at the time of formation of the state to 7.87% at present[5]). The livelihoods are almost totally based on natural resources—water, forest, agriculture, etc. Uttarakhand has also been the fulcrum for environmental activism such as, for example, the *Chipko* movement. About three-fourth of state's population is rural and virtually all depend on agriculture. Tourism and animal husbandry are other sources of income.

With over 15 important rivers and over a dozen major glaciers, Uttarakhand is a valuable freshwater reserve. Hydel power continues to be a prime resource base for state's economy (with more than 200 large and medium-sized hydro-projects). A large portion of the state is under forests, with several forest-based industries. Climate change will have direct impacts on livelihoods as most of the economic and livelihood sectors are vulnerable to the impacts of climate change.

Some of the reported climate-change-induced changes in the Uttarakhand Himalaya include receding glaciers and an 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, a rise in temperature, an increasing intensity and frequency of flash floods and drying up of perennial streams.

[5] 2012-13, State-wise YoY Growth Rate (at 2004-05 prices), Planning Commission

Transforming Crisis into Opportunity

Climate change escalates the already existing vulnerabilities (social, ecological, economic and cultural) and inequities of Uttarakhand and could manifest disastrously if not addressed adequately. At the same time, the state has already begun a range of initiatives across various sectors for building adaptive resilience to climate change as well as supporting mitigation.

Existing Initiatives in Uttarakhand towards Building Resilience and Mainstreaming Adaptation

Uttarakhand, since its creation in the year 2000, has set up institutions and promoted programmes that are bound to facilitate mainstreaming various adaptation measures, build the resilience of vulnerable communities and households, deepen impacts of national missions and/or provide co-benefits through developmental interventions.

- **Disaster Mitigation and Management Centre (DMMC)—**building resilience of vulnerable communities and households against natural hazards and risks, search & rescue programmes, Standard Operating Procedures (SOPs) for addressing a range of natural calamities and hazards, with early warning systems;
- Constitution of 12,089 Community Forestry Councils (**Van Panchayats**) in more than 12,000 villages to anchor natural resource-based livelihoods programmes, Green India Mission and NM Sustaining Himalayan Ecosystems;
- **Watershed Management Directorate (WMD)** under Watershed Development Department with detailed multi-layer land-use details for 1110 micro-watersheds ready to operationalize Local Level Adaptation measures at the grass roots level;
- **Uttarakhand Space Application Centre (SAC)** with state-of-the -art facilities for remote sensing;
- **Uttarakhand Organic Commodities Board (UOCB)** for operationalizing organic farming and revitalizing rain-fed agriculture;
- Premier Agriculture Universities and ICAR Institutions of Excellence such as G.B. Pant University, Pantnagar and Vivekanand Parvatiya Krishi Sansthan, Almora are engaged in **releasing new varieties of seeds for cereals, vegetables** and **millets**, adapted to changed temperatures;
- **Deepening agriculture extension services to sub-block levels**, twice yearly, holding extension-cum-inputs provision “fairs” in the presence of agriculture scientists, providing alternate extension services for rain-fed-cum-organic agriculture on a very large scale.
- **Crop Insurance Schemes** for agricultural crops, fruits etc.
- **Constitution of Biodiversity Management Committee’s (BMCs)** and preparation of People’s Biodiversity Registers (PBRs)

The challenge for the state is to holistically converge these existing initiatives and make additional efforts to integrate climate concerns and response measures into all aspects of the development process, from policy and planning to implementation. The state has adopted this as the underlying principle in the formulation of the Uttarakhand Action Plan for Climate Change (UAPCC) and aims to become a green and carbon neutral state by 2020.

*****

Process Adopted for UAPCC Preparation

Initial Processes and Preparation of an Initial Draft

The state government initiated processes towards the preparation of the UAPCC and the State Council for Climate Change (SCCC) was constituted in 19 January, 2011 under the chairmanship of the Chief Secretary, comprising 29 members including Principal Secretaries/ Secretaries in charge of various line departments as well as other senior government officials. The SCCC was mandated to oversee all aspects of the state's preparations and initiatives to address climate change and its impacts.

The government identified the State Forest Department (SFD) as the Lead Agency to coordinate preparation of the UAPCC in consultation with various line departments and other relevant stakeholders and nominated Mr. Jai Raj, Additional Principal Chief Conservator of Forests (APCCF)—Environment as the State Nodal Officer to coordinate among different departments/agencies.

Eleven sectoral working groups (Agriculture, Forest, Water Resources, Livestock and Animal Husbandry, Health, Industry, Disaster, Energy, Road and Transport, Urban Development and Tourism) were constituted, each under a Principal Secretary/Secretary who drafted their sectoral papers. Inputs to the UAPCC were developed by the working groups by mid-2011, subsequent to various deliberations and interactive processes of developing sectoral inputs in the groups. The Chief Secretary took several rounds of meetings to facilitate the inputs from the various working groups, which were collated into an initial draft UAPCC, based on the Common Framework provided by the Ministry of Environment and Forests (MoEF), Government of India (GoI). The initial draft was circulated to solicit comments and inputs and also put up on the website of the State Forest Department so that anyone who wanted to share inputs could do so. United Nations Development Programme (UNDP) assisted the state government in these activities.

Revision Process and Preparation of a Revised Draft

After a process of initial review of the initial draft UAPCC and receiving inputs/comments on it, it was felt necessary to carry out a revision to fill in gaps and to update the document. UNDP assisted the state government with carrying out this process. A secondary review was carried out by the technical team, which recommended some changes to the existing draft. These included (i) the need for a more structured framework for the UAPCC, (ii) the need for the UAPCC to articulate an overarching state-level vision and commitment and the institutional architecture to guide, govern, support, coordinate and monitor implementation of the plan across various sectors and (iii) the need to incorporate additional elements in the plan including bringing in additional sectors, articulating the roles of the private sector, financial institutions, civil society and approaches to gender mainstreaming.

A timeline of processes undertaken in the revision process is given below (Table 1 and Figure 1).

Table 1: Timeline of UAPCC revision process/activities

Month/Dates	Process/Activity
March 2012	Revised framework for the UAPCC created in close consultation with APCCF, Mr Jai Raj and Dr R S Tolia, NTPC Chair, Doon University, Dehradun; guidance notes on new framework also prepared.
19 March, 2012	Meeting of key line department personnel and working group members organized at the behest of the Chief Secretary to discuss revision process and revised framework and guidance notes circulated.
19–27 March, 2012	One-on-one meetings with sectoral line departments and key working group members as well as several other stakeholders.
26–27 March, 2012	Two-day stakeholder consultation workshop (Garhwal Region) at Doon University, supported by World Wide Fund for Nature (WWF) India (Figure 2).
13–14 April, 2012	Two-day stakeholder consultation workshop (Kumaon Region) at Govind Ballabh Pant Institute for Himalayan Environment and Development (GBPIHED), Kosi Katarmal (Figure 3).
18 April, 2012	Revised draft submitted; put up to MoEF's Technical Review Committee.
19 April, 2012	MoEF Technical Review Committee grants prima facie clearance for UAPCC.
May, 2012	Penultimate version of UAPCC generated, uploaded on website for public access.
1 October, 2012	Civil society consultation on the UAPCC in Dehradun.
26-27 November, 2012	Expert consultation with Climate and Development Knowledge Network.
27 November, 2012	Round table on gender issues in UAPCC
January 2013	Generation of final edited version of the UAPCC
7 November 2013	Workshop on Climate Change with Ministers, MLAs, officials etc. of the State Govt. organised by the British Deputy High Commission, Chandigarh and the Confederation of Indian Industries, Uttarakhand Chapter
23 December 2013	Approval of UAPCC by the State Council of Climate Change presided by the Chief Secretary with the instructions to incorporate changes in the context of 16-17 June, 2013 natural disaster.
30 April 2014	One day State Consultation on Gender and Climate Change in the Indian Himalayan Region organised jointly by IUCN, Swiss Agency for Development and Cooperation (SDC) and Indian Himalayan Climate Adaptation Programme (IHCAP) held in Dehradun

Figure 1: UAPCC revision process meeting on 19 March 2012 at the Uttarakhand Secretariat

Figure 2: Consultations of 26–27 March 2012 at Doon University

The two-day stakeholder consultation workshops at Doon University and at the Govind Ballabh Pant Institute of Himalayan Environment and Development (GBPIHED), Almora were designed so that Day 1 of the workshop focussed on seeking voices/inputs from grassroots communities and representatives including *Pradhans* and *Pramukhs* from across the Garhwal region of the state and Day 2 focussed on dialogue with scientific and academic institutions as well as with civil society groups/organizations, with a view to soliciting inputs on (i) climate change and its impacts and (ii) mechanisms for connecting science (both basic and applied) and civil society to practice and policy in the UAPCC. Brief notes on the proceedings of the workshops are given in Annexure 1.

Figure 3: Consultations of 13–14 April at GBPIHED, Kosi Katarmal, Almora

The inputs received from the above processes have been used to revise the first draft of the UAPCC and create the revised draft. This draft was widely disseminated and comments/inputs were sought not only from the government but also from academia and research organizations, the private sector, civil society and other stakeholders. The inputs received on the initial draft have been incorporated.

The UAPCC is anyway intended to be a 'dynamic' document and will undergo periodic reviews and revisions and will be updated on an ongoing basis as the knowledge base broadens and as more data and evidence become available. The UAPCC therefore has to be perceived as an evolving document, with ample flexibility to internalize changes and developments occurring at the national, regional and local levels over time.

The draft UAPCC was submitted to the MoEF for technical review and an in-principle approval was received on 19 April, 2012 with a few comments/suggestions for improvement. These were incorporated and a penultimate version of the UAPCC was generated in May 2012 and uploaded on the forest department's website for public access and inputs. An additional civil society consultation was held in Dehradun on 1 October, 2012 and an expert consultation with the Climate and Development Knowledge Network (CDKN) on 26–27 November, 2012. Further, the country's first ever inter-departmental roundtable on mainstreaming gender in a State-level Action Plan on Climate Change (SAPCC) was hosted by the Uttarakhand Forest Department, the nodal departments for the Uttarakhand SAPCC (UAPCC), in collaboration with the Centre for Public Policy, Doon University; and supported by *Alternative Futures*, a Delhi-based development and policy research organization and Central Himalayan Environment Association (CHEA), a Nainital-based grassroots development organization. The invitation from Mr Jai Raj, Additional Principal Chief Conservator of Forests (APCCF), the nodal officer for the UAPCC, signalled the importance of integrating gender concerns in the UAPCC for all relevant departments. The day-long roundtable, inaugurated by Prof. V K Jain, Vice-chancellor, Doon University and chaired by Dr R S Tolia, former Chief Secretary and Chair, Centre for Public Policy at Doon

University, was held at the university campus on 27 November, 2012. The inputs from this workshop have been included in Annexure 1.

*****

Part A: Baseline Assessment

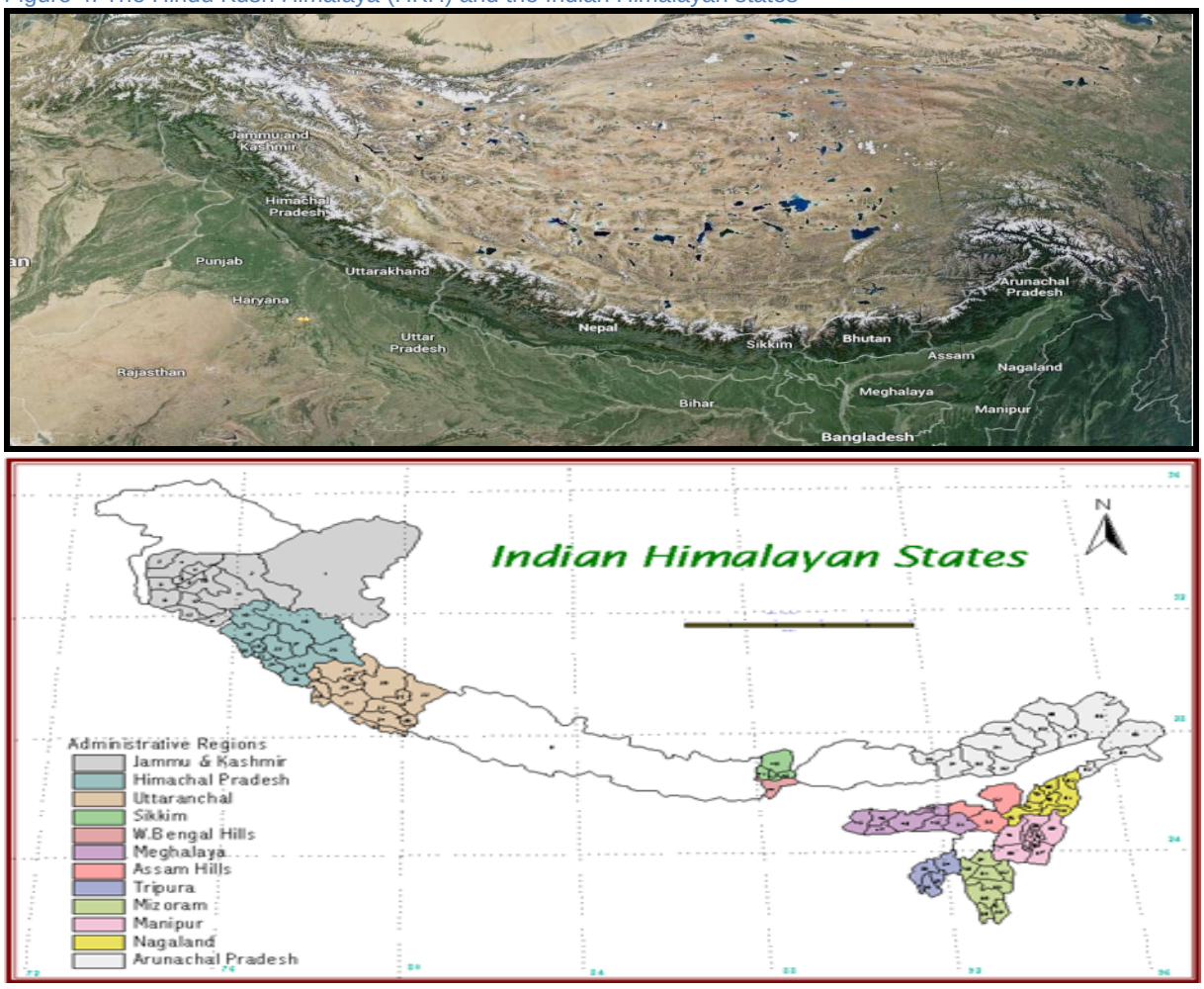
1 State Profile

1.1 Overview

1.1.1 Geographical Context—The Himalaya

The name 'Himalaya' has been derived from two Sanskrit words, *Hima* (snow) and *Alaya* (abode), 'the abode of snow'. The massive Himalayan arc extends over 2,500 km between Nanga Parbat (8,126 m), in the west and Namcha Barwa (7,755 m), in the east. Physiographically, starting from the Siwalik Hills in the south, the Himalayan mountain range extends to the Tibetan plateau in the north. The broad divisions are the Siwaliks, the lesser Himalaya, the greater Himalaya and the trans-Himalaya; extending almost uninterrupted throughout its length, separated by major geological fault lines (Figure 4).

Figure 4: The Hindu Kush Himalaya (HKH) and the Indian Himalayan states[6]



The higher regions of the Himalaya are snowbound throughout the year and in spite of their proximity to the tropics, the perpetual snow level seldom falls below 5,500 m. The Himalayan ranges encompass numerous glaciers (9,575); notable among them is the Siachen, which is the largest glacier in the world except the polar region. The Himalayan glaciers are the source for several large perennial rivers, which in turn further define and shape the mountain configuration and drain into major river systems of the continent. The IHR,

6 Sources: Google Maps © 2014 and The GBPIHED Envis Centre

including the Himalaya proper and the north-eastern hill states, lies between latitudes 21°57′ N and 37°5′ N latitudes and longitudes 72°40′ E and 97°25′ E, covering an area of 5,33,000 km^2. It stretches over 2,500 km from Jammu and Kashmir in the west to Arunachal Pradesh in the east, covering partially/fully 12 states of India, but its width varies from 150 km to 600 km at different places.

The region is vast, rugged and varied. The higher ranges remaining perpetually snowbound, overlooked by more than 13 peaks surpassing 7000 m in elevation. The IHR plays a vital strategic role in safeguarding the entire northern boundary of the nation. Apart from the national security standpoint, the Himalayan region is also important for its high forest cover. More than 65% of its geographical area is under forests, representing one-third of the total forest cover and nearly half (46%) of the very good forest cover of the country. More than 9,000 Himalayan glaciers and high-altitude lakes form a unique reservoir storing about 12,000 km^3 of freshwater. This reservoir releases its wealth to the rest of the country, mostly in a manner that sustains the lives of millions, deep into the plains.

1.1.2 Uttarakhand—Overview and Economy

Uttarakhand is one of the hilly states in the Indian Himalaya. Formerly a part of Uttar Pradesh (UP), Uttarakhand (formerly called Uttaranchal) (Figure 5) was created as the 27th state of the Indian Union on 9 November, 2000 by carving out the 13 hill districts of UP. It lies in the northern part of India between the latitudes 28°43′ N and 31°27′ N and longitudes 77°34′ E and 81°02′ E, having a maximum dimensions of 301 km in the east-west direction and 255 km in the north-south and covering an area of 53,483 km^2. The elevation ranges from 210 to 7817 m. The state shares its border with China (Tibet) in the north, Nepal in the east, inter-state boundaries with Himachal Pradesh in the west and north-west and UP in the south.

Figure 5: Uttarakhand and its districts

Broadly, the region constitutes of 13 districts falling in two major administrative units, viz., Garhwal (north-west portion) and Kumaon (south-east portion). Garhwal Division consists of seven districts, i.e. Dehradun, Haridwar, Uttarkashi, Tehri, Pauri, Rudraprayag and Chamoli, while the remaining six districts, viz., Pithoragarh, Bageshwar, Almora, Nainital, Champawat and Udham Singh Nagar, fall in Kumaon Division (Table 2).

Hindi, Garhwali and Kumaoni are commonly spoken in the state. English is the medium of education in many of its schools.

Table 2: General and economic profiles[7]

General Profile	
State formed on	9 November 2000
Total area	53,483 km^2
Total forest area	34,651 km^2
Capital	Dehradun (temporary)
Total number of districts	13
High Court	Nainital
Main crops	Rice, barley, maize
Main fruits	Apple, litchi, plum, peach, malta
Main rivers	Bhagirathi, Alaknanda, Mandakini, Pindar, Tons, Yamuna, Kali, Bhilangna, Sarayu, Ramganga
Main tourist and historic places	Nainital, Mussoorie, Pauri, Almora, Ranikhet, Khirsu
Main religious places	Badrinath, Kedarnath, Gangotri, Yamunotri, Panchakedar, Panchabadari, Panchaprayag, Haridwar, Rishikesh, Hem Kund Sahib
Population density (persons/km)	189
Total population (millions)	10.11
Decennial growth rate (2001–2011)	19.17%
Male population (millions)	5.15
Female population (millions)	4.96
Sex ratio (females per 1,000 males)	963
Literacy rate (%)	79.6
Economic Profile	
GSDP (₹ crore) (2011-12) factor cost	60,898
Per capita income (₹) (2011–2012) (current prices)	94,944
CAGR (%) (2004/05 to 2009/10)	12.9
Key industries	Auto and auto-components, agro and food processing, paper, machinery and equipment, pharmaceuticals, FMCG, tourism, hydro power, saw mills, plywood and resin factories and other forest-based industries
Key industrial areas	Haridwar, Dehradun, Sitarganj, Rudrapur

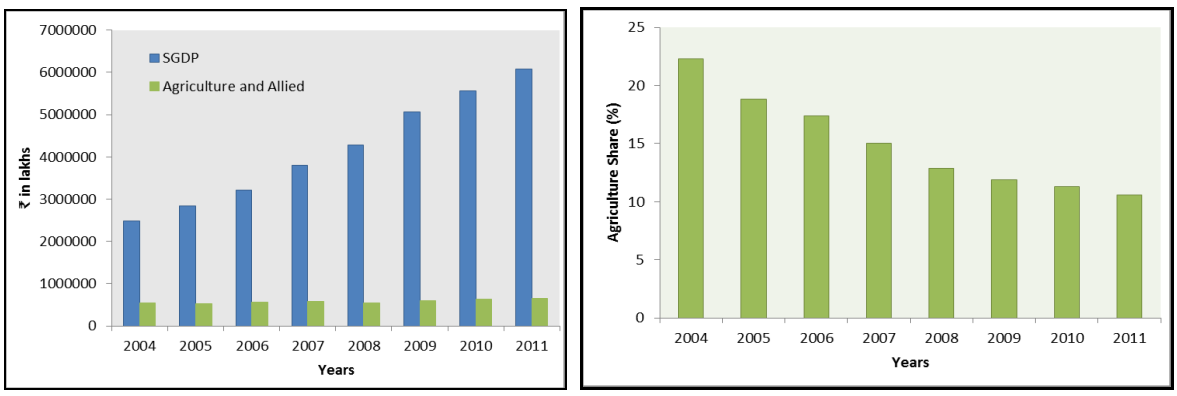
The Gross State Domestic Product (GSDP) stood at ₹60,898 crore in 2011-12 as against ₹55,536 crore in 2010-11, registering a growth of 9.65%. The state's Gross Domestic Product

[7] All demographic information is from the 2011 Census data. Economic data are from CII's Uttarakhand Investment Climate Report, November 2011 and Uttarakhand at a Glance 2012-13. For detailed information and state statistical data, see http://des.uk.gov.in/pages/display/61-uttarakhnad-at-a-glance

(GDP) registered a compounded annual growth rate (CAGR) of 12.9% between 2004-05 and 2009-10 as against the national average of 8.6%. However, its contribution to the national GDP was only about 1% during 2011-12. The state derives most of its GSDP from services and secondary sectors, with shares of 52% and 37% during 2011-12, respectively. Services sector registered a CAGR of 14.1%, while the secondary sector grew at a CAGR of 18.3% during the period from 2004-05 to 2009-10. This growth is largely driven by sub-sectors such as manufacturing, transport, warehousing, communication, trade, hotels and restaurants, financing, insurance, real estate and business services. Manufacturing recorded the highest CAGR, 27.5%, followed by trade, hotels, transport, storage and communication, with a CAGR of 16.8%. Agriculture and allied sub-sectors, which are part of the primary sector, grew by 1.55%. The growth of agriculture and allied sub-sectors was 4.62% in the year 2006/07, which has slowed down thereafter. Leisure, adventure and religious tourism play a prominent role in Uttarakhand's economy, with Corbett Tiger Reserve and hill stations being amongst the most frequented destinations. Other national wonders include the Valley of Flowers, which along with Nanda Devi National Park, is a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site. After attaining statehood, the economic progress of Uttarakhand has been rapid, with its economic growth rate increasing from just less than 3% per annum to surpassing 10% per annum. However, this rapid growth has been accompanied by an adverse impact on the local ecology, thus making the incorporation of sustainable development practices into the state's overall development strategy imperative. The Government of Uttarakhand has responded by making sustainable development an important element in the state's growth strategy.

Given the terrain of the state and its favourable climatic conditions, agriculture continues to be the major source of income for more than three fourths of the state's population. Agriculture and allied activities, with a share of about 11% (at constant 2004-05 prices) during 2011-2012, is a significant contributor to the state domestic product as against the national average of 14.1%. The size of agriculture and allied sub-sectors is growing; however, the share of agriculture and allied sub-sectors in the GDP is decreasing due to the increasing contribution of other sectors during the period from 2004-05 to 2011-12 (Figure 6). The state hosts several climatic zones, which gives it an edge in developing activities based on floriculture, fruits and nuts, vegetables and vegetable seeds. Given that Uttarakhand has significant area under forests, forestry and logging were a key component of the agricultural GDP (26.06% of the agricultural GDP) during 2011-12. The productivity of most of the crops in the state was less than the national average during the period from 1999-2000 to 2011-12 as more than half of the agricultural area is in hilly regions.

Figure 6: State GDP and contribution of Agriculture[8]



[8] GSDP, Uttarakhand, Ministry of Statistics and Programme Implementation

The per capita income (at current prices) of Uttarakhand registered a CAGR of 21.2%, from ₹24,740 in 2004-05 to ₹94,944 in 2011-12, whereas the per capita income of India increased by a CAGR of 14.0% 2004-05 to 2009-10. The state's per capita income is higher than the all-India average. In Uttarakhand, the Gini Coefficient[9] (2004-05 uniform recall period (URP)) for rural and urban areas is 0.28 and 0.32, respectively. It remains below the national average of 0.30 and 0.37 for rural and urban areas, respectively. Thus, the income disparity in the state is comparatively less skewed than that of India.

1.1.3 Uttarakhand—Human Development

UNDP data[10] suggest that Uttarakhand's Human Development Index (HDI) and the corresponding Inequality Adjusted Index (IHDI) stand at 0.515 and 0.345, respectively. The state's HDI and IHDI ranks among Indian states were 7 and 10, respectively. Considering the state's HDI ranking of 18 in 2005, it has made significant progress in human development since then.

The infant mortality rate (IMR) in Uttarakhand is estimated at 41 deaths per 1,000 live births for 2009 as against 48 for 2001.[11] The IMR for the state is better than the all-India average. The Crude Birth Rate (CBR) and Crude Death Rate (CDR) stand at 19.7 and 6.5, both slightly below the national average.[12] The health infrastructure in the state fares moderately on most of the health infrastructure indicators. It is evident that the state is better placed in terms of the number of Sub-Centres, Primary Health Centres (PHCs) and Community Health Centres (CHCs). There are 8 beds per 10,000 population in Uttarakhand (2008)[13] as against the national figures of 4 beds per 10,000 population (2008).

The overall literacy rate in Uttarakhand is 79.6%, which is higher than the national average of 74.0%. Male literacy in the state stands at 88.3%, while female literacy is 70.7%. The all-India male and female literacy levels are 82.1% and 65.5%, respectively. The state is better placed as compared with India as a whole in the case of literacy, Gross Enrolment Ratio (GER), pupil–teacher ratio and dropout rate.[14] The state has about 1.2%, 1.7% and 4.6% of the total number of government middle, high and senior secondary schools of the country, respectively. About 72% of the schools in the state are government schools and 28% are private schools.[15] This shows that the government plays a significant role in the education sector.

1.1.4 Hill Districts, Livelihoods and Vulnerabilities

The hill region districts are relatively less developed in terms of infrastructure, i.e., electricity, roads and irrigation. The inter-district inequality in infrastructure has resulted in increasing disparity in terms of income and livelihood between the hills and the plains. The land holdings are small and fragmented and irrigation facilities are limited. Soil and water conservation is another limiting factor for inclusive development. For physical, geographical and environmental reasons, the scope for agricultural policies based on modern input-intensive agriculture is severely constrained in the hill regions. The marketable surplus in hill

---

9 The Gini Coefficient is a measure of the inequality of a distribution, a value of 0 expressing total equality and a value of 1 maximal inequality.

10 M.H. Suryanarayana, Ankush Agrawal and K. Seeta Prabhu, *Inequality-Adjusted Human Development Index for India's States*. UNDP-India 2011.

11 SRS Bulletin, January 2011.

12 *ibid*

13 RHS Bulletin, 2010, Ministry of Health and Family Welfare, Government of India.

14 Census of India 2011, Selected Education Statistics 2007-08.

15 Selected Education Statistics 2007-08, MHRD.

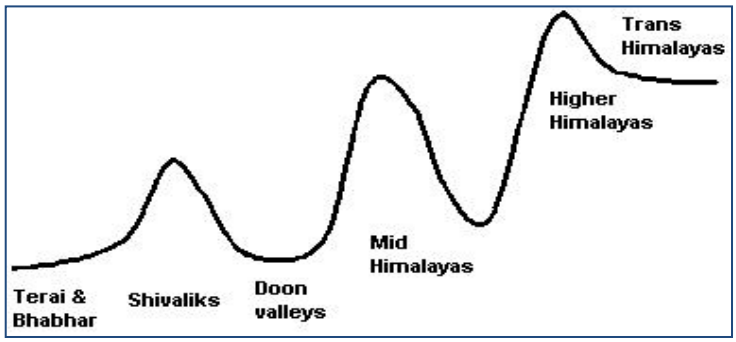
situations is low, marketing facilities are limited and marketing malpractices are prevalent. The remoteness and inaccessibility of hilly areas also inhibit the transfer of technology. The credit infrastructure and facilities in the remote areas are lacking. As a result, most of the rural population in the hills either survives on subsistence agriculture or migrates to other parts of the country for employment, leaving their lands untilled and fallow. The state faces the challenge of promoting livelihoods to retain people through local employment and income generation and to enhance their quality of life. Hill development remains an uphill challenge as out-migration of local peoples continues from the highland hinterlands.

1.2 Geological and Agro-Ecological Settings

1.2.1 Physiography

The Uttarakhand Himalaya is divided into the distinct non-montane and montane physiographic zones (Figure 7) as follows:

Figure 7: Physiographic zones of Uttarakhand



A. Non-montane

i. *Bhabhar:* This is a level surface zone at the foothills of the Himalaya, 34 km wide, where the Himalayan torrents rush down from the steep slopes and disappear under boulders and gravels due to the extremely porous soil type of the Bhabhar.

ii. *Tarai:* Situated below the Bhabhar and parallel to it, the Tarai is a marshy and damp tract (once 80–90 km wide) containing fertile soils with good water retention capacity.

B. Montane

i. *Sub-Himalaya:* Called the Sub-Himalaya because it possesses the least Himalayan features. It consists of two zones, the Shivaliks, the youngest of the Himalayan ranges and the Doon (flat longitudinal structural valleys) to the north of the Shivaliks. The Shivaliks extend in a narrow varying width of 6 to 30 km, with altitudes of 300–1,000 m.

- *Mid Himalaya:* This zone extends in a varying width of 60–90 km in an abrupt rise in elevation between 1,000 m and 3,000 m. It contains two types of physiographic sub-units: the Himachal ranges and the Himachal valleys and lake basins.

ii. *Greater Himalaya:* This zone has a varying width of 40–60 km. The altitude varies between 3000 and 7,000 m. Except for the lower valleys, this zone is perpetually

covered with snow and hence it is called Himadri. The region covers glacial landforms above 3,000 m.

iii. *Trans-Himalaya:* Also known as the Tethys Himalaya and the Indo-Tibet plateau, the region is in the rain shadow of the Greater Himalaya and is therefore a cold desert; the region is within the watersheds of Ganga and Sharda.

1.2.2 Agro-climatic Zones

The state has two distinct climatic regions: the predominant hilly terrain and the small plain region. The climatic conditions of Uttarakhand vary greatly due to variations in altitude and proximity towards Himalayan ranges. The climatic conditions of the plains are very similar to those in the Gangetic plain, i.e. tropical conditions. Summers are relatively hot and winters are chilly, with temperatures going below 0°C. The lowest temperature recorded is –3.0°C at Mukteshwar and the highest is 43.2°C at Pantnagar. The extremes can further intensify, depending upon the coverage of meteorological observatories.

The average rainfall in the state varies from 92 cm, in Srinagar, to 250 cm in Nainital. However, spatial distribution of the rainfall varies, depending upon the geographical location and slope and aspect of the place. The amount of rainfall is generally high in low mountainous regions such as Nainital and Dehradun and it gradually decreases with increasing height. About three-fourths of the total rainfall is confined to the monsoon season and remaining one-fourth occurs in other seasons due to the western disturbances and local orographic effects. The monsoonal activities generally start in the later part of June and pick up in July/August. The temperature and precipitation distributions and overall climatic conditions of the various districts of Uttarakhand are shown in Figures 8, 9 and 10, respectively.

Figure 8: Temperature regimes in Uttarakhand (interpolated data)

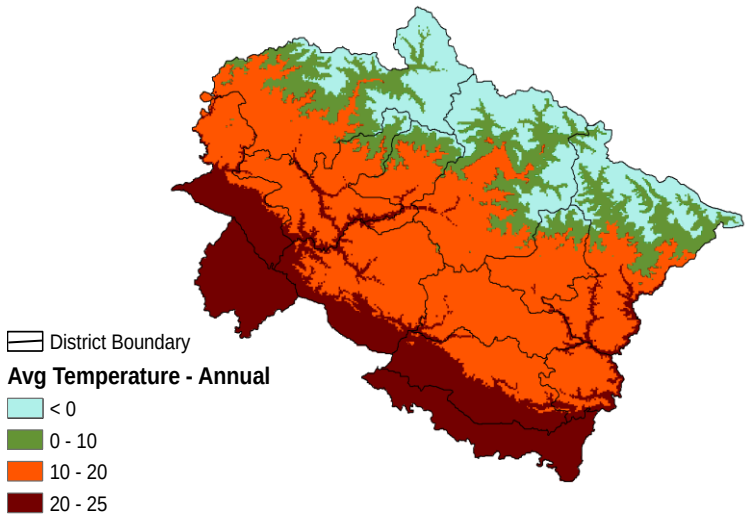


Figure 9: Distribution of precipitation over Uttarakhand (interpolated data)

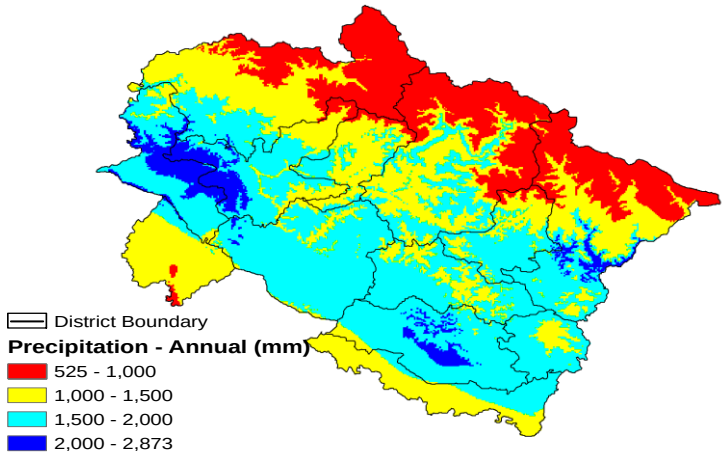
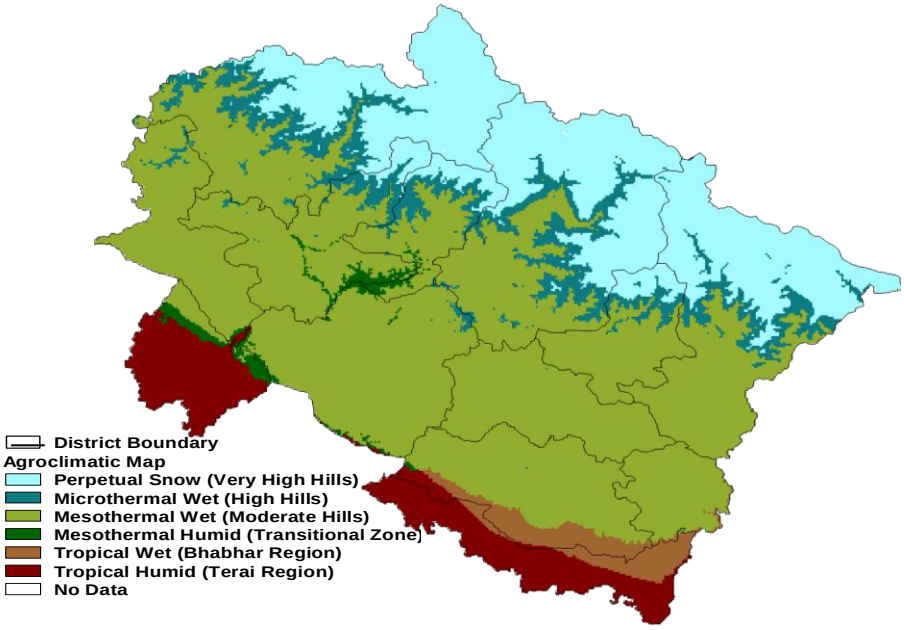


Figure 10: Overall climatic conditions in Uttarakhand



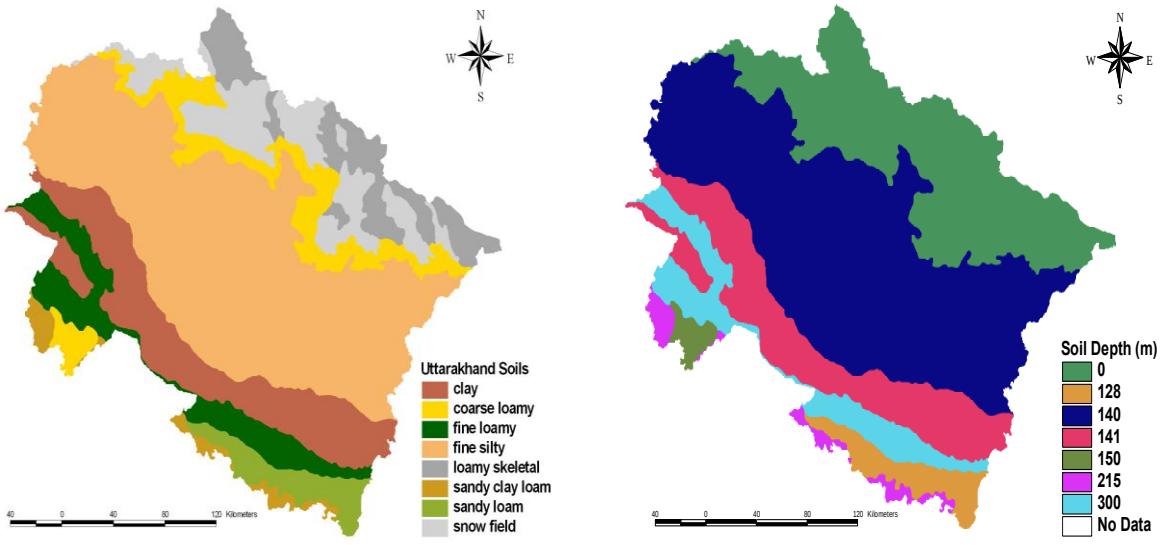
Details of the various altitudinal zones of the state such as soil type and crops produced are provided district wise, along with the rainfall distribution in these zones, in Table 3 (Figure 11).

Table 3: Altitudinal zones of Uttarakhand, their attributes, major produce and livestock

S.No.	Zone	Farming situation	Soil	Rainfall (mm/ year)	Districts	Principal farm produce and livestock
1.	Zone A, up to 1,000 m	Tarai irrigated	Alluvial	1400	U.S. Nagar, Haridwar	Rice, wheat, sugarcane, lentil, chickpea, rapeseed-mustard, mango, litchi, guava, peach and plums. Livestock: Buffalo and cattle.
		Bhabhar irrigated	Alluvial mixed with boulders	1400	Nainital, Dehradun and Pauri Garhwal	Rice, wheat, sugarcane, rapeseed-mustard, potato, lentil, mango, guava and

S.No.	Zone	Farming situation	Soil	Rainfall (mm/ year)	Districts	Principal farm produce and livestock
			and shingles			litchi. Livestock: Buffalo and cattle
		Irrigated lower hills (600–1000 m)	Alluvial sandy soil	2000–2400	Champawat, Pauri, Dehradun, Garhwal, Nainital, Garhwal, Tehri	Rice, wheat, onion, chillies, peas, potato, radish, cauliflower, pulses, oilseeds, soybean, mango, guava, plums and peaches. Livestock: Buffalo and cattle
		Rain-fed lower hills (600–1000 m)	Residual sandy loam	2000–2400	Champawat, Pauri Dehradun, Garhwal, Bageshwar, Nainital, Garhwal, Tehri	Finger millet, maize, rice, wheat, pulses, mango, guava, plums and peaches. Livestock: Buffalo, cattle and goat
2.	Zone B, 1000–1500 m	Mid hills, south aspect (1000–1500 m	Sandy loam	1200–1300	Champawat, Nainital, Almora, Dehradun, Tehri Garhwal, Bageshwar	Rice, finger millet, wheat, potato, tomato, peas, Cole crops, pulses, peaches and plums. Livestock: Cattle, sheep and goat
3.	Zone C, 1500–2400 m	High hills (1500–2400 m)	Red to dark	1200–2500	Pithoragarh, Almora, Chamoli, Bageshwar	Amaranth, finger millet, French beans, ole crops, potato, peas, peaches, plums, pear, apple, stone fruits. Livestock: Cattle, sheep and goat.
4.	Zone D, >2,400 m	Very high hills	Red to black clay	1300	Pithoragarh, Chamoli, Uttarkashi	Amaranth, buckwheat, peas, cole crops, apple and potato. Livestock: Sheep, goat.

Figure 11: Uttarakhand soils and soil depth mapping by NBSS&LUP



Soil is one of the most important natural resources and the biodiversity of a region strongly depends upon soil and climatic elements. Soil also greatly influences the productivity of

agro-ecosystems. Soil resources in Uttarakhand vary from the deep, alluvial and fertile soils of the Tarai tract to the recently laid down alluvium of the dun valley; the thin fragile soil of the Shivalik hills; the black soils of the temperate zone; and the arid, bare soil of the inner dry valleys. Soils in the bottom of valleys are more fertile than those found on the ridge top due to the presence of a large quantity of humus, mineral nutrients and moisture and due to the suitable soil depth. This natural resource is depleting gradually, day by day, as soil erosion in the area is increasing with the increase in deforestation and degradation. Various classifications of the types of soils of Uttarakhand exist.

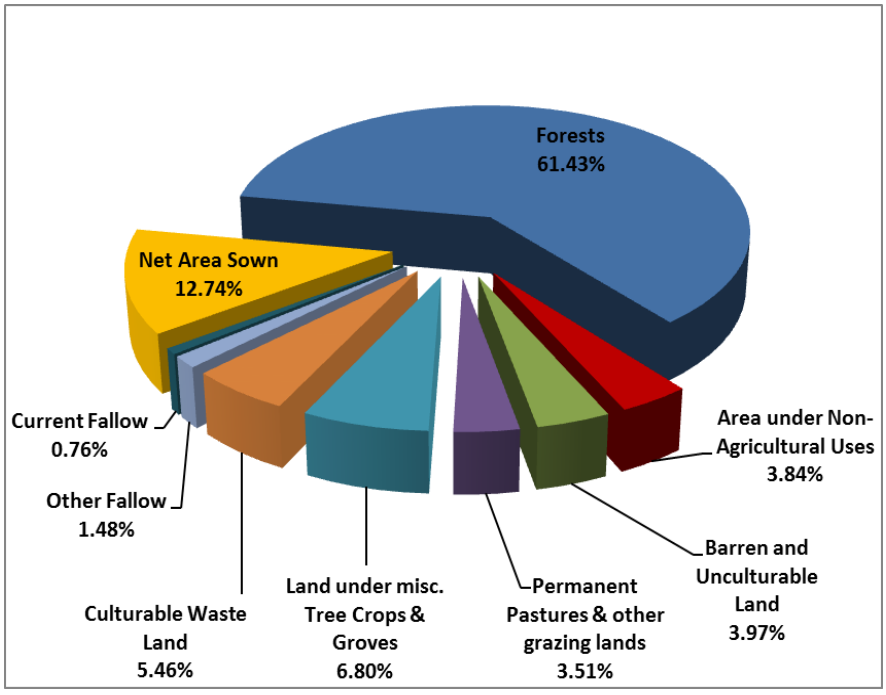
On the basis of soil texture, the National Bureau of Soil Survey & Land Use Planning (NBSS&LUP), Nagpur has divided the soils of Uttarakhand into eight different categories,[16] namely sandy loam, sandy clay loam, fine loam, fine silt, clay, coarse loam, loamy skeletal and snow field.

1.2.3 Land-use Pattern

Owing to its largely mountainous regions, the state is endowed with unique ecosystems. The northern region of the state is part of the great Himalayan range, covered with snow and glaciers. Two of the Indian sub-continent's major rivers – the Ganga and the Yamuna – also originate from the glaciers of Uttarakhand. Other parts of Uttarakhand are covered with dense forests that make up the bulk of the natural resources base.

As in most other hill economies, the people of Uttarakhand practice integrated systems of farming, forestry, horticulture, livestock rearing and off-farm activities. According to the 2010-11 records, the land use pattern in the state is given in Figure 12[17]. However, there has been a significant change in forest cover that has become 71.05% of the total geographical area in 2012-13[18]

Figure 12: Land-use pattern in Uttarakhand



[16] NBSS&LUP carried out a survey and sampling of soils several years ago, and thus the present soil pattern in the state may vary from the soil types reported by them. Therefore, there is an urgent need to conduct a comprehensive survey and sampling of the soils using the modern technologies of automated analysis, remote sensing, GIS and GPS.

[17] Department of Agriculture and Cooperation, Ministry of Agriculture, GoI; http://eands.dacnet.nic.in/LUS_1999_2004.htm

[18] Uttarakhand Forest Statistics 2012-13

1.2.4 Forest Cover

The area under forest in Uttarakhand is 3.4 million hectares, which constitutes 61.45% of its total land available for utilization. By legal status, reserve forests constitute 71.08%, protected forests 28.51% and unclassified forests 0.41% of the total forest area. The major forest types occurring in the state are Tropical Moist Deciduous, Tropical Dry Deciduous, Sub-tropical Pine, Himalayan Moist Temperate, Sub-Alpine and Alpine Forests. Forests are largely distributed throughout the state, with conifers and Sal being the major forest formation.

1.2.5 Hydrological Setting

The predominantly hilly state of Uttarakhand has a varied hydrogeological set-up and can be divided broadly into two distinct hydrogeological regimes, viz. the Gangetic alluvial plain and the Himalayan mountain belt. The former is covered with a vast expanse of alluvium and unconsolidated sedimentary material of varying size fractions (ranging from boulder to clay) and is a promising zone for ground water development. The latter zone, being predominantly hilly, offers much less potential for large-scale development of ground water. Ground water in the hilly region occurs mostly in fissures/fractures and emerges as springs. The springs are amenable to small-scale development of ground water resources in the state. The yield of tube wells in the Shivalik formation ranges from 50.4 m^3/h to 79.2 m^3/h and in the Bhabhar formations the yield is up to 332.4 m^3/h. In the Tarai belt the yield of tube wells ranges from 36 m^3/h to 144 m^3/h and in the Indo-Gangetic plains the yield varies from 90 m^3/h to 198 m^3/h.

1.2.6 Major River Basins and Sub-basins

The main drainage system of Uttarakhand has been grouped into the following six catchments:

Yamuna Catchment. The Yamuna River originates from the base of Bandarpunch peak. It has carved a deep V-shaped gorge. The Yamuna cuts across the Nag Tibba range and Mussoorie range near a place called Yamuna Bridge. The rivers Tons, Pabar and Aglar are its important tributaries. It passes through the Doon valley at its western boundary.

Bhagirathi Catchment. This is one of the two rivers that join to form the River Ganga. It originates from the snout of the Gangotri glacier at Gaumukh, which is at the base of Chaukhamba peak. The Bhagirathi River has cut a deep gorge across the granitic rocks of the higher Himalaya of Garhwal. Its main tributaries are the river Janhavi and the Bhilangna.

Alaknanda Catchment. The Alaknanda River joins the River Bhagirathi at Devprayag to form the River Ganga. It originates from the eastern slopes of Chaukhamba, from the Bhagirathi Kharak and Satopanth glaciers. The river flows by the side of the Badrinath temple. Its main tributaries are the Khiraonganga, Pindar Dhauliganga, Birahi, Nandakini, Mandakini, etc. It has formed a broad valley at Srinagar (Garhwal).

Mandakini Catchment. It comes out from the Mandakini glacier near Kedarnath. It cuts through a gorge of glacial debris. The river has formed road terraces at Augustmuni and Tilwara. At Tilwara, it is joined by the River Lastar Gad. The River Mandakini joins the river Alaknanda at Rudraprayag.

Pindar Catchment. The River Pindar originates from the Pindari Glacier, which is located between Nanda Devi and Nanda Kot peaks. The Sundardhunga River joins the Pindar near Dhakuri. The Pindar joins the River Alaknanda near Karanprayag.

Kali Catchment. The River Kali forms the boundary between Kumaon and Nepal. The Kali River forms the border between Nepal and the border districts of Pithoragarh and Chamoli. The main tributaries of the Kali are the Ladiya, Sarayu-Ramganga East, Goriganga, Dhauliganga East and Kuti Yangte.

The Land Survey Directorate (LSD) has divided Uttarakhand into eight catchments, which are divided into 26 watersheds. These are divided into 110 small watersheds and finally there are 1,110 micro watersheds.

Natural Lakes and Reservoirs. Uttarakhand has 31 natural lakes covering an area of about 300 ha. The state is endowed with eight large-sized man-made reservoirs in Tehri and Udhamsingh Nagar districts, covering an area of 20,075 ha. The Tehri dam is the largest dam in Uttarakhand, followed by Sharda Sagar reservoir, with a water area of 6,880 ha and Nanak Sagar reservoir, with a water area of 4,084 ha. These reservoirs are owned by the Irrigation Department. Additionally there are a total of 1,545 small ponds/tanks covering an area of 604 ha in the state. The reservoirs are generally used for irrigation.

******

2 Climate Profile

2.1 Future Climatic Projections

2.1.1 Possible Future Climate Scenarios for India and the Himalayan Region[19]

The projections/forecasts of climate change in the Himalayan region according to the 4 × 4 assessment made by the MoEF are summarized below (Table 4, Figure 13).

Figure 13: Temperature projection for India for 2030s for (a) December, January, February and (b) June, July, August—4 × 4 assessment

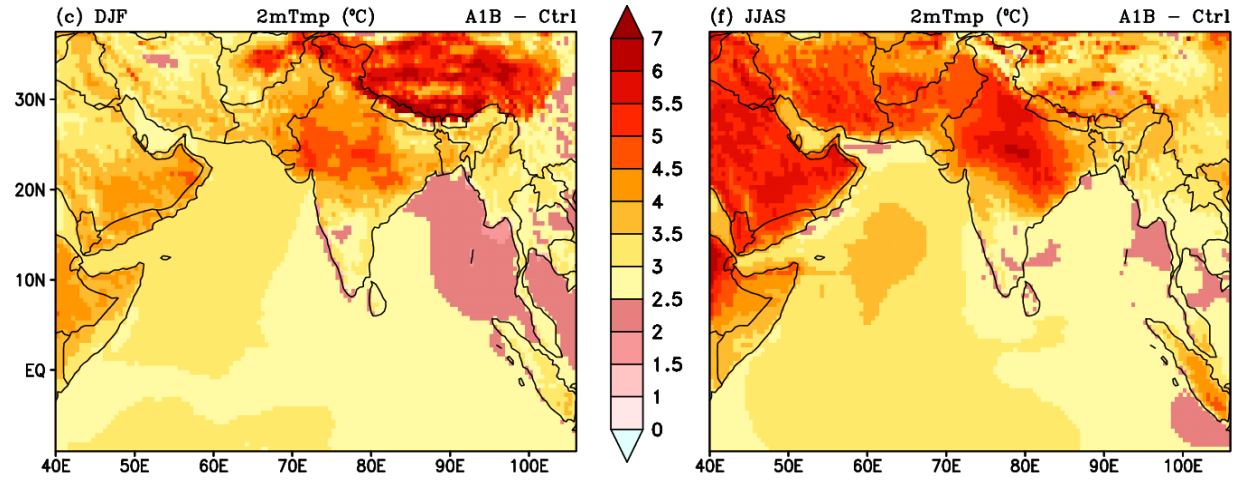


Table 4: Projected climate change parameters in 2030s with respect to 1970s—4 × 4 assessment

Features		Himalayan region
Temperature		Increase
Precipitation		Increase
Extreme temperature		Increase
Extreme precipitation	Intensity	Increase
	Number of rainy days	Increase

2.1.2 Annual Mean Temperature

Most parts of India show a warming trend, except the north-western parts of the country, where a cooling trend is observed. All the seasons show significant warming trends except after the monsoons, where the trend is positive but not significant. For India as a whole, a significant decreasing trend in the frequency of cold days and an increasing trend (close to 5% significant level) in the frequency of hot days have been forecasted. A warming trend has been forecast for the sea surface temperature of the north Indian Ocean region. The seasons may be warmer by around 2°C towards the 2030s.

Himalayan region: The annual temperature has been forecast to increase from 0.9°C ± 0.6°C to 0.6°C ± 0.7°C in the 2030s. The net increase in temperature ranges from 1.7°C to

[19] All figures and data in this subsection are quoted from Climate Change and India, A 4 × 4 Assessment, Indian Network for Climate Change Assessment, November 2010.

2.2°C with respect to the 1970s. Seasonal air temperatures are also forecast to rise in all seasons. However, winter temperatures (during October, November and December) are likely to decrease by 2.6°C in the 2030s with respect to the 1970s.

According to the forecast of the 4 × 4 study, there is likely to be an increase in the Temperature–Humidity Index (THI) in many parts of the Himalayan region between March and September, with a maximum rise between April and July. In the Himalayan region, thermal discomfort is likely to increase in the 2030s, with the THI > 80, thereby indicating that in the 2030s, most places in this region are likely to remain under a high temperature stress. The simulated seasonal and annual rainfall and mean temperature for the Himalayan region (baseline and A1B scenario) as simulated by PRECIS are presented in Table 5.

Table 5: Characteristics of simulated seasonal and annual rainfall and mean temperature for the Himalayan region (baseline and A1B scenario)

Himalayan	Rainfall (mm)					Mean temperature (°C)				
Q0	**JF**	**MAM**	**JJAS**	**OND**	**Annual**	**JF**	**MAM**	**JJAS**	**OND**	**Annual**
Means										
1970s	141	315	551	202	1208	-13.3	0.6	10.1	7.0	-0.4
2030s	144	307	615	203	1268	-10.6	5.8	12.1	-4.4	1.3
Standard deviations										
1970s	71.9	101.5	101.3	103.1	173.4	1.8	1.3	0.4	1.4	0.6
2030s	99.0	86.2	115.8	125.8	225.2	1.4	1.8	0.6	1.0	0.7

Himalayan	Rainfall (mm)					Mean temperature (°C)				
Q1	**JF**	**MAM**	**JJAS**	**OND**	**Annual**	**JF**	**MAM**	**JJAS**	**OND**	**Annual**
Means										
1970s	176	346	412	221	1154	-11.8	-0.2	0.9	-6.8	-0.8
2030s	201	361	449	216	1227	-9.6	1.7	10.1	-5.2	0.9
Standard deviations										
1970s	70.6	100.7	57	98.4	169.7	1.4	0.9	0.6	0.8	0.4
2030s	84.1	79.1	67.4	84.7	164.6	1.5	1.0	0.5	1.2	0.6

Himalayan	Rainfall (mm)					Mean temperature (°C)				
Q14	**JF**	**MAM**	**JJAS**	**OND**	**Annual**	**JF**	**MAM**	**JJAS**	**OND**	**Annual**
Means										
1970s	232	355	527	284	1398	-12.0	0.9	10.9	-0.6	0.4
2030s	232	399	612	362	1604	-9.9	2.9	12.9	-3.2	2.6
Standard deviations										
1970s	123	94.3	86.1	115.6	175.2	1.4	1.3	0.3	0.9	0.4
2030s	89.1	121.8	100.2	126.6	175.2	1.4	1.2	0.8	1.0	0.7

2.1.3 Rainfall and Monsoon

Increasing trends of rainfall are forecast for north-west India, the west coast and peninsular India. The 4 × 4 assessment forecasts that a rainfall of 10 cm/day may be an extreme for the north-west region, whereas it may not be a significant amount for the north-east region or along the west coast of India during the summer monsoon. The 4 × 4 assessment for precipitation forecasts a 3 to 7% overall increase in the all-India summer monsoon rainfall in the 2030s with respect to the 1970s. However, on a seasonal scale, except for the Himalayan region, all other regions are expected to have lower rainfalls in winter as well as in the pre-summer period.

Himalayan region: According to the 4 × 4 assessment, the annual rainfall in the Himalayan region may vary between 1268 ± 225.2 mm and 1604 ± 175.2 mm. The precipitation that has been forecast shows a net increase in the 2030s with respect to the simulated rainfall of the 1970s in the Himalayan region by 60 to 206 mm. The increase in the annual rainfall in the

2030s with respect to that of the 1970s ranges from 5% to 13%. All seasons in the Himalayan region are forecast to have an increase in rainfall, with the maximum increase in rainfall forecast to be in the monsoon months of June, July, August and September, 12 mm. The winter rain in the months of January and February is also forecast to increase by 5 mm in the 2030s with respect to the 1970s, with the minimum increase being in October, November and December. The Himalayan region is mainly fed by the Indus river system. The whole area is expected to experience an increase in precipitation in the 2030s scenario. The increase varies between 5% and 20% in most areas, with some areas of Jammu and Kashmir and Uttarakhand showing an increase of up to 50%. The general impact of the increase in precipitation is expected to be an increase in the sediment yield. The increase in the sediment yield in the Himalayan region is up to 25%, which can be detrimental for the existing water resources projects and has the potential to cause considerable damage to the environment.

Projections of extreme precipitation: On any particular day, if more rainfall than 2.5 mm is received, the day is considered to be a rainy day. In simulations, the frequency of rainy days is more in east and north-east India and less over western India. Q0, Q1 and Q14 simulations for the 2030s, however, indicate that the frequency of the rainy days is set to decrease in most parts of the country, except in the Himalaya, the north-western region and the southern plateau. The intensity of the rainy days increases more in the intense warming scenario Q14 with respect to simulations Q0 and Q1. However, a Q14 simulation suggests a decrease in the intensity of rainy days over the Western Ghats and northern India and an increase in the intensity by 2–12% in the Himalayan region, north-eastern region, western and north-western regions and the south-eastern coastal regions.

Projected changes in temperature extremes: Analysis of the three model simulations indicates that both the daily extremes in surface air temperature may intensify in the 2030s. The spatial pattern of the change in the lowest daily minimum and highest maximum temperatures suggests a warming of 1°C to 4°C towards the 2030s. Over the entire Indian landmass, this value exceeds 40°C, except over the mountainous regions and the west coast. PRECIS simulations for the 2030s indicate an all-round warming over the Indian subcontinent associated with increasing greenhouse gas concentrations. The annual mean surface air temperature rise by the 2030s ranges from 1.7°C to 2°C as in the three simulations.

2.2 Observed Climate Trends in Uttarakhand

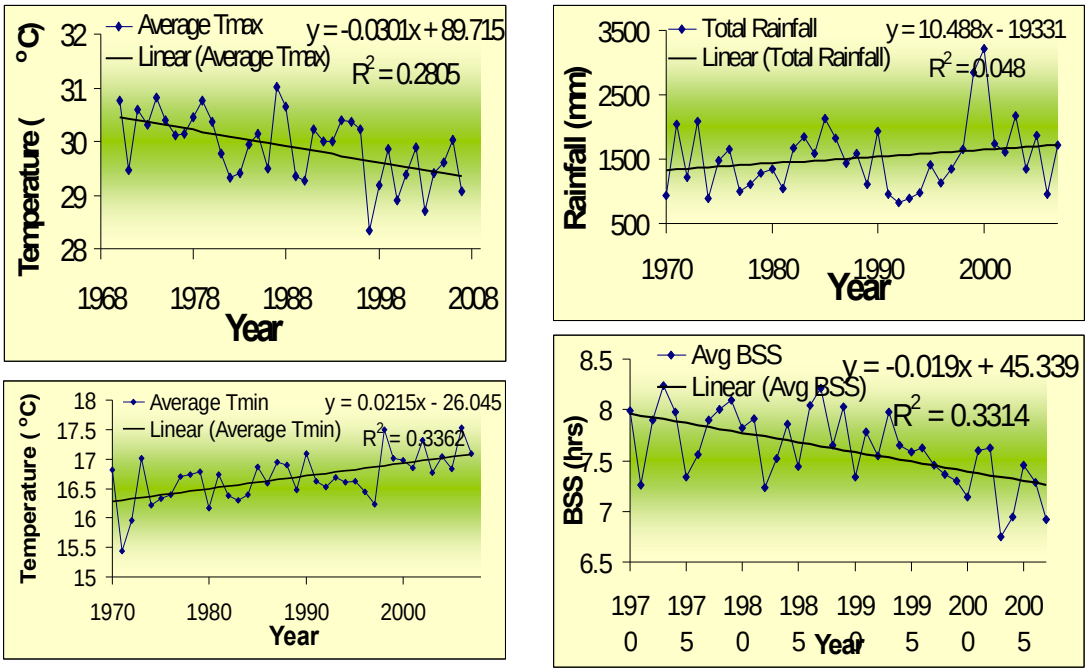
The pattern and trend in the weather parameter may vary from one place to another. The weather pattern of Pantnagar from 1968 to 2008 has been shown in Figure 14.

The maximum temperature of Pantnagar is continuously decreasing at a rate of 3°C/100 years and the minimum temperature of Pantnagar is continuously increasing at a rate of 2.1°C/100 years. This is representative for the plains of Uttarakhand. This pattern in the minimum and maximum temperatures is not very conducive for the growth and development of plants as increasing the night temperature will lead to increasing loss of food material in the process of respiration. Also, there are certain crops, such as tomato, which produce more when the diurnal temperature range (difference between maximum and minimum temperatures) is large. The mean temperature exhibits almost no trend (or decreases very slowly), with a large inter-annual variability.

The rainfall at Pantnagar is increasing at a rate of about 10 mm/year. This is largely due to the few high-rainfall events in the recent past. Otherwise, the amount of rainfall over the years is almost constant, with large inter-annual variability. A very alarming trend can be observed in the bright sunshine hours, which are decreasing at a rate of about 2 h/100 years.

This can prove detrimental to some crops, especially those that require more radiation. The bright sunshine hours are decreasing due to the increasing cloud cover. Increasing cloud cover is also responsible for the night warming and day cooling as it reflects the solar radiation back to space during the day and retards the long-wave radiation from the earth, which does not allow night cooling. The weather and climate are highly influenced by the local land use pattern and different physiographic processes and therefore may vary strongly from one place to another. The trends in the climate parameters can also vary spatially. Therefore, the climatic pattern of all stations should be precisely analysed in order to place a location-specific action plan.

Figure 14: Trends of maximum and minimum temperatures, rainfall and bright sunshine hours at Pantnagar Observatory, District Udham Singh Nagar



The observations of available temperature data[20] reveal that since the last 53 years (1955 to 2007), the average temperature of a Lesser Himalayan Hill station, viz., Almora—located at 29°35' and 79°35''E at an elevation of 1640m from the m.s.l. has increasing trend (Figure 15). This data indicates that the average temperature of Almora, i.e., 17.55°C (1955–2007) has increased up to 0.46°C during the last 53 years. This preliminary observation suggests that the average temperature is rising in the state.

Likewise, analyses[21] of rainfall records of 53 years (1955 to 2007) of Almora postulate the fact that the average annual rainfall has a decreasing trend (Figure 16). At present, on an average, the Almora Hill Station is receiving 23% or 244 mm less annual rain compared to its 53 years annual average rainfall, i.e., 1060 mm.

The normal monthly distribution of rainfall in the region reveals that the maximum rainfall occurs in the month of July, which constitutes the peak of the annual hyetograph and the months August and September constitute the recession segment of the hyetograph.

[20] Rawat J S. *et al*, Uttarakhand Centre on Climate Change, 1st Interim Report, issued by USERC, UCOST, UCCC and COE NRDMS Uttarakhand, 2011.

[21] ibid

Figure 15: Variation in annual average temperature and its trend at Almora

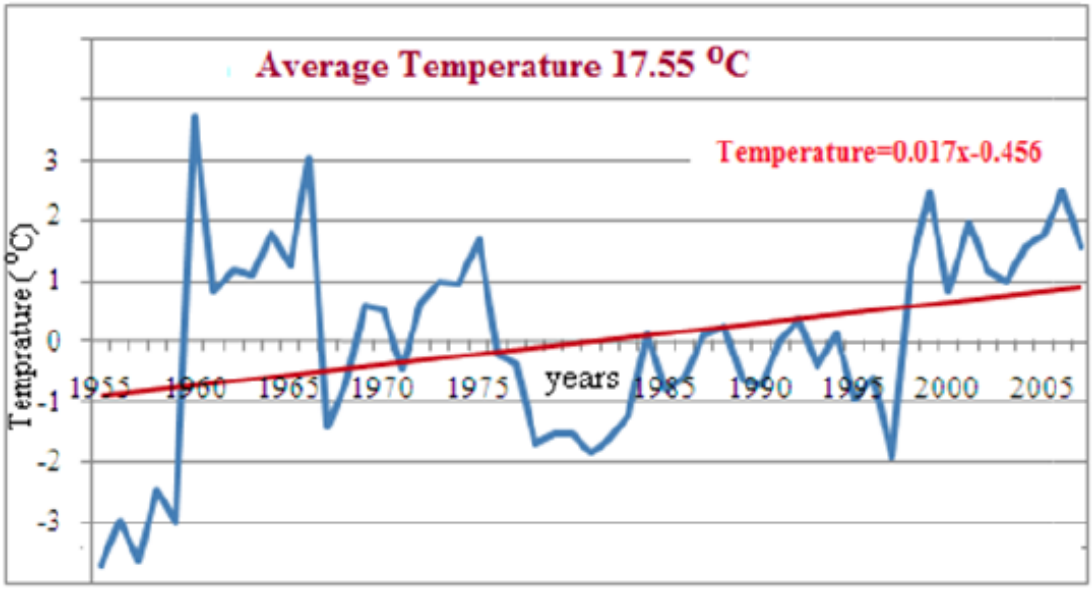
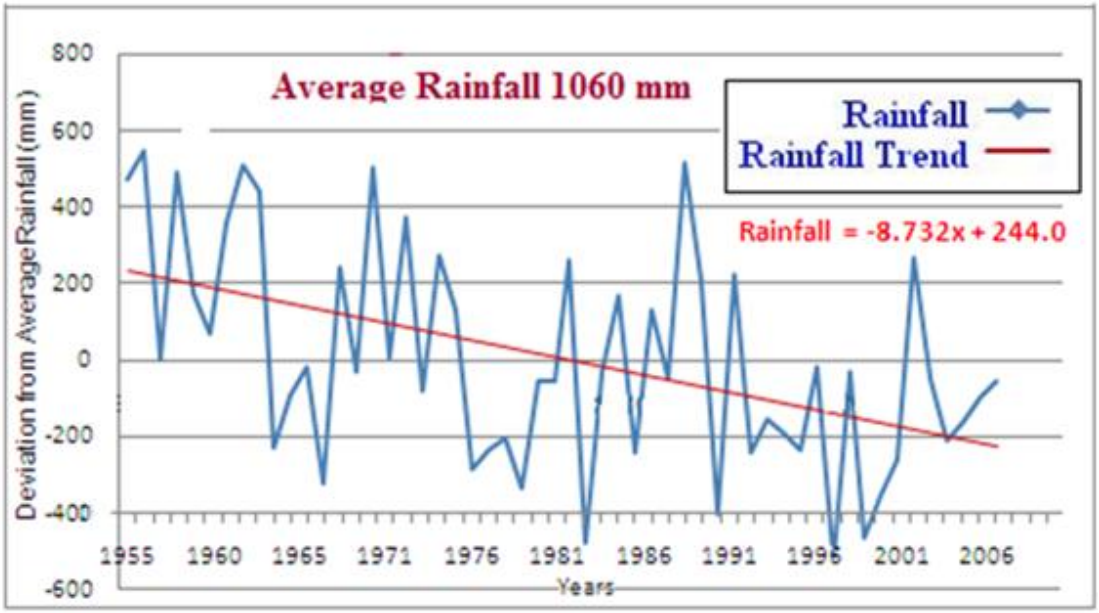


Figure 16: Variation from annual rainfall and its trend at Almora

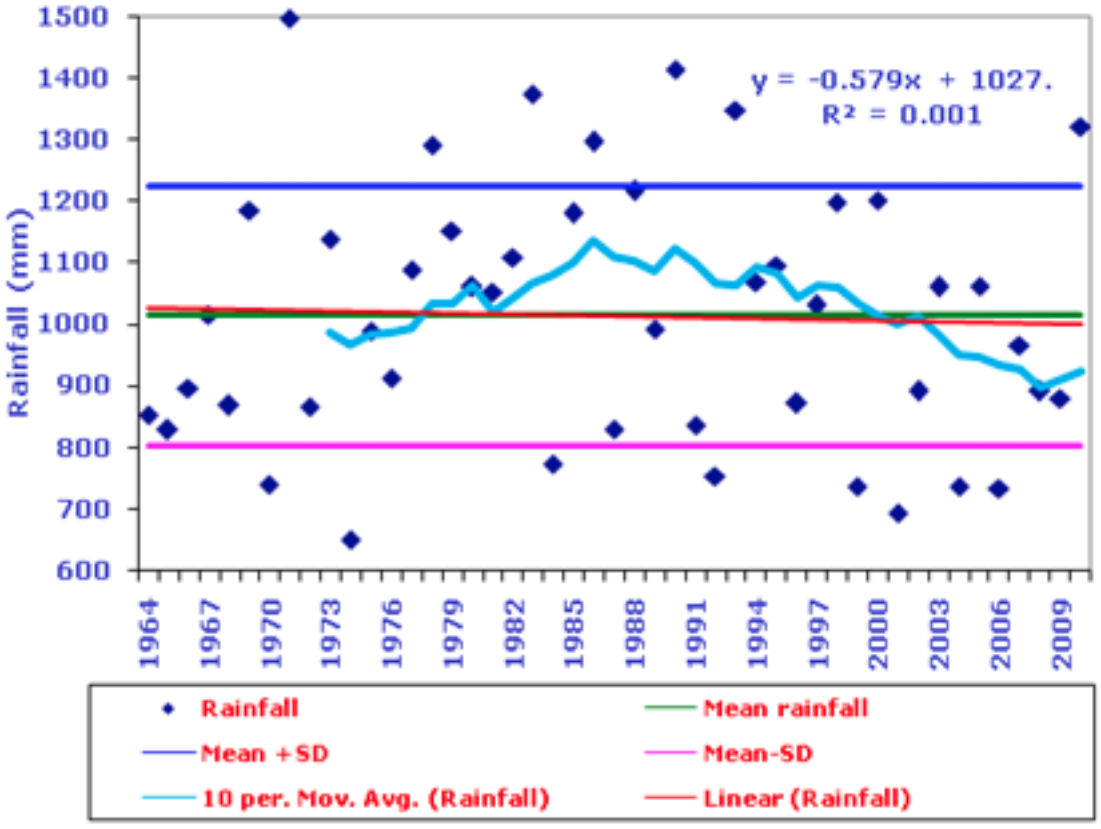


The rainfall records (2000–02) suggest that the peak of the annual hyetograph has been shifted from July to August and since the last two decades there are incidences when the peak of the annual hyetograph is being formed in the month of September. **This indicates that in future the peak of the annual hyetograph may be shifted from August to September.** The shifting of rainfall peak in the annual hyetograph reveals that the rainfall rhythm is gradually changing in Uttarakhand due to climate change.

The state witnessed very heavy rainfall in 2013 which was in the range of 124.5 – 244.4mm. On 15-17 June, 2013, there was a heavy downpour resulting in natural calamities in different part of the state and especially in the Kedarnath valley.

There also has been an increasing trend of occurrence of drought incidences in the recent past. Rainfall records from Hawalbagh, Almora (Figure 17) reveal that between 1964 and 2000 the total incidences of draught were 16, out of which 5 were severe but between 2001 and 2009, 7 draughts occurred out of which 3 were severe.[22]

Figure 17: Rainfall pattern at Hawalbagh, Almora



Snow cover is highly sensitive to climate change. Geographical distribution of snow cover area on different watersheds on different dates (from remote-sensing data) shows a declining trend (Figure 18).

The geographical distribution of snow reveals that on 15 and 21 October 1990 about 4,884.29 km^2 area of the state was under snow while on the same dates and months in 1999, the snow cover was found in 4,145.95 km^2 area. This reveals that the snow cover area was about 17.98% (or 738.34 km^2—Figure 19) less in Uttarakhand in October 1999 compared to that in October 1990, i.e., within a period of 9 years.

Results of the spot studies from Uttarakhand (Table 6a) reveal that the glaciers of Uttarakhand are retreating at different rates in different time periods.[23] The Pindari glacier has retreated about 2,840 m since the last 121 years at an average rate of 23.47 m/year. It was retreated at the rate of 26.22 m/year between 1845 and 1906, 20 m/year between 1906 and 1958 and 25 m/year between 1958 and 1966. The Thelu and Raktvarna glaciers have retreated 1,248 m (at the rate of 30.66 m/year) and 1,585 m (at the rate of 37.73 m/year) during the last 42 years (1962–2004).

[22] ibid
[23] ibid

Figure 18: Snow cover area in the month of October in different years in the watersheds of Uttarakhand

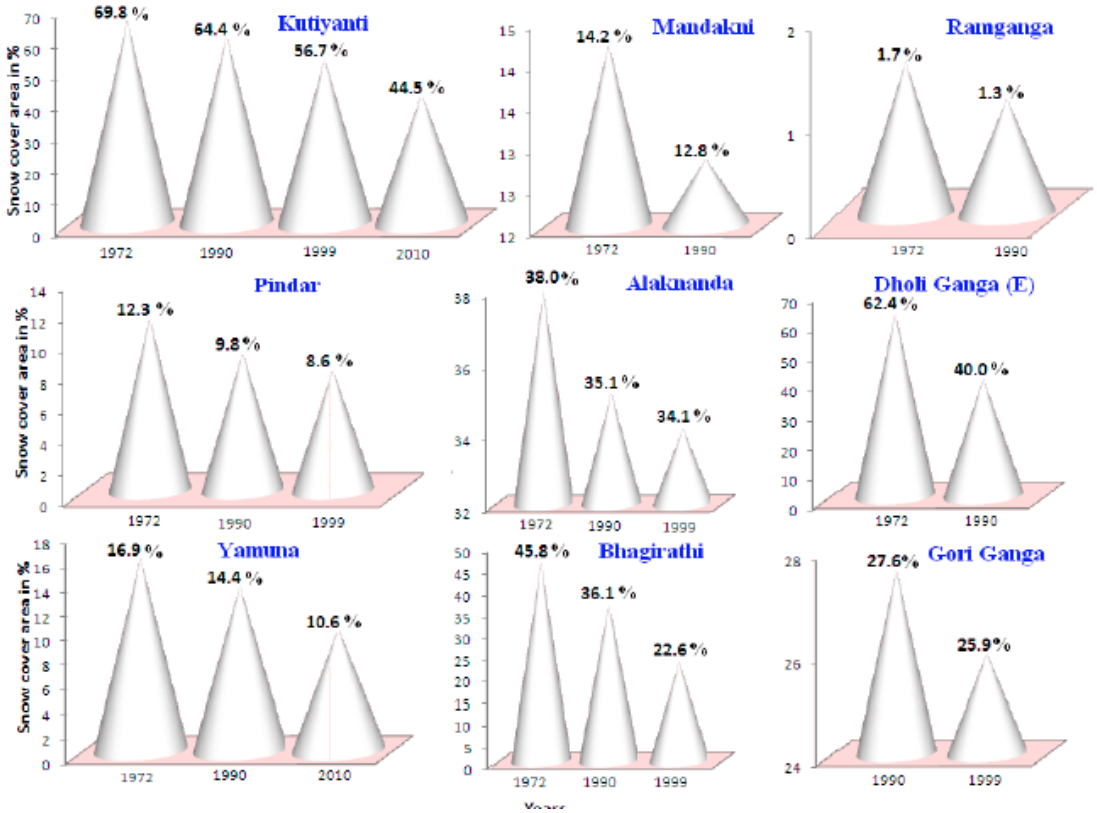
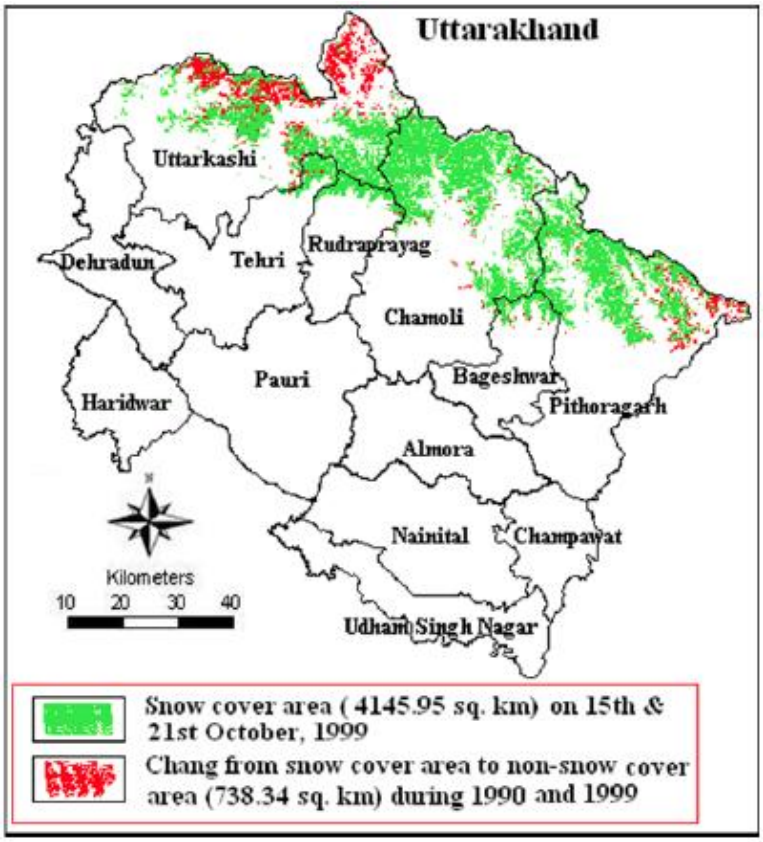


Figure 19: Status of snow cover area in October 1990 and October 1999 in the Uttarakhand State (based on of 15th and 21st October 1990 LANDSAT TM data and 15th and 21st October 1999 LANDSAT ETM+ data)



The Gangotri glacier is a system of as many as 32 tributary glaciers ranging from 1.05 km^2 to 17.70 km^2 in area. The tiny and small glaciers are retreating relatively at a faster rate. For example, Chhanguch, a tributary glacier of the Pindari, retreated at more than 10 times higher rate (i.e. 85 m/year) during 1958 to 1966 compared to the retreat rate (i.e., 25 m/year) of its master Pindari glacier. Similarly, the rate of retreat of the two tributary glaciers, viz., the Raktvarna and Thelu is near about two times higher compared to the retreat rate (19 m/year) of their master glacier, viz., the Gangotri. Numbers of tiny and small glaciers have completely disappeared from the region, which is not documented. Signatures of development of pro-glacial lakes have started coming up in the region, which is another sharp evidence of the impact of global warming in the region.

Table 6: Rate of recession of different glaciers of Uttarakhand

S.No.	Name of Glacier	Period	Duration	Recession	Rate of Retreat
1	Gangotri	1936–1996	61 years	1147 m	19 m/year
2	Pindari	1845–1906 1906–1958 1958–1966	61 years 52 years 8 years	1600 m 1040 m 200 m	26.22 m/year 20.0 m/year 25.0 m/year
		1885–1966	121years	2840 m	23.47 m/year
3	Milam	1849–1957	108 years	1350 m	12.5 m/year
4	Dokriani	1962–1991 1991–2000	29 years 9 years	480 m 161.15 m	16.5 m/year 18.0 m/year
Tributary Glaciers					
1	Chhanguch	1958–1966	8 years	680 m	85 m/year
2	Thelu	1962–2004	42 years	1248 m	30.66 m/year
3	Raktvarna	1962–2004	42 years	1585 m	37.73 m/year

2.3 Vulnerability Assessment of Uttarakhand

Some independent studies examining various (and often discrete) aspects of Uttarakhand's vulnerability to climate change have been carried out. These include WWF India's study of the Ganga Basin[24] (which includes Uttarakhand). An interim report has been brought out by the Uttarakhand Centre on Climate Change[25] (UCCC), Kumaon University. WWF India's report examines various factors contributing to exposure, sensitivity, adaptive capacity and the vulnerability index. Likewise, the UCCC Kumaon University report includes sections on evidence of climate change in the state as well as brief notes on vulnerabilities to various sectors/sub-sectors such as water resources (ice, glaciers, ground water, rivers and lakes), water quality, air and atmosphere, biodiversity (flora and fauna), agro-forestry and ecosystems, agriculture, food and livelihood security, human health and environment, disaster and hazard risks, electricity, tourism and industry and human settlement. More recently, the Uttarakhand State of the Environment Report 2012 by UCOST, Uttarakhand Science Education and Research Centre (USERC) and the Department of Science and Technology, Uttarakhand too has highlighted various aspects of climate vulnerability.

[24] Facing the Facts: Ganga Basin's Vulnerability to Climate Change, WWF-India, 2011.
[25] Interim Report, Uttarakhand Centre on Climate Change (UCCC), Kumaon University, March 2011.

Additionally, a few examples of documented 'perceptions' of climate change and its impacts are currently available, primarily from the standpoint of grassroots communities. One such example is the study conducted by the International Centre for Integrated Mountain Development (ICIMOD)—International Fund for Agricultural Development (IFAD),[26] which included community perceptions from Uttarakhand. Broadly, perceptions that were recorded in this study as well as from the consultations held in March and April 2012 as part of the UAPCC process show the following trends:

- Overall less rainfall, more erratic
- Overall decreased water availability
- Less or absent winter rains
- Increased frequency of intense rainfall events
- Increase in pests and disease
- Increasing temperatures
- Warmer and shorter winters with less snowfall (although the winter of 2011–2012 seemed to be an aberration, with extreme cold weather and excessive snowfall)

Brief notes from the WWF and ICIMOD-IFAD studies are given in Annexure 2. While these and other available information are a useful starting point to understand the state's vulnerability to climate change, there is a clear need for detailed vulnerability assessments of the state. Studies covering different sectors and the state in general will be carried out and are part of the action agenda under the UAPCC. Climate and Development Knowledge Network (CDKN), London has agreed to assist the state in assessing vulnerabilities to climate change across the state in important sectors.

*****

[26] Climate Variability and Change in the Himalayas: Community Perceptions and Responses, International Centre for Integrated Mountain Development, Kathmandu, Nepal, 2011.

Part B1: Overall Approach, Strategies and Actions

3 Overarching State Framework

3.1 State Vision and Commitment

Through the UAPCC, the Government of Uttarakhand commits itself to fostering inclusive, sustainable and climate-resilient growth and development of the state. This vision will be achieved through (a) charting a green development/carbon neutral growth strategy and climate-resilient development model; (b) integration of climate concerns into all aspects of development policy and implementation and (c) ensuring complementarity with and contributing to the national agenda on climate change. These will be supported by the strategies and actions outlined in this UAPCC and by all other necessary actions by the state government for achieving the vision.

3.2 Overall Approach, Principles and Strategies

The overall approach of the UAPCC will be to create and define an overarching climate response framework at the state government level as also develop flexible sector-specific response strategies and actions while keeping in mind the overall vision as articulated above. As already mentioned climate change escalates the already existing vulnerabilities (social, ecological, economic and cultural) of Uttarakhand and could manifest disastrously if not addressed adequately. Therefore, the climate response strategy of Uttarakhand has key elements such as accelerating inclusive economic growth, promoting sustainable development, securing and diversifying livelihoods and safeguarding ecosystem services. Further, the strategy is not to be viewed as a stand-alone action; instead, it will be integrated into the regular developmental planning process.

Climate change adaptation is the predominant philosophy and component of the climate response strategy of Uttarakhand. At the same time, it will leverage opportunities for mitigation too. The state lays equal emphasis on both 'hard' and 'soft' adaptation approaches—where 'hard adaptation options' include options that have physical attributes (e.g. infrastructure and engineering structures) and 'soft adaptation options' include the development of skills, processes, institutions, social systems, policies and programmes. The key elements of the climate response strategy for Uttarakhand also involve flexibility (within livelihoods and economic, social, cultural, ecological and institutional systems), diversification (involving multiple independent flows to livelihoods and natural systems), learning and education (from events at both individual and institutional levels and knowledge base required to develop new systems when existing ones are disrupted), mobility (an attribute of flexibility), operational techniques (dynamic plans for risk reduction before and following disruptions), convertible assets and innovation (designing new systems and options).

Specific elements of the overarching climate response framework at the state government level are articulated below (and additional elements will be added as and when necessary). The state will develop action-oriented operational plans and a budgetary framework for these in a time-bound manner. **It has also been ensured that all actions to be undertaken as part of the UAPCC have broad conformity with NAPCC and the eight national missions under it.**

3.2.1 Scientific Knowledge, Evidence Base and Understanding of Climate Change

The UAPCC recognizes that the currently available data/information on vulnerability to climate change and its impacts on the state, its economy, its various sectors and communities are limited. On this front, the UAPCC seeks to achieve the following outcomes (which are linked to the overall Knowledge Management Strategy under the UAPCC):

- Development of detailed climate vulnerability and risk analyses covering all districts, as well as specific analyses pertaining to each of the sectors addressed in the UAPCC.
- Improved scientific evidence base and coordination mechanisms between scientific research and academic institutions (including both national and state-level agencies) for building a scientific data and evidence base for the state.
- Collation of available scientific information and data on climate change pertaining to the state.
- Documentation (on an ongoing basis) of people's perceptions on climate change and its impacts and, where appropriate, establishing if these have scientific bases and validity.
- Collection of data and documentation of information related to customs and traditional knowledge in respect to natural resources management and utilization.

To fulfil the above outcomes, the state will take all necessary steps including initiating (as one of the highest priority agendas) processes for carrying out detailed climate vulnerability analyses and **developing a climate vulnerability atlas**, which will be updated on an ongoing basis. An appropriate state department/agency will be nominated to anchor this process. Dialogue between scientific research and academic institutions will also be fostered and coordinated on an ongoing basis. The UAPCC also recognizes that the scientific knowledge and evidence base is also limited and scattered. While Uttarakhand plays host to a large array of national and state-level scientific and research organizations, many of which are involved in research programmes/studies on various aspects of climate change, there is no single clearing house mechanism that aggregates the available evidence base and tracks all ongoing and planned research programmes that may have relevance to the state. The state therefore will put into motion a process for doing this. Climate Change Cells will be constituted in the line departments.

3.2.2 Governance Mechanisms, Institutional Decision Making and Convergence

As indicated in an earlier section, Uttarakhand is already implementing a range of steps/programmes that are climate friendly/carbon neutral. While continuing to support such initiatives, the state will seek to fulfil a range of outcomes including the following:

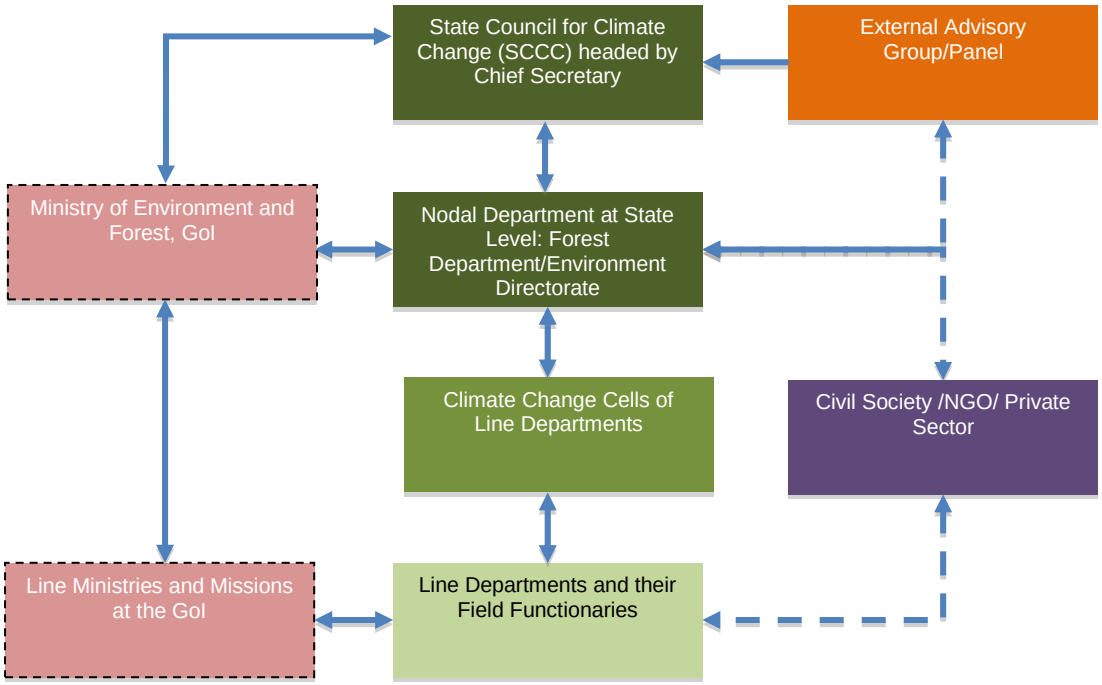
- Developing and putting in place overarching institutional and governance mechanisms at the state level to oversee and implement the UAPCC.
- Reviewing all state policies and revising these as necessary to articulate and integrate climate concerns.
- Articulating and integrating climate change considerations into development strategies, plans and programmes.

- Strengthening institutional decision-making mechanisms and processes (including monitoring and evaluation) to ensure cross-sectoral coordination related to climate change.
- Developing and adopting appropriate management approaches including regulatory, incentive-based and innovation-based approaches to encourage appropriate adaptation and mitigation measures.
- Developing and strengthening the institutional capacity for climate-related disaster risk reduction (DRR) and management.

In order to provide an overarching governance framework and guidance to the state's climate agenda, the state has already constituted the SCCC under the chairmanship of the Chief Secretary, comprising 29 members including Principal Secretaries/Secretaries in charge of various line departments as well as other senior government officials. The SCCC, which is mandated with the apex role of overseeing all aspects of the state's preparations and initiatives to address climate change and its impacts, has been activated and specific terms of reference will be further developed for it, including outlining other key responsibilities, reviewing all state policies and programmes and identifying gaps, risks, opportunities and possible corrective actions towards achieving the above outcomes.

The overarching state-level institutional architecture is given in Figure 20.

Figure 20: State-level architecture for UAPCC implementation



The State Forest Department, currently the nodal department for development of the UAPCC, will play an interim role as the nodal agency for overseeing all operational aspects, implementation and coordination of the UAPCC at the state level. It is anticipated that once the proposed State Environment Directorate (SED) comes into being, this role will be transferred to it. In the interim, a full-fledged Climate Change Cell will be set up with the State Forest Department to oversee implementation of the UAPCC. The State Forest Department (and subsequently, the SED) will work in close coordination with the SCCC and report to it on the operational aspects of the UAPCC.

The nodal agency/department overseeing the operational aspects of UAPCC implementation will be supported closely by several other state-level departments/agencies whose work is crosscutting. These will include (a) UCOST, (b) the State Disaster Mitigation and Management Centre (DMMC) and (c) the Watershed Management Directorate (WMD). Close coordination with the departments overseeing Rural Development, Panchayati Raj, Women and Child Development, finance and planning will also be ensured. While this UAPCC focuses on sectoral interventions across a selected set of government line departments/agencies, this will by no means exclude the role of other line departments/agencies and civil society/ NGOs/ private sector. These will be co-opted to support UAPCC implementation processes from time-to-time. The role of the climate change cells in these departments would be important to achieve this. A framework for implementation at the district and sub-district levels, including the role of Panchayati Raj and other local institutions, will also be formulated in the due course.

3.2.3 Capacity Development, Education and Awareness

The state recognizes that overall awareness of climate change and its impacts in Uttarakhand is limited. Therefore, the UAPCC seeks the fulfilment of the following outcomes:

- Significantly improved awareness of climate change and its impacts in government at all levels as well as in communities, civil society and the private sector in the state.
- Capacities of government line departments, agencies and civil society at all levels to analyse, plan, converge, implement and monitor programmes addressing climate change and its impacts.

Therefore, the state will initiate and foster a range of ongoing awareness and capacity-building measures aimed at targeting government departments and agencies at various levels to improve overall awareness levels. It is envisaged that each sectoral line department and state-level agency will develop and activate Climate Change Cells and actively seek and foster climate champions.

The state will also put into motion a process of building awareness on climate change and its impacts among the population and communities in general and develop and widely disseminate sets of actions that the citizens of the state can take to support the UAPCC. In addition, the state will examine the possibility of incorporating climate change–related modules into the educational curriculum across various levels, including the development of specific academic programmes on climate change at university levels. Appropriate external agencies will be co-opted as necessary to support the awareness and capacity-building processes.

3.2.4 Connecting Science, Practice and Policy

As an extension of the overarching principles related to actions for improving the scientific knowledge and evidence base articulated above, the state is committed to supporting processes that connect science to practice and policy. The following outcomes are envisaged towards this end:

- Data/research needs to support UAPCC implementation and related policy making identified (on an ongoing basis, as needs evolve).
- Mechanisms to foster dialogue with and between scientific research, academic agencies and civil societies.

- Specific mechanisms to adopt and implement practical approaches and solutions based on basic and applied research, including customary and traditional practices to support UAPCC implementation.
- A Centre for Climate Change in the State Forest Department/ Environment Directorate specifically for the above agendas of connecting science, practice and policy.

As such, under the UAPCC, the state seeks to actively consult and have a dialogue with relevant scientific organizations and academia in the formulation of state policies to develop a culture of evidence-based policy making. Similarly, it will also support similar consultation and dialogue in the formulation of developmental and sectoral programmes by the various line departments and agencies, through their Climate Change Cells, as has been proposed in the UAPCC. On an immediate basis, specific emphasis will be given to practical approaches and solutions (technological and otherwise) that have already been developed by various research centres and academic institutions that have not yet found the dissemination, outreach and exposure that are needed to make these widely available for deployment in the development contexts (both rural and urban).

3.2.5 Integrating Poverty, Livelihoods, Gender and Equity Issues

The UAPCC recognizes that because climate change can have disproportionately higher adverse impacts on the poor, women, children and aged and can also impact their livelihoods, developmental planning needs to explicitly integrate poverty, livelihoods and equity concerns. Uttarakhand's inclusive climate change policy will be guided by gender equality where men and women are equally valued and entitled. Gender mainstreaming in adaptation-focused programmes and schemes, especially in agriculture-related livelihoods, will empower women and not work only for their welfare. The multi-sectoral UAPCC envisages that the gender mainstreaming in Climate Change Directorate and the Climate Change Cells within all Line Departments, will equip these institutions to undertake gender analysis of all programmes and schemes and implement climate solutions to empower women to adapt to climate change. This will be done through broad-based gender sensitization activities, involvement of gender experts at various levels and constituting a gender empowerment sub-committee within each Climate Change Cell.

With policies, programmes and schemes often not 'gender-neutral,' the following four indicators can be used to test them for gender empowerment. Thus, policies, programmes and schemes will empower women and men if these:

a) **Create assets** for women and men alike. Assets such as land titles, livestock ownership, lease on forest land, biogas plants, rainwater harvest tanks, etc.;

b) **Create equal opportunities for income-generation** activities and for exercising **control over that income** through, for example, creating institutional arrangements to encourage women to actively engage with markets;

c) Lead to **reduction of labour and drudgery** for both women and men; and

d) Lead to **equal participation of women as *informed* decision-makers** in ***mainstream*** institutions to help shape laws, policies and programmes that impact their lives and livelihoods.

To implement gender-responsive climate adaptation plans, there will be a need for the following:

(a) Policy-level or legal changes, administrative orders or government notifications. *For example, the strong legal backing of biodiversity laws that now exists for patents and*

protection of traditional knowledge can be particularly useful for women's traditional knowledge and recognition of women as knowledge managers and trainers. Again, an administrative order making it mandatory for at least two women to be present to make up the quorum of Van Panchayats (where four of nine members are women) will help empower women in decision-making roles in mainstream institutions.

(b) Several studies across sectors to obtain gender-disaggregated ground-level information, mainly in the livelihoods-oriented sectors such as agriculture, livestock rearing and forests. *For example, higher temperatures in the wake of climate change are leading to an increase in weeds and weeding is essentially a woman's task, which urgently requires technological intervention to reduce her labour and drudgery. Or, organic agriculture demands far more labour input from women and a gender-disaggregated study on various tasks involved for preparing and applying bio-inputs will ensure that programmatic interventions target main stakeholders.*

A heightened focus will be put on gender budgeting, especially within the adaptation-focused sectors, to ensure that adequate financial resources reach women (not only men) through women-friendly financial instruments. *For example, women workers dominate the dairy sector but public resources in the diary sector do not prioritize women. Again, Kisan Credit Cards (KCCs) favour landowners who are predominantly male. This can be dealt with by giving KCCs through women farmers' groups/SHGs and by promoting ownership of land by women farmers.*

It is expected that these actions will significantly enhance and contribute to equitable adaptive climate resilience in the state.

3.2.6 Private Sector and Financial Institutions

As has been outlined in Part A, Section 1, of this UAPCC, the private sector already plays a significant role in contributing to the state's economy in the secondary and tertiary sectors. A range of PPP (private–public partnership) initiatives and projects are under way in the state through the Uttarakhand PPP Cell under the State Planning Department. Such PPP models can be useful for pooling resources and expertise and for up-scaling climate change adaptation (especially in terms of climate-resilient infrastructure and low-carbon goods and services) and mitigation initiatives by way of explicit incorporation of climate concerns into project frameworks. The private sector has great potential and competency for bringing innovative solutions and scale to the various models for climate change adaptation shaped by the civil society and/or government institutions; however, their primary thrust thus far has been limited to the clean development mechanism (CDM) and related projects.

Increasingly, there is a huge potential and need for the private sector to play critical roles in sectoral initiatives in the primary sectors as well—bringing in new management practices, technologies and technology transfer, innovation, capital and investments, capacity building, etc. In this direction, the UAPCC will seek to secure the following outcomes:

- A roadmap for exploring the potential role of private sector across the various focus sectors of the UAPCC, especially in the primary sectors such as agriculture (with special emphasis on rain-fed mountain agriculture and extension) and forestry.
- A review of existing initiatives by the private sector including CSR to examine the possibility of incorporating climate agendas.

- A review of existing policy frameworks governing the private sector, including the draft State PPP Policy, with the objective of exploring the incorporation of climate change concerns into PPP projects in the state.
- Outlining necessary enabling frameworks and regulatory mechanisms for involving the private sector.

As in the case of the private sector, increasingly, the financial sector and financial institutions will have critical roles to play in sectoral initiatives, especially across the primary sectors—bringing in new financial practices, products, innovation, capital, investments, etc. The financial sector and institutions have already been active in the primary sector, such as providing crop insurance, etc.—however, the experience has been mixed. As such, the UAPCC envisages the following outcomes:

- Developing a roadmap for exploring the potential role of the financial sector and financial institutions across the various sectors, especially in the primary sectors, such as agriculture (with special emphasis on rain-fed mountain agriculture and extension) and forestry.
- Outlining the necessary enabling frameworks and regulatory mechanisms for involving the financial sector.

3.2.7 Role of Civil Society

Civil society and voluntary organizations have played critical roles in shaping the development landscape of not only Uttarakhand but the nation. These will continue to have vital roles in the context of climate change and have the potential to deliver programmes and services to communities and to bridge the roles of not only the government and community but also the roles of scientific research institutions and the private sector with government and the community.

As such, the UAPCC envisages the following outcomes relating to the role of civil society:

- Developing a roadmap for exploring and articulating the potential role of civil society organizations (including non-governmental organizations (NGOs), NGO networks, community-based organizations (CBOs) and CBO networks) in UAPCC implementation, including capacity building at various levels, especially at district and sub-district levels, providing inputs to the UAPCC on poverty, equity and livelihood concerns, providing outreach and extension services, playing bridging roles, documentation of community perceptions and best practices, undertaking participatory research, knowledge networking and contributing to expanding the available evidence base on climate change.
- Identifying appropriate civil society organizations and their networks at various levels that can partner UAPCC implementation at various levels including the state, district and block levels and at the grassroots.

3.2.8 Role of International Agencies

Likewise, international/external agencies play significant roles in supporting developmental initiatives and bringing in technical assistance to the state. A range of international organizations, including multilateral, bilateral and other agencies, have supported and continue to support significant development projects across government departments as well as civil society. As such, it is envisaged that international organizations will also play a significant role in supporting various aspects of UAPCC implementation; the state will therefore proactively seek opportunities for collaborative partnerships with such

organizations, especially in the context of external support—financial support, technical assistance and advisory services, bringing in international best practices, knowledge management and networking, inter-state and regional dialogues on climate change, especially in the context of Himalayan states, etc.

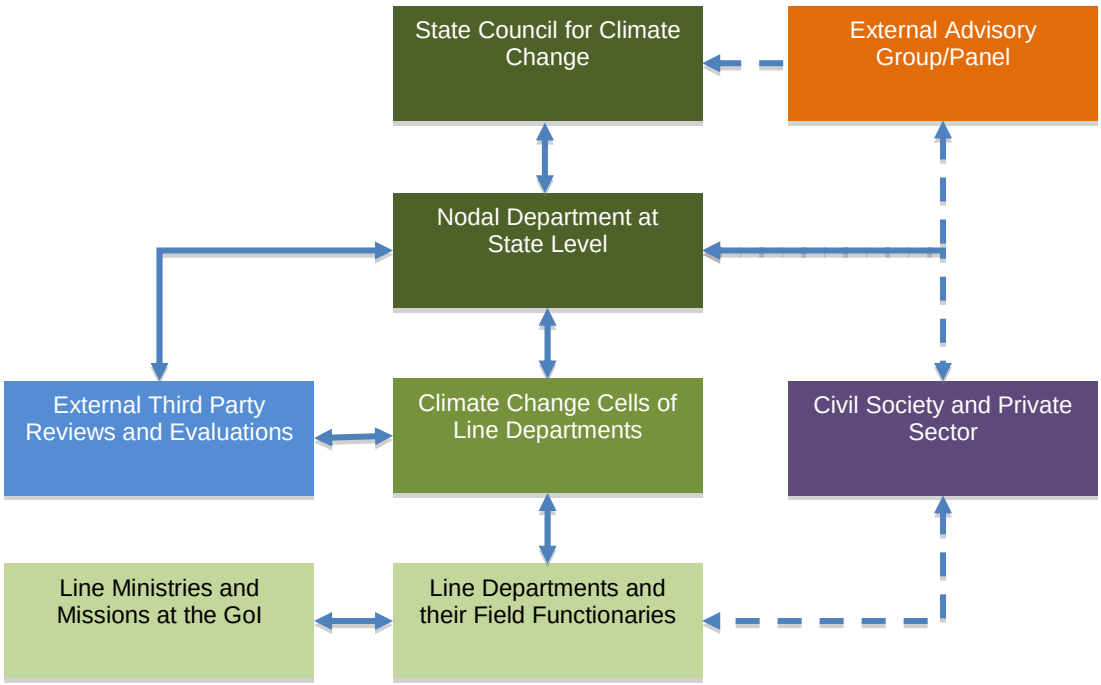
3.2.9 Monitoring Framework

A tentative and indicative outline of a monitoring and reporting framework is given in Figure 21.

The state is committed to ensuring that UAPCC implementation is complemented by a robust framework and mechanisms for monitoring and evaluation not only as a means of ensuring that the detailed operational plans that will be developed under the UAPCC are implemented as planned but, more importantly, as a tool for systematic review and programme improvement as the needs of the state will evolve with implementation. It is tentatively expected that reporting will take place on a quarterly basis at all levels and there will be internal reviews of implementation progress and performance on a half-yearly basis. Likewise, considering that this UAPCC broadly covers implementation plans over a 5-year period, there will be implementation of an external third-party evaluation during mid-2014 to critically examine implementation and recommend course corrections and another similar external evaluation will be carried out at the end of 2017.

A detailed and robust monitoring framework will be developed, including specific methodologies, protocols and templates for monitoring and reporting as part of the process of developing detailed work plans under the UAPCC.

Figure 21: Tentative and indicative monitoring framework for UAPCC



3.2.10 Knowledge Management and Dialogue across the IHR and Beyond

The UAPCC recognizes that knowledge creation, management and dissemination/exchange will be critical and central to the successful implementation of the SAPCC. The UAPCC also recognizes that Uttarakhand does not exist in an independent developmental vacuum; it exists in the developmental context of the IHR and also in the larger context of the HKH. Therefore, the UAPCC will seek to achieve the following outcomes in this regard:

- Develop and deploy mechanisms for collating the existing knowledge base on climate change and its impacts as relevant to the state and identify the anchoring/nodal organization for this (to be done in close collaboration with UCOST, which will host the scientific research-aggregating mechanism under the UAPCC).
- Develop protocols for new knowledge creation and documenting emerging best practices across sectors and at all levels, as well as document and share the perceptions of people on climate change and its impacts on an ongoing basis.
- Develop mechanisms and partnerships for sharing the knowledge base and emerging experiences including best practices not only within the state at all levels but also with other states in the IHR as also in the larger HKH context.

As such, it is envisaged that the UAPCC outcomes related to knowledge management will be cross-cutting and also closely connected to the envisaged outcomes on capacity building. Additional elements of knowledge management may be taken up from time to time during UAPCC implementation as required.

*****

4 Sectoral Implementation Approaches

4.1 Overall Common Implementation Framework

It is envisaged that UAPCC implementation under the various sectors of the state will be governed by a common implementation framework[27] as in Figure 22.

Figure 22: Common framework elements for sectoral implementation under UAPCC

The common elements will include the following:

- *Sector policy reviews*. Each sector will undergo a policy review and where appropriate, climate change concerns and sectoral responses will be articulated explicitly.
- *Sector climate vulnerability assessments.* Sectoral climate vulnerability and risk assessments will be carried out as part of a larger vulnerability and risk assessment for the state and where appropriate, sectoral programme elements will be re-framed based on the findings.

[27] Since these will be common across sectors, in order to avoid repetitiveness, they will not appear in the descriptions of each sectoral programme.

- *Sector climate change impacts evidence base strengthening.* Each sector will put into motion a process of building the evidence base on climate change and impacts on the sector.
- *Sector public/community perceptions documentation.* Each sector will carry out periodic documentation of public/community perceptions on climate change and its impacts relevant to the sector.
- *Periodic consultations with civil society and communities.* Each sector will carry out periodic consultations with civil society and communities to gauge adaptive resilience needs.
- *Incorporation of poverty, equity and livelihood concerns.* Each sector will, where appropriate, incorporate and explicitly articulate poverty, equity and livelihood concerns in their policies, plans and budgetary processes.
- *Gender Concerns*. The different schemes of various sectors will be examined in terms of gender concerns by Women and Child Welfare Department before being given the final approval.
- *Monitoring and evaluation protocols.* Each sector will, in line with the overarching state-level framework, develop and deploy monitoring and evaluation processes and protocols to guide effective programme implementation.
- *Knowledge management activities.* Each sector will, in line with the overarching state-level framework, carry out knowledge management activities and contribute to the state-level processes on an ongoing basis. Under the UAPCC, the Uttarakhand State Council for Science and Technology (UCOST) will perform the role of a knowledge aggregator and become a clearinghouse of all data/information on existing and planned research projects and initiatives relating to climate change in the Uttarakhand context. Towards this, the proposed activities of UCOST are as follows:
    - Hosting of a geo-portal on climate change.
    - Serving as a host-hub for knowledge/information sharing related to climate change.
    - Providing a knowledge repository.
    - Identification of potential research and development (R&D) domains concerned with climate change issues in the state.
    - Demonstration of technologies, carrying out R&D and establishment of protocols for transfer of technology relating to climate change.

Additionally, efforts will be made to explore the options for participation of and leveraging the private sector and financial institutions in each sectoral programme. Likewise, where appropriate, suitable external support agencies will be leveraged/sought to bring in additional implementation support or technical assistance.

*****

Part B2: Sectoral Approach and Strategies

5 Agriculture

5.1 Overview, Characteristics and Status

Agriculture includes horticulture, and their linkages and support system. Agriculture is a prime source of sustenance for most mountain communities. Five major farming systems are prevalent, namely: (i) a cereal-based production system (ii) a horticulture or agri-horti-based production system, (iii) a vegetables and floriculture-based production system, (iv) a livestock-based production system and (v) an agri-horti-silvi-pastoral-based production system. Foodgrains, oilseeds, vegetables, fruits such as apples and livestock produce are the major products. The response of agricultural crop production in different agro-ecological regions to climate change varies according to crop composition, edaphic conditions and the cropping pattern. Wide variations in edaphic, topographic and climatic conditions and selection procedures over centuries of cultivation have cumulatively resulted in the preservation of an immense crop genetic diversity in Uttarakhand.

Out of the total reported area of 53.48 lakh ha, only 7.66 lakh ha (14%) is under cultivation. Most of the agriculture in the state is rain-fed. The net irrigated area of the state is 3.36 lakh ha (2010-11), which is mostly confined to the plains. The cropping intensity in Uttarakhand is 157.63% higher than the national average. As has been detailed in the State Profile sub-section, the state has four agro climatic zones covering six altitudinal farming situations (Table 7):

Table 7: Farming situation in Uttarakhand

S.No.	Farming situation	Soil	Principal crops
1.	Irrigated lower hills (600–1,200 m.)	Alluvial sandy soil	Rice, wheat and vegetables.
2.	Rain-fed lower hills (600–1,200m.)	Residual sandy loam	Finger Millet, maize, rice, wheat.
3.	Mid hills, south aspect (1200–1,700m)	Sandy loam	Rice, finger millet, wheat, potato, tomato.
4.	Mid hills, north aspect (1200–1,700m.)	Brown forest soil	Rice, finger millet, wheat, potato, tomato, peas, cole crops.
5.	High hills (1,700–2,500 m.)	Red to dark	Amaranth, finger millet, french beans, cole crops, potato, peas.
6.	Very high hills (2,500–3,500 m)	Red to black clay	Amaranth, buckwheat, peas, cole crops, potato.

5.1.1 Land Holding and Land Use Pattern

Most of the area of the state is under forests and wastelands, thus leaving only a small amount of land (about 14%) for cultivation. Of the cultivated land, about 50% of the land holdings are sub-marginal and a further 21% of the land holding is between 0.5 and 1 ha. Thus we find that about 70% of the land holdings are less than 1 ha in size and cover about 27% of the area under cultivation, while about 26% of the land holdings is between 1 and 4 ha in size, covering about 51% of the total cultivated area. Also, just over 3% of the land holdings are above 4 ha in size and cover about 22% of the total cultivated area. As there are a large number of cultivated lands and the area is under small and marginal holdings, the input cost per unit of output is higher.

5.1.2 Irrigation

Most of the agriculture in the state is rain-fed. The net irrigated area of the state stands at 3.36 lakh ha (2010-11). The net irrigated area, as a percentage of the net sown area in the state, is 47%. The state is also home to a range of unique irrigation methods/techniques and facilities.

5.1.3 Crop Production Scenario

In the state, farmers generally adopt two types of agricultural practices, i.e. the rain-fed and the irrigated. Cereals are emphasized in irrigated agriculture and two crops are taken in an agriculture year. However, in the rain-fed system, millets, pulses and tuber crops are grown along with cereals and oilseeds. Mono cropping is a common practice in the irrigated areas. In contrast, mixed cropping is common in rain-fed areas. Mixed cropping practiced in the hill region helps maintain the crop diversity and reduces the risk of environmental uncertainty.

Time and the amount of precipitation have major impacts on crops both in rain-fed and irrigated areas. In rain-fed areas, the sowing time, crop duration and productivity are directly linked to the quantum and distribution of rainfall, while in irrigated areas the distribution of rainfall affects germination and harvesting of crops. The growth of food grain production is quite variable in different areas. As a result, the agriculture scenario presents a mixed picture. The productivity of Udham Singh Nagar, Haridwar, Nainital (plain) and Dehradun (plain) districts is very high; the productivity of the hilly areas is very low, although the valleys are fertile. The plains' agriculture and hill agriculture stand in stark contrast to each other. While the productivity in the plains can be compared with that of the agriculturally developed regions of the country, the productivity in the hills lags far behind. Plains' farming greatly benefited from the advent of the Green Revolution. At the same time, hill farming systems have their inherent strengths, including the fact that they are largely organic, mixed cropping based and subsistence driven. Table 8 illustrates this dichotomy.

Table 8: Dichotomy of agriculture in the state

Plains agriculture	Hill agriculture
Characterized by commercial farming	Characterized by subsistence farming
Mono cropping is common	Mixed cropping is prevalent
Consolidated holdings	Scattered and fragmented holdings
Percent of irrigation is 92%	Percent of irrigated area is 11%
Seed replacement rate 20%–25%	Seed replacement rate 4%–5%
Use of chemical fertilizer 150–200 kg/ha/year	Use of chemical fertilizer 5–7 kg/ha/year
Productivity of main crops Rice 23 q/ha Wheat 33 q/ha	Productivity of main crops Rice 13 q/ha Wheat 12q/ha Ragi 13 q/ha Sawan 13 q/ha
Has benefited greatly from the advent of the Green Revolution	Has been completely deprived of the benefits of the Green Revolution
Productivity is exhibiting a declining trend. Organic and microbial content of the soil have been lost to a very great extent. Carbon content in soil has reduced from 2% to 0.5%. Requirements of inorganic fertilizers and pesticides are growing steadily to sustain the same level of productivity. Restoration of soil health and propagation of pest-resistant, suitable genetically modified crop varieties is required. Extension efforts for adoption of crop rotation practices, farm residue manuring and popularizing water economy measures are required.	Productivity is almost stable. Suitable for organic farming as in most of the areas conversion period will be just 1 year and around 65 million tonnes (MT) of biomass is available annually for composting. However, a lot of extension effort and research for selection among local cultivars and prescribing suitable package of agronomic practices for the same are required. Great deal of agro-bio-diversity exists. There is a need to adopt *ex situ* and *in situ* conservation measures.

The trend of foodgrain and oilseed production is shown in Table 9.

Table 9: Trend of food grain and oilseed production

Year	Total foodgrains			Total oilseeds		
	Area (ha)	Production (MT)	Average yield (q/ha)	Area (ha)	Production (MT)	Average yield (q/ha)
2000/01	9,85,047	1,647,022	16.72	25,283	14,752	5.83
2001/02	9,81,475	1,644,858	16.76	25,486	15,325	6.01
2002/03	9,62,447	1,527,484	15.87	27,669	15,525	5.61
2003/04	9,72,351	1,631,431	16.78	30,444	27,259	8.95
2004/05	9,90,560	1,719,877	17.36	32,401	30,233	9.33
2005/06	9,70,145	1,518,772	15.66	34,003	29,827	8.77
2006/07	9,67,615	1,723,564	17.81	28,308	23,293	8.23
2007/08	9,42,591	1,723,499	18.28	26,775	23,171	8.65
2008/09	9,60,386	1,685,591	17.55	25,272	21,196	8.39
2009/10	9,40,955	1,727,612	18.36	26,221	27,691	10.56

5.2 Vulnerability to Climate Change

No detailed vulnerability and risk assessment of the agricultural sector in Uttarakhand to climate change currently exists. However, available evidence in qualitative terms suggests that:

- The overall predictability of weather and climate will decrease, making the day-to-day and medium-term planning of farm operations more difficult.
- Increases in the frequency of droughts and floods are likely to affect production negatively, especially in subsistence sectors.
- Higher night temperatures may increase the dark respiration of plants, diminishing net biomass production.
- The productivity of most crops will decrease due to increases in temperature and decreased water availability. Greater losses are expected in the rabi crop as compared with those in kharif.
- Loss of biodiversity from some of the most fragile environments, such as forests and agro-forestry systems.
- Spatial changes in the diversity of tropical/sub-tropical crops (maize, rice, etc.) and spatial changes in the diversity of temperate crops (apple, cabbage, cauliflower, carrot, potato).
- Increasing temperatures will increase fertilizer requirements for the same production targets and result in higher greenhouse gas (GHG) emission costs of crop production.
- Winter-kill of pests is likely to be reduced at high latitudes, resulting in greater crop losses and a greater need for pest control. The incidence of diseases and pests, especially alien ones, could increase.
- Present (agro) ecological zones could shift in some cases over hundreds of kilometres horizontally and hundreds of metres altitudinally, which is crucial for some plants, especially trees and animal species, which cannot follow in time. Farming systems cannot

adjust themselves in time. For instance, the cool upper stretch with the presently elevated maximum temperature of 25.5°C at Haridwar has become conducive to warm water fishes. Warm water fishes such as *Glossogobius giuris*, *Puntius ticto*, *Xenentodon cancila*, *Mystus vittatus* and *Catla catla*, mainly inhabiting the middle and lower Ganga, are now present in the upper Ganga at Haridwar and above.

- Higher temperatures will allow seasonally longer plant growth for crop growing in cool and mountainous areas that remain snowbound (or remain at very low temperatures not suitable for vegetation) for most of the time, allowing in some cases increased cropping and production. In contrast, in already warm areas, climate change can cause reduced productivity.
- High levels of organic matter content can be found at cool and moist sites where conditions for primary production are still sufficient, but decomposition of their litter is limited due to low temperatures and limited soil aeration.
- There will be damaging effects of increasing UVB on crops. Reductions in yield up to 10% have been observed experimentally with very high UVB values and will particularly affect plants where the CO_2 fertilization effect is strongest. On the other hand, UVB increases could increase the amounts of a plant's internal compounds that act against pests.

People's perceptions about climate change derive not from any direct measurements of climate but from the way the climate affects their immediate surroundings and livelihood. For people in the central Himalaya, a good climate means sporadic low rainfall from March to mid-May; peak rainfall during July–August; moderate rainfall/heavy snowfall during December–January; and an absence of cloudbursts. People consider onset of the monsoon to be more uncertain compared with other phases of rainfall. Climate changes felt in the recent decades included a shift in peak rainfall time from July/August to August/September and winter precipitation from December/January/February and increase in frequency of cloudburst and warming (see Table 10).

Table 10: Perceptions of climate change and impacts on agriculture

Kind of Change	Evidence
Warming	Decline in snowfall period, depth and persistence, decline in apple yield, success of cabbage/pea/tomato cultivation in high elevations in recent years, shortening of maturity period of winter crops, increased pest infestation
Decline in rainfall during March–May	Large-scale mortality, abandonment of *Panicum milliaceum* in rain-fed area, declining yields of amaranth
High rainfall during August/September instead during the normal peak in July/August	Damage to rainy season crops when they are close to maturity, increased frequency and severity of landslides
Winter precipitation in January/February instead of in December/January and decline in intensity of snowfall	Delayed sowing of winter crops, decline in barley and wheat yields
Increase in instances of cloudbursts	Heavy losses of life and property

5.3 Issues, Challenges and Priorities

5.3.1 Main Issues and Challenges

- *Majority of small, marginal and fragmented land holdings.* About 70% of the land holdings are less than 1 ha in size and cover about 27% of the area under cultivation,

while about 26% of the land holdings are between 1 and 4 ha in size, covering about 51% of the total cultivated area. As a large number of the holdings fall under the small and marginal category, application of economies of scale is difficult.

- *Predominance of rain-fed agriculture.* About 55% of the area in the state is under rain-fed agriculture. Irrigation facilities are limited to the plain areas and valleys. In the hills the ratio between net irrigated area and net sown area is about 11%, while the same for the plains is 91%.
- *Problem of soil erosion.* Soil erosion is a constant problem, with about 88% of the area experiencing soil erosion of more than 10 t/ha/year (above the permissible soil loss limit) and 35% of the area suffering from very severe soil erosion (>40 t/ha/year).
- *Limitation of use of farm machinery in hill areas.* Mechanization has the potential to improve productivity; however, several factors inhibit the use of improved farm machinery in hills, including the poor purchasing power of farmers.
- *Crop depredation by wildlife.* More than 70% of the area is under forests and has a rich flora and fauna. As such, most of the villages adjoin or are in close proximity to forest areas. Reports and incidences of crop depredation by wildlife—especially by monkeys and wild pigs—are on the rise and are perceived as a serious threat to agriculture.
- *Higher cost of production for agriculture in the hills.* Owing to limitations to the use of improved methods and techniques in hill agriculture, the cost of cultivation is much higher. Consequently, youth are reluctant to engage in farm practices. Enhancement of subsidies on various agricultural inputs to 50% is required.
- *Migration and impacts.* A significant migration is taking place, especially from the hill districts—many farmers are leaving their areas and migrating to cities and towns in search of better livelihood options, leaving their lands fallow and uncultivated.
- *Inadequate infrastructure in agriculture.* Inadequate value addition, storage and agro-processing units; non-availability of cold storages; and a lack of road and transportation are a big constraint to marketing.
- *Low (and often unavailability of timely) inputs and access to last-mile connectivity for extension services in agriculture due to unavailability of agri-inputs on time.* Inaccessible terrain and institutional issues hamper the availability of timely inputs and connection to efficient and effective extension services (despite the state having excellent research facilities, tried and tested sources of extension products and services).
- *Continued vicious cycle.* The cycle of low production, low productivity, low input supply, non-awareness of new technologies and lack of extension support leaves the farmer practicing inefficient farming operations.
- *Reduction in crop genetic diversity.* This is with respect to local/land races.
- *Most of the land is owned by men but women till the land*—In the hilly agro-based economy, land primarily belongs to men though majority of them work outside their villages, leaving their womenfolk to till the land. Not owning the land prevents women from accessing many government programmes and schemes as these accrue to land owners rather than to farm workers. In the wake of climate change, this also prevents women from taking quick decisions on even basic matters such as what crops to sow and what farming practices to adopt in order to adapt to climate vagaries.

5.3.2 Priorities

Food and nutritional security

- Improvement of soil health in plains areas and soil and water conservation in hilly areas.
- Development and extension of farm economic models under the farming system approach in the organic mode for small and marginal farmers and market base diversification of agriculture.
- Water management for irrigation—maintenance of old infrastructure and creation of new infrastructure.
- Revitalization of rain-fed agriculture.
- Promotion of production of nutritional/coarse cereals, pulses and oilseeds.
- Identification of problems relating to crop production and intervention based on the research, education and extension system.
- Standardization and quality control of agricultural inputs.
- Promotion of voluntary consolidation of holdings and co-operative or contract farming.
- Watershed management-based long-term planning and implementation for development of agriculture, forestry, horticulture, fisheries and animal husbandry.
- Optimal use of public–private resources for extension in multi-dimensional agriculture.
- Organization of Krishak Mahotsava each year before the rabi–kharif sowing seasons.

Economic security of farmers

- Promotion of mechanization and development of infrastructure facilities in agriculture and market intervention to ensure the payment of fair prices to farmers for their produce.
- Establishment of Special Agriculture Zone and promotion of agriculture-based industries.
- Institutional and policy reforms in agricultural marketing.
- Promotion of electronic literacy among farmers.
- Management of pre-harvest and post-harvest basic facilities such as crop loans, crop insurance, marketing centres, storage and collection centres and cold storages. Farmers' information and advisory centres will be established at each block.
- Promotion for quality improvement in agriculture production according to the norms of inland and international markets.
- Promotion of PPPs in various fields of agriculture.

Sustainable agriculture, conservation of biodiversity and environmental security

- Promotion of sustainable agriculture.
- Establishment of gene banks to conserve agro-biodiversity.
- Eradication of invasive alien species.
- Documentation of traditional knowledge.

- Complete crop diversification of hill rain-fed agriculture into organic mode and horticulture by 2020.

Agriculture education and research

- Emphasis on rain-fed farming, floriculture, fisheries, agricultural economics, agricultural management, post-harvest technology, etc.
- Short-term courses under formal education system and distance learning system.
- Establishment of Syllabus Improvement Cell under the control of Extension Directorate of G.B. Pant University of Agriculture and Technology.
- Separate university of horticulture and forestry in the state.
- Use of information technology in agricultural production and rural development.
- Conservation of traditional knowledge and enhancement of its use in local agriculture.

5.4 Relevant Existing Initiatives

Some of the existing agricultural policies and programmes targeting increased agricultural production in Uttarakhand are very relevant in the context of climate change. Watershed management programmes, soil and water conservation initiatives, rainwater harvesting, input availability and efficiency, mechanization, promoting horticulture and medicinal cultivation and compensation for crop depredation by wildlife, are particularly relevant. Some of the key programmes in the agriculture sector in the state relevant to the context of climate change are described below.

Watershed management. Anchored by the WMD, the decisions regarding the effective management of watersheds in the State are taken through active participation of all stakeholders, particularly the local people. The main objective of the watershed management programme is 'to improve the productive potential of natural resources and increase incomes of rural inhabitants in selected watersheds through socially inclusive, institutionally and environmentally sustainable approaches'. There are 1,110 micro watersheds in Uttarakhand, out of which 584 are being treated by various agencies/programmes such as the Employment Assurance Programme and the Uttarakhand Decentralized Watershed Development Project (UDWDP). Around 204 micro watersheds are snowbound and do not require treatment. However, still there are 322 micro watersheds that have not been taken up for treatment.

Soil and water conservation programme. Uttarakhand is having serious problems of soil erosion. About 88% of the area is experiencing soil erosion of more than 10 T/ha/year (above the permissible soil loss limit) and 35% of the area is suffering from very severe soil erosion (>40 T/ha/year). Landslides, mine-spoils and torrents are the main causes of massive erosion. Ecological degradation in the mountain region is a threat of huge proportions, affecting agricultural lands as well as the rural habitations. As the watershed development programme is spatially and temporally limited in scope, this needs to be supplemented with soil and water conservation programmes in critically affected regions. Therefore, strategies are being developed for distinct zones for development of crops and a package of practices for each of the focus zones. Each of the focus zones has potential for niche crops and unique eco-sustainable practices that need to be leveraged for high income generation and corresponding economic growth in a sustainable manner. A mechanism is being developed for dissemination of information on the weather, market prices and market demands and other related extension services.

Increasing the availability of inputs. Currently, agricultural inputs in different regions of the state are being increased by providing considerable subsidies for the inputs. Krishi Mahotsavs are being arranged twice in a year in the rabi and kharif seasons, in which all the agricultural inputs are made available to the farmers. Not only inputs but also expert advice is given to the farmers. A scheme for production and distribution of improved seeds has been implemented in Uttarakhand with a 100% central share. There are different programmes under this scheme such as (1) aid for transportation of seed, (2) establishment of seed banks, (3) controlling quality through the National Seeds Research and Training Centre, (4) a seed village programme, (5) strengthening the services for seed replacements, (6) seed production in the private sector, (7) human resource development, (8) promoting seed export, (9) production of seeds of hybrid rice and (10) use of biotechnology in agriculture. Most of the programmes are being handled by the Tarai Development Corporation (TDC).

Increasing the seed replacement ratio. Currently, the seed replacement ratio in the plains of Uttarakhand is 10%–12%, while it is only 3%–4% in the hill region. It is one of the major factors responsible for low productivity. Efforts are now on to ensure the availability of seed. Also, technology to produce good quality of seeds is being made available to farmers through TDC (responsible for producing, procuring, certifying and distributing quality seeds).

Promoting organic farming. Yield levels can be effectively raised in a stable and sustainable manner by adopting organic farming methods, since extensive use of chemical fertilizers may ultimately lead to soil deterioration. Currently, the use of fertilizers in the hill districts is very low and around 10,000 ha is under organic farming, covering over 15,000 farmers and 45 crops. The key objective of orientation towards organic farming is to improve crop productivity, soil health and the income of the farmers. Organic products have a parallel market, which, if captured in a strategic manner, can lead to rapid development of these hill districts. Uttarakhand is the first state of the country to be declared as an organic state. UOCB came into existence to promote and coordinate dispersed organic activities and efforts for organic farming in the state. Trainings in organic food processing and value addition have been imparted to producer groups, but inadequate infrastructural facilities hamper the efforts. It is necessary to integrate the farmers to generate surpluses for exports, but the physical geography of the hill villages makes this difficult. Another issue is in branding organic products for premium sales.

Promoting horticulture and ago-horticulture. In addition to staple foods, the hill districts of Uttarakhand have diversified into the production of spices and condiments such as chillies, ginger and garlic. The area under these is as high as 2,275 ha in Almora, 1,098 ha in Champawat and 962 ha in Pithoragarh. Some parts of Pauri District grow sugarcane also. The area under fruit cultivation is quite high in Uttarkashi and almost all hill districts have vegetable cultivation. There is great potential for diversification into oilseeds such as sesamum, rapeseed, mustard and soybean. These will contribute towards increasing income in the hill regions.

Herbal and medicinal plants. Uttarakhand has observed an increase in the area under cultivation of medicinal and aromatic plants (MAPs). This positive change in attitude of farmers towards MAPs is because of the high returns. Intercropping of MAPs with foodgrains can help diversify the income basket for small and marginal farmers. The state has the Herbal Research and Development Institute (HRDI), which works on MAPs used in cosmetics, soaps and perfumes. Although the productivity of land in the hills is very low, there is a huge demand and ready market for MAPs. The HRDI has identified areas in selected hill regions where MAPs can be grown and has adopted a cluster approach that includes production and processing. The HRDI has tried to install processing units among the

clusters of farmers close to their farms. The Institute also has storage facilities where farmers can store their oil extracts if they are not sold at an appropriate price in the market.

There is huge commercial potential for the oils and essences extracted from MAPs. Aromatic plants such as lemon grass, citronella, palmarosa, chamomilla, tulsi, geranium, naramotha, Japanese mint, khus and marigold are used extensively in the cosmetics industry. The main problems are the high cost of processing and the difficulty of getting buyers to the processing units. There is also huge scope for medicinal plants and medicinal trees such as tejpatta, amla, harad, ritha and bahera. To increase production and productivity, it is important to spread the cluster approach and facilitate low-cost processing. The Forest Development Corporation has made 3–4 mandis where auctions of MAPs take place. There is a need to take appropriate measures for improving the productivity and production of herbal and medicinal plants and their trade in the state. MAPs can be a strong option for diversification, provided proper linkages with the market can be developed.

Promoting mechanization. The state has been providing improved agricultural machinery, tools, devices and implements to farmers at subsidized rates. Whereas in the hilly region, lightweight machinery, implements and tools are popular, in the plains, power machinery, tractors and tractor-driven implements are common. Water-lifting pumps, sprinkler sets and plant protection implements are also provided. A scheme with 100% central government support is in operation to popularize the different implements through demonstrations in Uttarakhand.

Extension reforms. The need for reforms in agriculture extension has been explicitly raised in the National Agriculture Policy (NAP), the report of the Expenditure Reforms Commission, as well as the XI Plan. Keeping the recommendations of these policy initiatives in view and to provide policy directives for extension reforms, a broad policy framework for agriculture extension has been developed with elements of reforming public sector extension, promoting the private sector to effectively complement, supplement and wherever possible substitute public extension, augmenting the support of the media and information technology for extension, mainstreaming gender concerns in extension and capacity building/upgrading skills of farmers and extension functionaries.

This programme was started in 2005/06 and is being implemented at the district level through the Agriculture Technology Management Agency (ATMA). This scheme is running in eight districts, viz. Dehradun, Nainital, Almora, Chamoli, Champawat, Udhamsingh Nagar, Uttarkashi and Pauri. Activities in the remaining districts are being conducted under macro-management agriculture. Another scheme for extension reforms is being operated in the state with the help of the GoI, which is contributing 90% of the cost of the scheme. Under this initiative, different small schemes are operational, such as SAMETI (State Agriculture Management and Extension Training Institute, Pantnagar) and ATMA.

Agricultural insurance. Rashtriya Krishi Bima Yojna (RKBY) was introduced in 2002/03 as a centrally sponsored programme, equally funded by the central and state governments. The objective of the scheme is to insure selected crops against natural calamities such as flood, drought, pest attack and epidemics. Paddy, wheat and mandua are the main crops covered under this scheme. This programme is being implemented by Bhartiya Krishi Beema Company Ltd.

Agro-climatic Planning and Information Bank (APIB). To harness the natural resources in a sustainable manner, the Government of Uttarakhand has started detailed mapping of natural resources. For this purpose, APIB has been established in the Ministry of Agriculture, with the Department of Agriculture being the implementing agency and the Indian Institute of

Technology (IIT)—Roorkee and the Indian Institute of Remote Sensing (IIRS) (Dehradun) being collaborating agencies. Technical and financial sanction has been accorded by the Ministry of Agriculture, GoI for three pilot phase districts: Pauri, Hardwar and Champawat. Remote-sensing images of IRS P6 LISS IV, 5.8 m resolution, 1:10,000 scale and LANDSAT MSS and Geomatics Technologies are being utilized. In addition, field surveys to collect, collate and interpret spatial and non-spatial data will also be carried out.

Strengthening agricultural statistics. Accurate knowledge on agricultural produce is very important for framing policies and taking timely decisions. With this objective, two different schemes ((1) timely reporting of agricultural statistics and (2) improvement of crop statistics) are in operation in the state, fully funded by the GoI.

Rashtriya Krishi Vikas Yojna (RKVY). This centrally sponsored programme has been implemented in the state for promotion of investment in the agricultural sector. Under the RKVY, different programmes are being undertaken on the basis of agro-ecological situations, available technologies and natural resources to increase the incomes of stakeholders.

Mukhyamantri Food Security Mission. The scheme has been launched in Uttarakhand to provide food security to people. It is envisaged that every year 10,000 ha of uncultivated/fallow land will be treated to increase the share of cultivated land. Cultivation of legume crops will be promoted on the treated land. It is also proposed to replace the rice crop with legume and maize crops to increase the productivity of the land.

Plant protection. Under this scheme, a subsidy is provided for recommended chemicals, bio-fertilizers, micronutrients, etc. to protect and increase the productivity of crops. A 50% subsidy is given on the purchase of above-mentioned inputs by the central government. However, for schedule castes and scheduled tribes, the subsidy is up to 90%. In the year 2010/11, a provision for a 50% subsidy has been made to promote the cultivation of green manure.

Laboratories to support agriculture. Several dedicated laboratories have been established for the advancement and adaptation of agricultural technology in the state.

Kissan Soochana and Salah Kendra. Under this scheme, information and advisement centres are established to advise farmers about technological advances in agriculture. All the centres are being connected with the Internet for faster communication and retrieval of information. Meetings are also organized from time to time to impart agro-technology. So far, 64 centres have been established in the state.

Ensuring finance and credit. Uttarakhand has started implementing the Pradhan Mantri Rojgar Yojna (PMRY) in the state from 2004/05 for the benefit of successful small-scale industries (SSIs) that are willing to expand their ventures. Under this scheme, all PMRY beneficiaries who have been regularly repaying the instalments of their loan and have a good track record and desire to expand projects are being supported.

5.5 Sectoral Vision and Strategies

5.5.1 Sectoral Vision and Commitment

Uttarakhand is situated in the Himalaya, where maintenance of the ecological balance is of vital importance. Proper land and water management with due emphasis on agricultural extension has tremendous opportunities for increasing nutritional food security. Therefore, treatment of the catchment area and practices of sustainable agriculture are of utmost importance. Additionally, considering that most of the agriculture in the state is rain-fed, revitalizing this sub-sector will be a high-priority agenda.

5.5.2 Strategies

For improving the scientific knowledge and evidence base and understanding climate change and its impacts, a range of research projects/initiatives are proposed, including the following:

- Sub-sector study on revitalization of rain-fed agriculture in Uttarakhand.
- Evaluation of major hill crops for tolerance of different situations of drought stress, terminal heat stress and cold stress.
- Screening of suitable crops/crop varieties for varying weather under field situations to fit in the crop rotations, inter-cropping and mixed cropping.
- Impact assessment of climate change/climate variability on yield trend of major hill crops through the InfoCrop crop simulation model.
- Analysing the impact of the climate on production, demand and supply in a changing market economy.
- Studies to minimize soil and water losses through resource conservation technologies.
- Development of the Integrated Farming System Model for different agro-ecological situations.
- Identification and improving availability of suitable inocula for composting.
- Promotion of traditional crops such as various millets.
- Use of information and communication technologies including mobile telephony for dissemination of information about weather forecasts such as the arrival of the monsoon and precipitation.
- Promotion of Rashtriya Krishi Bima Yojana.
- Resource conservation through appropriate mechanization techniques.
- Contingency crop planning for changing weather conditions through alterations of production technology.
- Preservation of genetic material of various indigenous varieties.

The broad elements of the adaptation strategy in agriculture sector in Uttarakhand will include[28] (a) investments in adaptation research capacity (varieties, land use systems, resource conservation technologies, pest surveillance, traditional knowledge in agriculture); (b) changes in policies (e.g. incentives for resource conservation, integrated and diversified farming systems, promoting organic farming, pricing of resources, credit for transition to adaptation technologies); (c) investments in infrastructure for water management and soil conservation; (d) relocation to more productive areas and practices; (e) greater insurance coverage for the farming operations; (f) improved information, knowledge base and dissemination of information on climate changes and options to adapt to them; (g) creating alternate livelihood options, etc.

Similarly, from the point of view of improvement of crops and systems, the adaptation strategy includes the following elements: (a) natural adaptation—crops and animals show varying ability to adapt to climate variability by shifting their optimum thermal range; (b) genetic adaptation—breeding crop varieties for heat tolerance through conventional/modern

[28] Singh S D., Impacts of Climate Change on Agriculture, Indian Agriculture Research Institute.

breeding techniques and screening heat-tolerant crop genotypes followed by exploitation of desirable genes, mainly in germplasm adapted to such conditions; (c) non-genetic adaptation—agro-physiological interventions such as dates of sowing, frequent irrigation, changes in agronomic practices, crop diversification and green manuring to reduce vulnerability to climate change and identification of crop genotypes for faster grain growth rates with delayed leaf senescence under higher thermal regimes; (d) crop insurance—reducing climatic risks of crop productivity through crop insurance; and (e) better support prices and credits—better support prices for agricultural produce and bank credits are essential for crop sustainability and for meeting the additional adaptation costs of climate change. Post-harvest storage infrastructure augmentation as well as promotion of value addition and food processing will be given additional emphasis. The state will also take steps to promote apiculture and reduce current threats to honey bees with a view to boosting agricultural productivity.

Under the capacity development, education and awareness components and regular training of the farmers will be taken up in order to make them understand the impact of climate change on agriculture and to take appropriate measures to protect crop and to increase the productivity. Village knowledge centres (VKCs) in clusters of villages will be established with Internet and satellite-based linking (EDUSAT). A technical person (Krishi Mitra) may be designated at each knowledge centre to assist farmers in day-to-day agricultural operations and will maintain the VKC. Krishi Mitras can be trained agricultural institutions such as Govind Ballabh Pant University of Agriculture and Technology (GBPUA&T), Pantnagar, Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora and National Academy of Agricultural Research Management (NAARM), Hyderabad.

To connect science, practice and policy, efforts will be made to review existing policies and amendments made towards evidence-based policy making. Policy measures that support the priorities of the sector under the UAPCC will be strengthened and the support base required for such strengthening will be ensured.

Women's involvement in an agricultural capacity is high in the state and likely to be most adversely affected by the impacts of climate change. In these contexts, the responsibility for adaptation is likely to fall on their shoulders—including finding alternative ways to feed their family. However, statutory and/or customary laws often restrict women's property and land rights and make it difficult for them to access credit and agricultural extension services, while also reducing their incentives to engage in environmentally sustainable farming practices and make long-term investments in land rehabilitation and soil quality. Despite these obstacles, recent evidence demonstrates that women who are already experiencing the effects of weather-related hazards—such as erratic monsoon patterns, flooding and extended periods of drought—are developing effective coping strategies, which include adapting their farming practices. Therefore, efforts will be made to further recognize and support the role of women in adaptation, including promoting women's involvement in decision-making processes and implementation. Also, given the key role of women in agriculture, efforts will be especially made so that gender-disaggregated data become available.

*****

6 Forests and Biodiversity

6.1 Overview—Characteristics and Status of Forests

Uttarakhand has about 71% of its land under forests. The variation in the landscape has created a highly diverse *flora* and *fauna* and, consequently, resources. The various classification of forests in the state as per the legal status is provided in Table 11[29].

Table 11: Details of classification of forests as per legal status

Category	Area (in km^2)	% of Geographical Area
Reserved Forests	24,642.932	46.08
Protected Forests	154.021	0.29
Civil & Soyam Forests	9,730.555	18.19
Private Forests	123.506	0.23
Increase in Forest Area in Pithoragarh Forest Division	3,348.510	6.26
Total	**37,999.524**	**71.05**

Details of the forest and tree cover data of Uttarakhand[30] is given in Table 12.

Table 12: Details of forest and tree cover

Category	Area (in km^2)	% of Geographical Area
Tree Cover	642	1.20
Forest Cover	24,496	45.80
Forest and Tree Cover	**25,138**	**47.00**

Reserved Forests constitute about 71.1% of the total forest area, Protected Forests around 28.52% and Unclassified Forests about 0.35% (Figure 23). The State has six national parks, six wildlife sanctuaries and two conservation reserves constituting about 13.79% of its geographical area. A forest cover map of the State is given in Figure 23.

[29] Uttarakhand Forest Statistics, 2012-13, Forest Department, Uttarakhand

[30] India State of Forest Report, 2011

Figure 23: Statistics related to the percentage of forest cover of Uttarakhand[31]

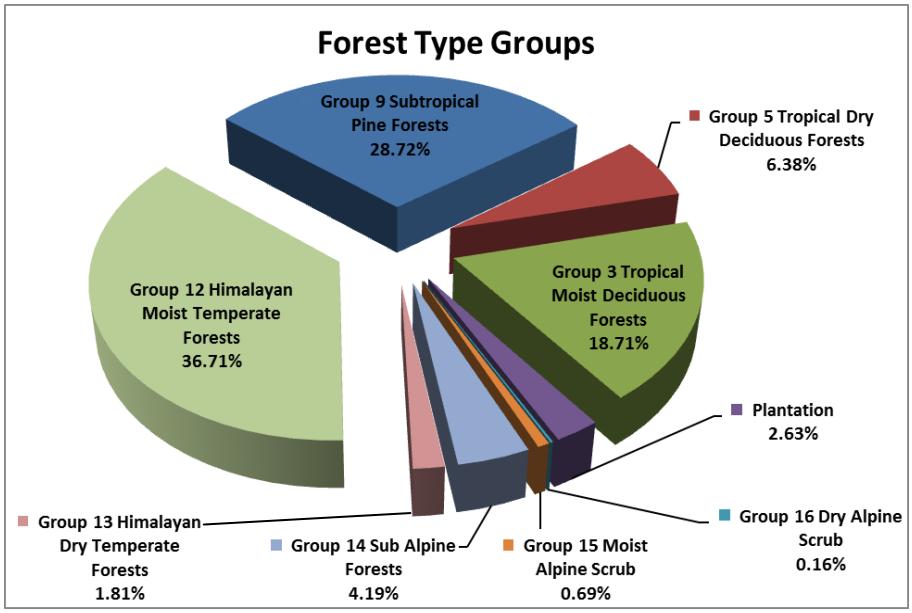
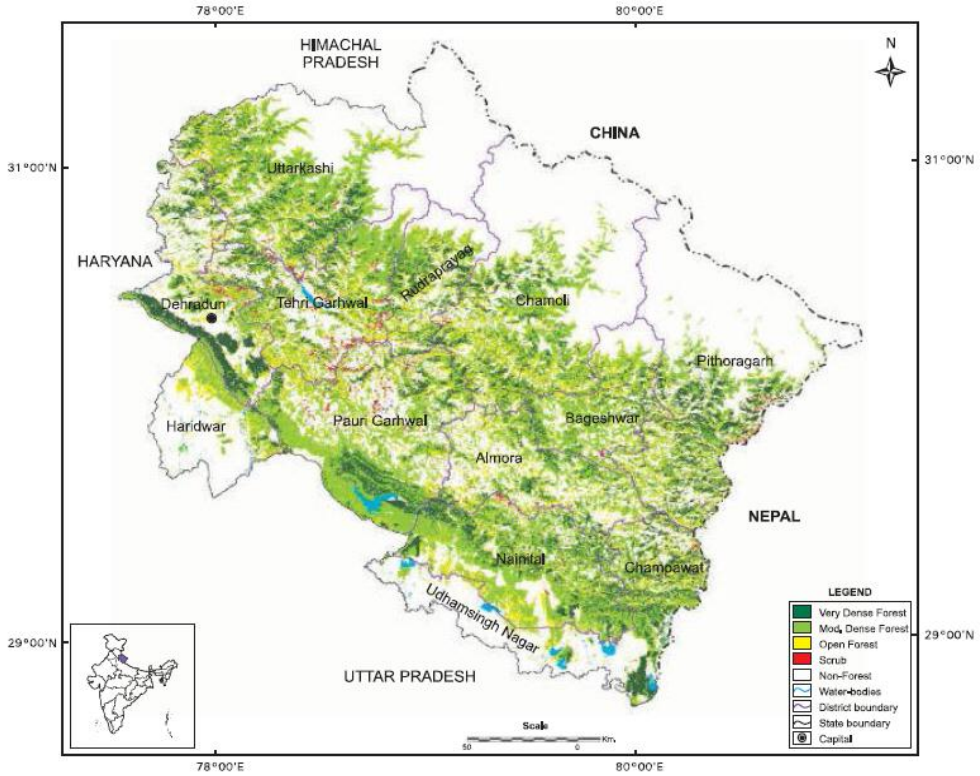


Figure 24: Forest cover map of Uttarakhand (Source: Forest Survey of India)



31 *Ibid.*

The district-wise forest cover in Uttarakhand is indicated in Table 13[32]:

Table 13: District-wise forest cover in Uttarakhand

District	Geographical Area	2011 Assessment				Percent of GA	Change	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Almora	3,139	222	928	427	1,577	50.24	0	10
Bageshwar	2,246	194	883	304	1,381	61.49	0	4
Chamoli	8,030	427	1,586	682	2,695	33.56	0	6
Champawat	1,766	336	571	274	1,181	66.87	0	8
Dehradun	3,088	584	695	328	1,607	52.04	0	24
Pauri Garhwal	5,329	523	2,094	672	3,289	61.72	0	59
Haridwar	2,360	26	353	240	619	26.23	1	0
Nainital	4,251	601	1,923	566	3,090	72.69	-3	13
Pithoragarh	7,090	567	1,115	412	2,094	29.53	0	32
Rudraprayag	1,984	246	581	298	1,125	56.70	0	5
Tehri Garhwal	3,642	298	1,232	617	2,147	58.95	0	89
Udham Singh Nagar	2,542	171	247	128	546	21.48	3	0
Uttarkashi	8,016	567	1,959	619	3,145	39.23	0	21
Grand Total	**53,483**	**4,762**	**14,167**	**5,567**	**24,496**	**45.80**	**1**	**271**

6.2 Overview—Characteristics and Status of Biological Diversity

There are several ecosystems in Uttarakhand, namely forest ecosystems, agro ecosystems, aquatic ecosystems, grassland ecosystems, wetland ecosystems, cold desert ecosystems, urban ecosystems and human ecosystems. The forest ecosystem is the largest ecosystem in the state and supports other ecosystems actively.

6.2.1 Floral diversity

According to scientific studies carried out by the Botanical Survey of India (BSI), Uttarakhand is a floristically super-diverse state, with ca. 4,700 species of flowering plant, representing nearly 25% of the Indian angiosperm flora, reported. This vast diversity, under 1,503 genera and 213 families of flowering plant, including 93 endemic species, is found in various vegetation types, ranging from the sub-tropical forests in the upper Gangetic plain and Shivalik zone in the south to the arctic–alpine vegetation of the trans-Himalayan cold desert in the north. Besides 487 species of fern, of which 15 species are endemic, 18 species of gymnosperm are also reported from the state. Every now and then a new species is discovered during the taxonomical surveys conducted by various agencies.

6.2.2 Faunal diversity

Uttarakhand is bestowed with a great faunal diversity. It is home to many species of bird, mammal and reptile and to threatened and endemic species. According to the Northern Regional Centre (Dehradun) of the Zoological Survey of India (ZSI), Uttarakhand has a faunal biodiversity that has 3,748 species belonging to 1,848 genera and 427 families, both vertebrate and invertebrate. To be precise, there are 499 genera with 1,060 vertebrates and 1,349 genera with 2,688 species of invertebrate found in Uttarakhand. Of these, 451 species

[32] *ibid*

have been reported by researchers for the first time from Uttarakhand, constituting new records for the state. Twenty-two of these are also new records for India. Thirty-five species reported from Uttarakhand are endemic to the state, while one is endemic to India. The enormous faunal diversity is represented by 102 species of mammal (which is about 25% of the known Indian species), 743 species of bird, including migratory winter visitors (representing 60% of the Indian avifauna, second only to Assam), 72 species of reptile and about 439 species of butterfly. While the butterflies are an indicator of the good health of the ecosystem, the mayflies, dragonflies and damselflies are indicators of the quality of water and are represented by more than 200 species in Uttarakhand alone.

The mammalian diversity of Uttarakhand is ca. 23% of the total mammalian diversity of India. The state is represented by 7 families, 26 genera and 55 species of the order Carnivora, which forms 40% of the total Indian carnivore diversity. The avian diversity constitutes about 60% of the known Indian diversity. Out of 743 avian species, 43 are listed under the threatened category. The reptilian diversity of Uttarakhand constitutes about 15% of the Indian reptile diversity. The amphibian diversity of the state constitutes about 8% of the total amphibian diversity of India. Uttarakhand has a total of 132 species of fish out of the 2,546 species of fish found in India. Of these 132 species, 10 species are endangered (7.5%), while 10 species are exotic (7.5%) and 11 species (8.3%) are endemic. Uttarakhand is a storehouse of the invertebrate diversity of the country. A total of 2,688 species are known from 1,349 genera, with 35 species endemic to the state, while 10 out of these 35 species are endemic to the country also.

6.3 Vulnerability to Climate Change

No detailed assessment of vulnerability of the sector to climate change exists; however, available evidence suggests that the general effect of projected climate change is that the habitat of many species will move poleward of upward from their current locations. Disturbances can increase the rate of species loss and create opportunities for establishment of new species. The abrupt changes in climatic conditions in the mountainous part of the Himalaya are directly or indirectly affecting the vegetation development and regeneration of important species. The variation in rainfall and temperature may lead the variations in phenological events of many species, particularly the dominant oaks. Some early studies on phenological aspects of tree and shrub species in the Himalayan region are available and could potentially be used as base line data would be helpful to predict the vegetation—climate change response and adaptation of species in such conditions. Alpine ecosystems are particularly vulnerable to warming, as species occurring near the mountaintops will have no space for their upward march. The regeneration of many species is dependent on the monsoon rainfall especially the dominant Sal, *banj* oak and *telonj* oak. The variation in such conditions may adversely affect the regeneration and growth of these species. Similarly many other species are vulnerable to the climate change phenomenon.

6.4 Issues, Challenges and Priorities

The IPCC Fourth Assessment Report spells out the following key vulnerabilities:

- The Himalayan ecosystem is particularly at risk with the rise in global temperatures. The biodiversity which resides in the higher altitudes will have less and less place to occupy and will be at increased risk of extinction.
- The increase in global temperatures will cause an increased occurrence of GLOFs (glacial lake outburst floods) and will affect the size of the glacial lakes. The breakage of such lakes can be extremely devastating to human habitations, among others.

- It can be stated that the precipitation will be with increased intensity and will become more erratic. This will make the fragile ecosystems susceptible to damage by cloudbursts, increased soil erosion, etc. The overall pattern of rainfall is expected to be heavy rainfall followed by long period of droughts. This will reduce the overall availability of water in the hills.
- The alpine meadows have high soil organic content and are very good at sequestering carbon. They are also extremely rich in biodiversity. The increase in global temperatures threatens the existence of alpine meadows and makes them vulnerable to extinction.
- There will be a gradual shift of plant species towards higher altitudes. This will force local communities to shift to newer agricultural and fodder species. Because of this and the fact that the area lies in a highly sensitive seismic zone, there is bound to be a heavy stress on the housing sector.
- Increased tourism activities will cause severe stresses on the fragile Himalayan ecosystems, which are already reeling under the pressure of water scarcity, excessive constructions, heavy usage of fuel wood and improper waste management, to name a few.

The 4 × 4 assessment has projected that there will be changes in forest vegetation types with the rise in temperature and the Himalayan region has been shown to be the most vulnerable to this shift. The Indian network for climate change assessment (INCCA) also projects that the temperature increase is likely to be 0.9°C to 2.6°C by the 2030s, compared with the 1970s and a 2%–12% increase in the intensity of precipitation. Increases in the frequency of forest fires and glacial melts have also been projected.

6.5 Relevant Existing Initiatives

Uttarakhand is rich in forests and has a long history of scientific forest management. It has an excellent protected area network. The state has village-level institutions that are adept at managing chunks of forests, which are called *Van* Panchayats. Presently 12,089 *Van* Panchayats are entrusted with the management of over 5,449.64 km^2 of forests. Forestry operations are being carried out under various state and centre-sponsored schemes, with an annual average planting of 10,000 to 15,000 ha.

A major portion of the forests is managed by the Forest Department in accordance with management plans, which are updated on a 10-year basis. Besides, there are panchayat forests managed by the *Van* Panchayats, traditional village-level institutions with a legal backing, in addition to revenue and private forests. Traditionally the forestry and biodiversity sector has been conservation oriented, with a special thrust on the participation of local communities. There is a moratorium on the felling of green trees above an altitude of 1,000 m. The climate consideration is already becoming an integral part in the formulation of management plans. The department has already constituted a Green India Mission Cell and a 10-year perspective plan is in the process of finalization under the mission.

The rich and varied biodiversity of the state has attracted naturalists, wildlifers, taxonomists and conservationists since time immemorial and the state has been explored extensively. Comprehensive information on the floral and faunal resources of the state has been recorded and published by various agencies including the Forest Research Institute (Dehradun), universities, individual researchers, the BSI and the ZSI. The state has a network of with one biosphere reserve, six national parks, six wildlife sanctuaries and two conservation reserves to conserve its biodiversity. The Bharat Ratna Pandit G.B. Pant High Altitude Zoo, at Nainital, is a valuable centre for *ex situ* conservation of high-altitude wild fauna.

6.6 Sectoral Strategies

6.6.1 Sectoral Vision and Commitment

The overall sectoral vision and commitment will be to improve forest and biodiversity management practices through multiple strategies and initiatives in the state to minimize the impacts of climate change and for the overall well-being of the state and its people.

6.6.2 Strategies

For improving the scientific knowledge and evidence base on climate change and its impacts, the following will be taken up for immediate research under the Forest Department:

- Evaluation of total carbon stock and annual increment for Uttarakhand.
- Monitoring the carbon fluxes of forests in various ecological and altitudinal zones.
- RS-GIS analysis of the whole state to evaluate/monitor the carbon stock.
- *Ex situ* conservation of the genetic diversity of both the flora and fauna.
- Documentation and monitoring of the biodiversity of various ecosystems.
- Development of appropriate silvicultural techniques with climate change considerations.
- Research on the eradication of invasive alien species.
- Management of forest fires.
- Monitoring the population dynamics and movements of wildlife.

Likewise, the following will be taken up by the Uttarakhand Biodiversity Board:

- Studying the impacts on high-altitude wetlands, alpine meadows and moraines.
- Documentation of traditional knowledge related to biodiversity.

A decentralized forest governance as envisaged in Mission for a Green India is being developed and strengthened. The emphasis is on revamping local institutions such as *Van* Panchayats, the Forest Development Agency and Biodiversity Management Committees set up under the Forest Rights Act. These institutions are crucial for supporting livelihood activities and prudent use of the natural resource base with a perspective of developing larger landscape-level governance. Capacity development of local institutions and building a cadre of community foresters, especially the unemployed/underemployed youth, are important steps in this direction. The Green India Mission has cited the example of the carbon assessment under 'Project Kyoto: Think Global Act Local' in Lamgarha Block in the state. Partnerships with NGOs will be facilitated for a better organic link with the local communities. Alliances of the forest frontline staff with enthusiastic school children and college students will further pave the way for a constant dialogue with the local communities.

The forestry and biodiversity sector has important links with various other sectors such as agriculture, animal husbandry, water resources and alternative energy. Active involvement of local institutions will be the basis for a holistic development plan for enhancing the adaptive capacity of the people. There will be efforts by the Forest Department to avail benefits under Reducing Emissions from Deforestation and Forest Degradation Plus (REDD+), CDM and other carbon market mechanisms.

With the current pace of warming, the resilience of the ecosystems is also threatened. This hampers the adaptive capacity of the communities. Moreover, this part of the Himalaya

provides water, food and energy security and other ecosystem services to a large part of the sub-continent. The depletion of these ecosystems will have a cascading effect on the adaptive capacity of the vast population downstream. In addition, this area falls under a sensitive seismic zone.

The significant points with respect to the forestry, wildlife and biodiversity sectors are as listed below.

1. There is a need to carry out studies to find out the impact of global change on the carbon mitigating capacity of the forests. There may be significant effects on the growth/decomposition rates, the area, type and intensity of natural disturbances, land-use patterns and ecological services.
2. Since a large portion of the population of Uttarakhand is dependent on forests for their basic needs such as fuel and fodder, any climate response strategy has to be developed with the community in mind. Comparing environmental and social co-benefits and costs with the carbon benefit will help promote sustainable development.
3. Extensive measures need to be taken by using both traditional as well as modern inputs to contain forest fires. With the increase in the temperature, the forests are likely to be more prone to fires. Hence, wildfire management needs to be taken up at a priority basis to combat an increased frequency and intensity of wildfires in the future.
4. The forestry sector also provides opportunities for formulating projects under CDM. REDD+ is a potential global tool in the forestry sector for climate response.

Table 14 represents the inter-relations between parameters of climate change and the evolution of a strategy towards developing adaptation and mitigation potential.

Table 14: Inter-relations between parameters of climate change and the evolution of a strategy for adaptation and mitigation potential[33]

Problem	Impact	How to address?	Objective
Change in vegetation types, die-backs, insect pest attacks, loss of biodiversity	Shrinking sink	Increasing the existing area under forests and trees and improving the quality and density of the degraded forests.	Maximize sink, enhance resilience of forests and ecosystems, avoid possible large leakages
Altitudinal and latitudinal shifts of species	Problem of wildlife corridors	Linking of protected areas	Conserve biodiversity, minimize man-animal conflicts
Increased forest fires	Large leakage	Climate-friendly silviculture, forest fire/disaster management	Retain sink
Increased water stress	(a) Degradation of life support systems	Soil and water conservation, rangelands, agro/farm forestry	Adaptation
	(b) Increase of demand-supply gaps of various forest products	Alternate livelihood options	Adaptation
Extreme events, outbursts of glacial lakes and floods	Housing sector, tourism and others	Alternate materials for construction, regulated tourism	Adaptation

Proposed actions/programmes will include the following:

1. Increasing the existing area under forests and trees and improving the quality and density of the degraded forests. The activities contemplated under this are the following:

[33] Managing Forests for climate Change, FAO, 2010

- Management intervention in scrub forests.
- Plantation of climate-resilient species beneficial also to local communities in open forests according to the principles of three-tier forests.
- Assisted natural regeneration in moderately dense forests.

2. Enhancing natural resources and livelihood options of the vulnerable sections:

- *Rangeland Management*—the threats to rangelands in Uttarakhand can be listed as follows:

  a. Local populations including certain pastoralist nomadic communities, such as gujjars, are highly dependent on the rangelands for grazing their cattle.

  b. The upward movement and shrinkage in areas of high-altitude meadows, unpredictable changes in species assemblages and the possible upward shifting of human habitations in the future are likely to increase pressures on these areas.

  c. The pastoralist nomadic communities, such as gujjars, have concessions for grazing their cattle in the rangelands and bugyals, which might exacerbate the situation.

  The following are action points towards meeting these challenges:

  a. Mapping of all important rangelands using remote sensing and geographical information systems (RS-GIS), followed by ground truthing.

  b. Conservation of high-altitude meadows through local and nomadic communities and related institutions (2,500 ha/year).

  c. Alternate livelihood options for communities such as non-timber forest produce (NTFP) collection, community based eco-tourism, biomass briquetting, establishment of decentralized nurseries and cultivation of medicinal herbs including yarsagambu.).

  d. Improving the variety of cattle.

  e. Protection and management initiatives towards regulated grazing.

- *Agro-forestry*—Agro-forestry provides a rich mix of no-regret options that build the biophysical and socio-economic resilience of natural and societal systems. It can contribute to mitigating current sources of stress, including climate variability and could be relevant to adaptation to future climate change.

  The action points are as follows:

  a. Mapping of all land areas with a potential of agro-forestry using RS-GIS.

  b. R&D for varieties of different species for best commercial use and climate change concerns.

  c. Establishment of quality planting material production centres.

  d. Training programmes and extension activities.

3. Soil and water conservation

The observed warming (over several decades) has been linked to changes in the large-scale hydrological cycle, such as increasing atmospheric water vapour content; changing precipitation patterns, intensity and extremes; reduced snow cover and widespread melting of ice and changes in soil moisture and runoff.

The soil and water conservation activities will include the following:

- Minimizing the human interference in the ecology of the glaciers.
- Identifying vulnerable areas with the help of experts.
- Strategic and scientific planning for road cutting that results in minimal loss of soil and water resources.
- Construction of large-scale rainwater harvesting structures to reduce the water stress in moisture-deficient areas.
- Enhancement of soil and moisture conservation regime by introduction of multi-tier forest plantations.
- Rejuvenation of traditional chals, khals and tals with emphasis on indigenous traditional knowledge.

4. Biodiversity conservation

   The activities related to biodiversity conservation are as follows.

   - Establishment of biodiversity management committees.
   - Making biodiversity registers.
   - Management of invasive species (lantana, parthenium, eupatorium, etc.) and replacement by suitable species (bamboo, grass, etc.).
   - Creation of water holes/anicuts.
   - Maintenance of existing water holes/anicuts.
   - Conservation of wetlands; conducting studies of and managing high-altitude wetlands.
   - Establishing a task force to identify/prioritize corridors.
   - Involve all stakeholders to regulate change of land use.
   - Maintaining cover through agro-forestry, preventing crop raiding in corridors through fencing.
   - Maintenance and development of existing zoos, rescue centres for wildlife and botanical gardens.
   - Maintenance and development of biodiversity centres and biodiversity hotspots.
   - Providing rapid responses in cases of crop raiding and chance encounters of humans with animals, including ex gratia payments.
   - Rehabilitation of rescued wildlife

5. Fire management

   With changes in the monsoon system, short-term, high-intensity precipitation accompanied by intervening drought-like conditions are the major possible threats. According to the studies carried out by the Forest Research Institute (Dehradun), the pine forests shed about 6 T of dry leaves/year/ha. This, along with shifts in forest types and large-scale diebacks, is likely to pose increased fire hazards, calling for more planned operations for management of fires and associated research.

The main components of the strategy that will be adopted for effective fire management are as follows:

- Quick response teams for firefighting.
- Daily monitoring of fire threats with the help of satellite imagery and information technology.
- Utilization of *pirul* (pine needles) as an energy-efficient eco-friendly energy source in the form of briquettes, for making pine needle check dams and in bio-gasifiers for production of electricity and collection of *pirul* instead of controlled burning.

A range of capacity building, education and awareness building measures will be taken up; the Forest Department will undertake a detailed capacity needs assessment, especially the need for frontline field staff/personnel. Additionally, the assessment will also examine the scale and scope of capacity development that should be directed at local communities for sensitizing school children and college students. Appropriate action measures will be designed and taken up based on the capacity needs assessment results.

As climate change is unfolding, the science of climate change too is in the process of development. Nevertheless, adaptation and mitigation efforts are urgently needed corresponding to the existing level of scientific understanding; while efforts will be on to keep refining the data. With further improvements in data and observations, better-informed decisions will emerge at regional levels. Therefore, the Forest Department's strategies will be based on the available evidence and corresponding no-regret options while maintaining rigour and flexibility to detect and respond to any sudden trigger-offs or positive feedbacks. Though the line between long-term and short-term research is very thin and the mandate and requirement of both types of researches vary temporally and spatially, an effort is made below to list the major long- and short-term research goals in the forestry sector of Uttarakhand as part of the Forest Department's efforts to connect science, practice and policy:

- Adapt and develop dynamic vegetation models relevant to tropical and sub-tropical forest types, plantations and natural ecosystems such as wetlands and grasslands.
- Initiate studies to assess the likely impacts of climate change on natural ecosystems and identify vulnerable and sensitive ecosystems such as forests, montane grasslands, plantation systems and *bugyals*.
- Initiate focused short-term field ecological and physiological studies in selected forest type sites to generate parameters for various plant functional types required for dynamic vegetation models.
- Develop an adaptation framework relevant to forest and grassland ecosystems and develop adaptation strategies, practices and management systems.
- Plan and implement pilot adaptation projects to demonstrate effectiveness of adaptation practices.
- Assess the vulnerability of forest-dependent communities to climate impacts.
- Develop programmes to enhance the adaptive capacity of forest-dependent communities.
- Assess the implications of REDD+, forest conservation and sustainable management of forests for Uttarakhand.

- Develop a methodological understanding of carbon stock changes under REDD+, forest conservation and sustainable management activities.
- Develop models for assessing carbon sequestration and the mitigation potential of different forestry and plantation activities.
- Assess the rates of changes in carbon pools under different forest and plantation systems to assist the development of CDM projects, based on cross-sectional studies.
- Develop emission factors for GHG inventories in land-use sectors, forests, grasslands, wetlands, etc.
- Assess the mitigation potential of different bio-energy technologies.
- Assess the environmental impact of plantations of different bio-fuel crops.
- Estimate the land availability for biomass feedstock (woody biomass and oilseeds) and production for energy.
- Assess the competition for land for carbon sequestration versus bio-energy for fossil fuel substitution.
- Assess the impacts of climate change on sustainable biomass feedstock production for energy.

Most of the activities prescribed here are in consonance with the draft proposal of the National Mission for Green India and the National Mission for Sustaining the Himalayan Ecosystem. In addition to the overall common framework for monitoring described in an earlier sub-section, the proposal envisages monitoring at four levels, namely:

- On-ground self-monitoring by the local community, implementing organization and Forest Department.
- Field review by an external agency.
- Remote-sensing-based forest cover monitoring by the Forest Survey of India.
- Intensive monitoring of a few pilot areas by an implementing agency, the Forest Department and a support organization.

It is essential to recognize that, in addition to being crucial carbon stores, forests provide a home and livelihood for several people. Women play a crucial role in agro-forestry, especially when it comes to NTFPs such as food and materials for crafts, building materials, medicines and rituals. The collection of forest materials can also be an important income-generating activity. Women possess extensive local and/or indigenous knowledge about tree species and medicinal and edible plants. In the state, women are the primary guardians of the forests and their rich biodiversity. Policy making in the forest sector is male dominated and tends to neglect the needs and interests of women.

The specialized knowledge of women about forestry, botany, biodiversity and water management makes them critical resources in combating deforestation. To realize their potential, the Forest Department will examine options for adopting policies that support women's leadership and recognize their expertise and support women in combating gender discrimination. It will also take necessary steps to ensure that all forest-protection mechanisms and measures will include affected communities in consultation, decision making and implementation, including effective participation of women in the process. In particular, the historical role and positive contribution of women in the governance and

nurturing of forests will be taken cognisance of, including through steps taken to ensure their full participation in decision making.

Community-based natural resource management requires enhancement of forest-based biomass in the form of food, fuel wood, grass/fodder and timber and non-timber forest products to help the community augment their livelihoods. The concept of the Mahila Kisan Nursery is a step towards empowerment of women. Collection of pine needles is also emerging as a viable option for augmenting livelihoods and reducing fire hazards. Maintenance of ecotourism destinations in partnership with local communities also provides livelihood opportunities. Further, the Forest Department is now in the process of taking steps to address the issue of crop depredation by wildlife, especially monkeys and wild pigs.

A healthy relationship between scientific knowledge and traditional knowledge is very much required for combating climate change. It is required to develop, expand and mainstream traditional adaptation measures into adaptation strategies. Traditional knowledge should be further studied, supported documented and integrated into scientific research.

The private sector can play a role in incentivizing collection and adding value to NTFPs, growing of medicinal plants by the people and promoting agro-forestry and thus enhancing livelihood opportunities. As such, the Forest Department will actively examine the creation of enabling mechanisms for increased roles for the private sector in selected operations/activities in a highly consultative and transparent manner.

*****

7 Livestock and Animal Husbandry

7.1 Overview—Characteristics and Status

Uttarakhand is well endowed with a variety of livestock: cattle, buffaloes, goats, sheep, pigs, horses, ponies, mules and poultry. Large populations and low productivity are the hallmarks of livestock in Uttarakhand, across all species. Individual livestock holdings are small and often have a mix of different species, except in the case of tribal and transhumant communities (large migratory flocks of sheep and goats particularly). Cattle are the most popular and so they are the preponderant species. According to the 2007 round of the Livestock Census, the districts constituting the state of Uttarakhand had 2.24 million cattle, 1.22 million buffaloes, 1.34 million goats, 0.29 million sheep and over 2.60 million poultry. The Livestock Census 2007 summary is given below (Table 15).

Table 15: Uttarakhand livestock summary (2007)

Sl. no.	Species	1997 (lakhs)	2003 (lakhs)	2007 (lakhs)	Change process (%)
1.	Cattle	20.309	21.882	22.351	(+) 1.01
2.	Buffalo	10.943	12.282	12.195	(+) 1.56
3.	Sheep	3.104	2.958	2.904	(–) 0.64
4.	Goat	10.857	11.582	13.353	(+) 2.30%
5.	Equine	0.238	0.174	0.154	(–) 2.66
6.	Pig	0.316	0.327	0.198	(–) 3.73
7.	Poultry	9.723	19.840	26.019	(+) 16.76

The livestock population in Uttarakhand, given its geographical area, is small. Concomitantly, the per-capita distribution of livestock (0.35) is more than the national average (0.24), which is due to the smaller human population of the state. Most of this population is non-descript and low in productivity, across all species. The cattle in Uttarakhand are mostly non-descript and small, but for a small number of cross-breeds: 3.39 lakh in all, just over 15% of the total cattle. The number of breeding females among the cattle was 8.13 lakh in 2007; 6.47 lakh were non-descript and 1.66 lakh were cross-bred (25.66%), most of them being concentrated in the districts of Udham Singh Nagar, Haridwar, Nainital and Dehradun.

Buffaloes are the main dairy animals in Uttarakhand and almost all of them are grades of Murrah from the neighbouring states, brought in for milk production. The growth in buffalo numbers has been some 1.56% per annum over the last 10 years (1997–2007), entirely demand driven, in response to the demands of the growing organized dairy industry in the state. The population size of sheep is smaller and sheep are concentrated in the upper reaches of the districts of Pithoragarh, Pauri, Tehri, Uttarkashi, Rudraprayag, Dehradun and Chamoli. Their holding pattern too is different from the other species (larger flocks, migratory). Goats are common in Uttarakhand, distributed in all districts, with very heavy concentrations in the districts of Almora, Pithoragarh, Pauri and Tehri, widely held across all land-holding categories. The poultry in Uttarakhand, over 60% of them *desi* fowls in backyards, are quite important from the point of view of livelihoods as they are owned almost entirely by marginal farmers. The pig population in Uttarakhand is tiny, seen mostly in the plains and foothills areas around Haridwar, Udhamsingh Nagar and Dehradun; and the ownership entirely confined to marginal farmers.

Over 80% of the rural households own livestock and earn a part of their living out of them. Livestock production is the endeavour of the small holders (marginal, small and landless) and over 80% of all species of livestock and almost 100% of the *desi* poultry in Uttarakhand are owned by them. The livestock sector in Uttarakhand is therefore extremely livelihood intensive and investment in livestock development is critical to rural prosperity. The per-capita bovine population in the state (0.35) is higher than the national average (0.24), whereas the per-animal daily milk production is lower (3.503 kg) than the national average (3.940 kg). Increasing the cattle population for greater production is not an option due to a 36.09% fodder deficit and other logistic constraints in the hills. Increasing the per-animal productivity is the best available option (Table 16).

Table 16: Per-capita availability

Availability (per capita)		
Product	**2009/10**	
	India	**Uttarakhand**
Milk (g/day)	264	388
Meat (kg/year)	3.28	1.013
Egg (numbers/year)	51	26
Fish (kg/year)	4.02	0.350

Uttarakhand has a mix of almost all domesticated species of livestock, very large in numbers and very low in productivity, across the board. In economic terms they are a wealth indeed, low productivity notwithstanding, as the sector supports the livelihoods of nearly 80% of the rural households in the state, at least in part in the majority of cases and fully in some (tribal communities and nomads exclusively living off livestock). Livestock populations in Uttarakhand were growing steadily over the decades until the mid-1970s, which were a watershed of sorts for the livestock sector, as both qualitative and quantitative changes began to set in in the animal populations, reflecting the changes taking place in the state's economy. The most remarkable of these changes are as follows:

- Sharp reduction in the numbers of the working males among the cattle and the consequent slowing of the growth of the *desi* cattle numbers.
- Changes in the male: female ratio among the cattle (ratio moving steadily in favour of the females over the past two decades, rapidly rising cross-bred cow numbers), heralding a shift in the priority of the farming community in bovine production from work animals to milch animals.
- As the growing dairy industry in the state gets organized, the buffalo has claimed its pre-eminent position as the main dairy animal and its population (female) is growing steadily at 1.52% per annum.
- Vigorous market pull pushing up the goat population, in spite of the government policy being loaded against the species.
- The steadily declining numbers of sheep in the face of mounting global competition in wool quality and quantity.
- The burgeoning *desi* fowl population (backyard poultry system), driven by its livelihood intensity, supporting the bottom 40% of the state's poorest of the poor (marginal farmers and rural landless) in terms of household incomes and family nutrition.

Hence decreasing the number of low-production cattle is a priority agenda of the government not only with the objective of increasing milk production but keeping in view the 36.09% deficit of fodder in the state. Hence the concerns of climate change are already being addressed, albeit on a very low scale. There is a need to increase efforts in this direction so that absolute livestock numbers are reduced within a firm timeframe and issues of food security are also addressed at the same time.

7.2 Vulnerability to Climate Change

No detailed vulnerability and risk assessments are currently available for the animal husbandry sector. An important observation put forth by some experts is that the production of greenhouse gases by ruminants through rumen fermentation and degradation of dung is significant in places where intensive livestock rearing is practiced. But in Uttarakhand, as is the case in many parts of India, livestock holdings are small and restricted to a few animals per household. Hence there is no concentrated production of these gases and no mass accumulation of dung. Intensive dairy activities are restricted to only urban and peri-urban areas in Uttarakhand.

It has been envisaged that climate change will bring about an increase in global temperatures, which will have various effects on the agro-climatic situations around the world. Various projections have been made, based on which it has been reasoned that the livestock sector will also be adversely affected. Hence adaptation strategies need to be put in place so that the livestock adapt to these anticipated adverse effects.

Some of the main anticipated effects of rising global temperatures on livestock are changes in disease patterns such as increasing disease morbidity and variations in disease occurrence and decreases in the availability of feed, fodder and water, leading to direct competition between man and animal for scarce food and water resources. Hence, a growing livestock population will lead to an increased demand for feed and fodder, whereas, conversely, increasing global warming will cause a decrease in the production of feed and fodder and shortages of water.

Increases in the global temperature and a changing rainfall profile will seriously affect the pattern of occurrence of livestock diseases. Changes in the climate modify the reproduction, maturation, survival rate and dispersal of vector species and consequently bring about changes in the time, duration, severity, morbidity and mortality of the diseases borne by these vectors.

Though the perceptions of the community with regard to the livestock sector per se have not been documented, changes in the occurrences of particularly two important viral diseases (foot and mouth and *peste des etits ruminants* diseases) have been seen in the past few years. These diseases used to occur in the monsoons and the months immediately after the monsoons. These diseases have now started occurring during the peak of winter and the months immediately following the winter. This in turn is reflected in the increase in demand for vaccination of livestock against these diseases during the winter months.

7.3 Issues, Challenges and Priorities

The livestock sector in Uttarakhand is extremely livelihood intensive and it has been estimated that, in dryland and mountain ecosystems, livestock contributes anywhere between 50% and 75% of the total household income of the rural population (12th Five Year Plan Approach Paper 2012—Planning Commission of India). Adequate support to these massive and highly diverse livestock populations in these regions is needed, commensurate with its importance. A comprehensive programme that specifically raises the capacity of the rural

poor to conserve and manage their livestock resources and enables them to derive sustainable incomes from these resources is necessary. The programme will focus on the dependence of the rural poor on small ruminants such as goats, pigs and promote a range of fodder options for them. Decentralization and convergence of policy support for these options is crucial for diversification of livelihoods in smallholder farming. The issues, challenges and priorities for the livestock sector have been summed up in the matrix in Table 17.

Table 17: Issues, challenges and priorities for the livestock sector

S.No.	Issues	Causes	Challenges	Priorities
1.	Fodder deficit (36.09%)	Limited land under fodder crops in hills, mostly rain-fed. More than 62% of the land under reserve forest. Hence, grazing and harvesting of fodder from these areas restricted. Remote and geographically difficult terrain and limited road connectivity increases the cost of transportation of fodder from plains. No hill-centric R&D towards mitigating this fodder deficit.	To mitigate this fodder deficit using various available technologies, methodologies and opportunities	Policy changes at the level of the GoI permitting the harvesting of green and dry fodder from reserve forests Funding R&D dedicated to developing technologies, fodder varieties specific to the Himalaya
2.	Low per-animal milk production	Most cattle and buffalo populations are non-descript and low-yielding. Feed and fodder deficit	Increasing per-animal milk productivity through breed improvement and replacement with high-yielding animals to some extent	Establishing a buffalo breeding station in Uttarakhand for production of buffalo breeding bulls of superior genetic merit. Establishing livestock markets in the state for easier trade in livestock
3.	Poor infrastructural facilities at veterinary hospitals, dispensaries production support institutions	Budgetary constraints	Upgrading infrastructure and providing the latest equipment and diagnostic facilities in these centres	Increasing monetary provisions under the ESVHD-CSS for Uttarakhand Re-defining objectives and increasing budgetary support to production support institutions
4.	Limited mobility	Difficult geographical terrain	Providing prophylactic and therapeutic veterinary health care at the doorstep	Establishing ambulatory veterinary services so that services can be delivered at the doorstep of the farmer
5.	Animal husbandry practiced as an ancillary activity	Livestock rearing is practiced as a supplementary activity secondary to agriculture	Creating opportunities in the livestock sector in such a way that they are pursued as full-time activities	Mobilizing financial instruments in such a way that livestock sector activities can be easily funded Establishing marketing linkages and value addition of livestock produce
6.	Low egg production	Unorganized poultry development in the state due to difficult	Increasing egg productivity and production of animal	Providing subsidy for poultry feed

S.No.	Issues	Causes	Challenges	Priorities
		geographical distribution Previously, less impetus was given to poultry development programme Lack of Infrastructure for poultry-breeding purposes	proteins for rural food security	Establishing mother units at district/block level for producing and making available month-old chicks
7.	Poor quality of small-ruminant germplasm	In-breeding due to non-availability of exotic germplasm	Making available good-quality breeding bucks and brood mothers	Facilitating the import of exotic germplasm and/or germplasm of superior genetic merit from other states
8.	Increasing dropouts amongst para-vets in hills	Artificial insemination, vaccination, castration and first aid do not provide sufficient income for sustaining the para-vets' livelihoods	Establishing sustainable artificial insemination centres in the private domain	Providing tapering grants to these para-vets in the hills during the project period
9.	Income Tax	Income from livestock enterprise is taxable	Rates need to be rationalized	At par with agriculture
10.	Power	Commercial electricity rates are applicable	Rates need to be rationalized	At par with agriculture
11.	Bank interest	Interest is charged at market rates	Rates need to be rationalized	At par with agriculture
12.	Traditional breeds	Emphasis on high-yielding breeds	Re-building emphasis and interest	Revival and revitalization
13.	Livestock predation by wild animals	Habitat loss, expansion of agriculture	Policy considerations, inter-sectoral co-ordination	Addressing habitat issues, wildlife corridors, etc.
14.	Animal diseases	Changes in pest/parasite life cycles	Need for further understanding of possible changes in animal disease occurrences and patterns	Further studies and investigations into possible climate related causes and sharing of information and enhancing vet services at community level

7.4 Relevant Existing Initiatives

As is true for the rest of the country, a large-scale intensive livestock rearing system is not a part of the general scenario in the case of Uttarakhand. Livestock rearing is the endeavour of the small farmer, with very smallholdings often having a mixture of various species. As opposed to other countries where intensive livestock rearing systems are followed, the production of GHG by rumen fermentation and degradation of dung are not concentrated on. Thus one of the existing adaptation initiatives, albeit by default, is the pattern in which livestock husbandry is carried out in the state, the small, scattered and diversified nature of livestock holdings. The intensive systems of livestock rearing are only followed in urban and peri-urban pockets of the state close to major cities and towns. These are now slowly closing down due to municipal legislations since they are taxing the already over-burdened sewage and solid waste management (SWM) systems. The high costs of inputs, water scarcities, sanitation issues, competition from multinationals, increased cost of real estate, shortage of skilled labour, etc. are now making these intensive systems economically unviable.

The Government of Uttarakhand is pursuing the agenda of cross-breeding for increasing the production potential of its livestock. This is being done with the sole objective of increasing the per-capita productivity of its livestock. It is assumed that this will lead to a reduction in

the absolute numbers of dairy animals, but at the same time it will also lead to an increase in the overall milk production. Another initiative taken under the breed improvement programme is the castration of scrub bulls. This, coupled with increasing farm mechanization, has led to the reduction of males amongst cows and buffaloes. This is reflected in the continuous decrease in the population of buffaloes in Uttarakhand over the last decade (Livestock Census 2007, National Sample Survey Organization).

The prophylactic vaccination measures being undertaken by the state for the control of common animal diseases are also strategies that will help in adaptation and the emergence of resilience amongst livestock during the events envisaged during climate change. Routine practices adopted by the Animal Husbandry Department wherein preventive measures are initiated before the onset of disease episodes in particular seasons also help in developing resilience amongst livestock as and when the seasons for those diseases set in.

7.5 Sectoral Strategies

7.5.1 Sectoral Vision and Commitment

The vision and commitment of the livestock sector is to create new opportunities and intensify/amplify existing opportunities in the field of animal husbandry for employment generation and enterprise development in the state in an environmentally sustainable way and ensuring inclusive growth across all livestock-holding categories and communities with the ultimate objective of increasing animal productivity; protecting and creating livelihoods; enhancing income generation and providing employment.

7.5.2 Strategies

At present there are no institutional mechanisms in place within the department to document the effects of climate change and there is no level of sensitization amongst the officers and staff. Hence, efforts will have to be made to first sensitize the officers of the department regarding aspects of climate change and their relevance to the livestock sector. With respect to this, the development of human resources has been incorporated in the design of the proposal so that initially sensitization is carried out and subsequently scientific knowledge is shared. Collation of evidence base mechanisms will have to be evolved. These will include studies on the adaptation mechanisms evolved, resilience and/or susceptibility to common livestock diseases, spread of zoonotic diseases, changes in the pattern of disease occurrences, issues pertaining to water, feed and fodder and the changes in production trends of livestock produce over a period of time.

Any effect on production indices of milk, meat, egg and wool, will be automatically recorded by the department through its dedicated statistical cell already in existence along with demographic studies. As far as disease surveillance and monitoring is concerned, this too will be undertaken by the state animal husbandry department with the help of the centrally sponsored National Disease Reporting System (NADRS). Data will also emerge from the monthly disease reporting forms that are received from all the institutions of the department.

The College of Veterinary Science of the GBPUA&T, Pantnagar; Indian Veterinary Research Institute, Mukteshwar Campus, Nainital; and G.B. Pant University, Hill Campus, Chamba, Tehri Garhwal are three of the institutes dedicated to conducting research in the livestock sector. Specific scientific issues related to the effects of climate change on livestock holdings, changes in disease incidences and patterns, developing modules for disease forecasting so that remedial actions can be initiated well in time and initiating R&D on fodder crops for the hills will be some key areas where the expertise of these institutions will be harnessed.

The effect on various breeding indices in cattle and buffaloes as a result of climate change will be assessed by the Uttarakhand Livestock Development Board (ULDB) on a continuous basis. Similarly all effects on the production, breeding and disease occurrences in the case of small ruminants will be studied on a continued basis by the Uttarakhand Sheep and Wool Development Board (USWDB).

Under its reform agenda for the department, the Department of Animal Husbandry has already created special-purpose vehicles for species-specific development in the state. The ULDB was formed for the production, supply and distribution of quality breeding inputs to the artificial insemination and natural breeding centres of the state and the USWDB was created for a holistic development of the small ruminant sector. The Department of Animal Husbandry has also been re-organized and re-cast for improving its efficiency. The department in its turn is the nodal department for all issues related to the livestock sector and will continue to be responsible for all governance issues and institutional decision making.

The major portion of the state is under forest cover, be it reserve forests or other forests and since most of the village communities and transhumant livestock rearers are dependent on forests for meeting the needs of their animals, a convergence issue definitely exists, especially from the standpoint of the large fodder deficit. As such, specific emphasis will be given to co-ordination with the Forest Department to enable joint discussions/planning of fodder resources and improving availability.

In addition to this, convergence with watershed programmes also exists, as the livestock component is also included in their mandate. Close co-ordination with the Department of Health and Family Welfare for the control of zoonotic diseases is also of importance. Management of livestock populations in urban and peri-urban areas calls for close co-operation between the Department of Animal Husbandry and the Department for Urban Development. Since water is needed by livestock for drinking and bathing and is needed for irrigation of fodder crops, convergence with urban and rural water supplies as well as the Irrigation Department is a must.

Livestock contributes to the household income and food basket of more than 80% of the rural households. The programmes for ensuring better overall animal health are the following: strengthening of vaccination delivery mechanisms for prophylaxis against animal diseases; optimizing breeding efficiency; ensuring the availability of year-round green fodder; development of human resources; creating, protecting and enabling livelihoods; income generation and employment avenues; continuous monitoring and evaluation and assessment of the impact of all the programmes being implemented by the department routinely and as part of the climate change agenda.

Animal husbandry is thus one of the best tools for building resilience and reducing vulnerability across communities and all sectors and investment in this sector is the critical tool to address any possible perils that may arise as a result of any adverse changes occurring due to anticipated events of climate change. The breed improvement programme for cattle and buffaloes, initiating alternate feed resources and better feeding practices, planting fodder trees and increasing the Van Panchayat lands under fodder crops will definitely bring about a reduction in the emission of GHGs.

A range of initiatives are being proposed for implementation under the UAPCC.

Policies: Policies and procedures will be put in place so that these anticipated adverse effects are addressed in a planned manner along with the co-benefit of a reduction in GHG emissions.

Project management: Livestock programmes will be implemented and co-ordinated by the Department of Animal Husbandry, for which a separate Central Project Management Unit (CPMU) will be established at the Directorate of Animal Husbandry (Dehradun). The CPMU will be further supported in this effort by the two Divisional Project Management Units (DIVPMU), one each for the Garhwal and Kumaon divisions located at Pauri and Nainital, respectively and by the District Project Implementation Units (DPIU), which will be located in the 13 districts of the state and will be responsible for the field implementation of the programme. All the programmes and initiatives envisaged will be implemented through the line department in co-ordination with other role players including other government departments, the ULDP, the USWDB, the Uttarakhand Gau Sewa Ayog and voluntary organizations of national repute involved in the livestock sector. The CPMU will report to the Central Advisory Council for Climate Change constituted by the state government as directed by the government from time to time.

Disease surveillance, forecasting and mitigation: The existing disease surveillance system needs to be strengthened and suitably re-organized to meet the anticipated requirements of the future. There is a need for the development and adoption of a standard operating procedure (SOP) for disease outbreaks and other calamities causing episodes within the livestock scenario as a result of global warming. The Department of Animal Husbandry has already started a programme under the centrally sponsored project NADRS. As a first step, 111 locations, including all block headquarters, district offices and the directorate, are being linked by a 'Virtual Private Network' so that the disease-reporting system becomes immediate. A new location-specific reporting system is being developed by the National Informatics Centre (NIC) for uniform reporting from all these locations, thus ensuring timely disease forecasting so that necessary mitigation steps can be initiated. This effort is being supported by the GoI.

Strengthening of institutions: Veterinary hospitals (VH), dispensaries, laboratories and other production-support institutions of the AHD are in urgent need of strengthening and modernization. The department is definitely making efforts towards equipping these institutions so that their service-delivery capacity and quality are improved. Additional support to the AHD will definitely herald a rapid change in the way livestock health and related services are being provided. These institutions require support in terms of maintenance, modern equipment, mobility and human resource development.

Mobile veterinary and diagnostic services: The concept of a stationary VH in Uttarakhand is a concept that needs to be re-thought since the major part of the state is in the hills. In these hills it is very difficult to bring animals to a hospital for treatment, vaccination and artificial insemination and practically all services are delivered at the farmers' doorsteps. Hence, it is proposed to introduce mobile veterinary ambulances that will deliver livestock services at road heads along pre-defined routes.

All disease diagnostic facilities are stationary in the state. Blood, serum and other tissue samples are collected, preserved and sent to these laboratories for diagnostic tests. Often it is already too late and fatalities occur before diagnosis is established. It is hence proposed to set up at least two mobile laboratories in the state, one for each division, which can be rushed to areas where incidences of disease outbreaks have occurred. This will help with instant diagnosis and prevent the loss of valuable livestock wealth.

Organizing intensive livestock health and infertility treatment camps: The increase in inter-calving period leads to direct losses to the livestock owners both in terms of production losses and decreased profits from feeding a non-producing animal. Infertility is one of the single most important factors in cattle and buffaloes that lead to an increase in the inter-calving

period. Often such unproductive cattle are abandoned by farmers. In the case of buffaloes, though, some amount of money is salvaged by the livestock owners through sale for slaughter and the value of its hide. Organizing livestock health camps and addressing issues of infertility in domestic animals is one of the most effective measures for providing expert veterinary health care facilities for farmers at one place. This activity is already being carried out by the AHD and requires acute scaling up so that its impacts can be of real value to farmers.

Strengthening vaccine cold chain management system: Vaccination is one of the basic tools through which livestock can be protected against major livestock diseases and hence it is of the greatest importance. It is perhaps the only tool that can help in mitigating disease outbreaks whenever they occur so that the surrounding susceptible population is immediately protected. One of the single most important factors in the vaccination programme is the delivery of these vaccines to the end user at refrigeration temperatures ranging from 4^{o}C to 8^{o}C. Owing to the far-flung locations of the areas and the villages being in remote locations, the problem of delivering a quality vaccination programme has always been a challenge for the department. With the easy availability of electricity in the state, the setting up of cold chain management systems with reasonable power backups is now a very easy option. This cold chain can also be utilized in reverse for sending samples from diseased animals under a cold chain till they reach the diagnostic laboratories.

Fodder development: It has been estimated that the state has a fodder deficit of about 36.09%, which is going to get adversely affected if there is a rise in global temperatures coupled with the anticipated scarcity of water. As of now, every household owning livestock spends several hours a day on the collection of fodder for its animals. The onus of this effort has sadly fallen on the already over-burdened women in these households. Addressing issues of fodder deficit with alternate strategies will not only mitigate the deficiency of fodder but will also help reduce the drudgery of women involved in this work so that the time saved from this menial and mundane task can be better utilized by them.

Efforts have already been initiated by the department through various schemes to address this shortage. The setting up of 19 nurseries for providing planting material of Napier grass and other perennial fodder grasses is one such effort. It needs to be intensified on a massive scale not only with the cultivation of grasses but fodder trees as well.

Technological interventions: Pilot projects for harvesting fodder grasses during the flowering seasons so that their protein content can be preserved, as opposed to the traditional practice of letting them dry on the slopes and then harvesting them according to the need and subsequent storage will be undertaken. Fodder-compacting technologies have been used for the manufacture of complete feed blocks at two locations in the state, with an installed capacity of 15 T each. Compacting wheat straw into blocks makes it easier and more cost effective to transport fodder in the hills. In addition to compacting, the blocks are bound with molasses and some feed ingredients so that they also provide energy and a basal maintenance ration for livestock in the hills. The installed capacity of these plants is sufficient for the time being, but facilities need to be created for additional storage space for several metric tons of wheat straw. This is important for procuring and storing large volumes of wheat when it is harvested. Since the price of wheat straw is very low at that point of time, the cost of the compacted feed block can be reduced and made uniform the year round. Hence, monetary arrangements in the form of rotating seed capital for the procurement of bulk amounts of fodder will be made.

These compacted feed blocks are being marketed through a chain of fodder banks that have been established and efforts will be further intensified wherein the blocks are available to the farmer on a full-cost basis.

Package of practices: Improved animal husbandry practices will be demonstrated and farmers will be provided inputs so that the implementation of various packages of practices is intensified.

Construction of mangers: In the hills it is a common practice to feed fodder to livestock by just untying a bale and placing it in front of an animal. Most of the fodder is wasted and trampled upon as well as soiled by the dung and urine of the animal. Even after repeated demonstrations under various watershed programmes, efforts to motivate farmers to make mangers for clean and efficient feeding of straw have failed. Perhaps they have not been at the level where they could have an impact. Leopard-proof manger designs will also be adopted.

Chaffing fodder: In addition to this, chaffing of straw is never carried out. The straw is fed as such, thus adversely affecting its digestibility and consequent bio-availability to the animal. Hence the chaff-cutting initiative needs to be strengthened further so that the livestock is fed chaffed straw rather than the whole straw.

Other initiatives: There are certain communities within the state that follow a pastoral way of raising livestock and are transhumant in nature. They live and move along with their herds and flocks year round in search of pastures. During the summer they can be found in the alpine pastures (bugyals) in the higher reaches of the Himalaya and during winter they travel to the lower valleys and plains in the foothills. Their migratory routes and temporary dwellings have been used over the decades. These shelters can be either in reserved forests or in other areas where temporary enclosures with small shelters can be erected for the protection of their stock in the night and during inclement weather. Because the proposed location of most such shelters is likely to be in forest areas, this activity can be carried out by the Forest Department on behalf of the Animal Husbandry Department.

Livestock rearing is carried out in hundreds of households in Uttarakhand in very small holdings, with two or three animals per household. Hence a household's supply of dung is not enough to meet the requirements of even a small biogas plant. Biogas plants will greatly help in cutting down greenhouse gases as the majority of them will be harnessed and put to use for generation of energy for domestic chores. Dairying as an enterprise is largely dependent on markets for sustainability. Hence, it is profitable in urban and peri-urban areas, where ready markets are available for selling the produce. In the case of the hills, due to shortages of fodder and the difficulties in the marketing of milk due to the hamlets being located far away and in remote places, commercial dairy farming is a difficult option. The small ruminant (sheep or goat) serves as a very good option for generating income and securing livelihoods. It is proposed to intensify this activity by encouraging the rearing of goats under stall-fed conditions, keeping in view its livelihood intensity and high internal rate of return.

Uttarakhand is unique in the fact that it has more than 1,200 community-owned and managed *Van* Panchayats that are being used for augmentation of fodder production in the state. These *Van* Panchayats can also be used for providing shelter to stray cattle so that they can be prevented from entering forests areas and causing damage to forests. The poultry population in Uttarakhand is growing at a rate of about 16% every year and is one of the most livelihood-intensive activities, often supporting resource-poor farmers, particularly the landless, marginal, disadvantaged groups and those living below the poverty line. There has

been a phenomenal rise in the poultry sector in the state. About 60% of the birds are *desi* birds, in the unorganized sector.

The backyard system of poultry development involves the setting up of small units of low-input-technology birds by providing 50-day-old chicks to the beneficiaries. The birds are reared by farmers under free-ranging conditions, with zero-input foraging for their food and surviving on kitchen waste. The department has six parent farms producing chicks and supplied to the farmers of the state. The total present-day capacity of these installed hatcheries is for the supply of 3.45 lakh day-old chicks annually. It is envisaged that in order to intensify the backyard poultry programme, the production capacity of the hatcheries will have to be enhanced by adding another parent unit. This will augment the capacity of the farm to supply an additional amount of 1.8 lakh day-old chicks per annum.

The development of human resources has always been a priority agenda of the department and forms its core philosophy. Convergence with regard to the animal husbandry and issues pertaining to climate change across departments will be established and will be a major component of the project. Sensitization of livestock owners, bare foot service providers, para-veterinarians, middle-level functionaries and officers of the department regarding issues pertaining to water, irrigation, agriculture, forests, rural development and power will form key areas of convergence with regard to climate change. Hence a major thrust will be placed on creating awareness, capacity development and educating the major role players involved in rearing livestock and/or involved in providing services and all those involved in the livestock value chain.

As is true for the rest of the country, the onus of providing farm advisory services, production support services and all regulatory services to the livestock sector is on the government. Efforts are now being made, albeit still on a very minuscule scale, towards privatization of all farm advisory and production support services. An example is provided by the training of suitably educated, unemployed local youth (men and women) to provide breeding services, primary veterinary first aid and complete prophylactic vaccination of livestock in their respective areas. These trained individuals act as barefoot service providers to the local farming community at mutually agreed market prices. How successful the programme will be, only time will tell, but providing livestock services in the remote and often difficult geographical terrain in Uttarakhand has always been a difficult task anyway and alternative models will have to be developed and put in place for the future.

The training component will require capacity building of all the major stakeholders, including officers and staff of the Department of Animal Husbandry and the livestock-owning community in general. The main emphasis of the training will be to sensitize them about the various effects that climate change will possibly bring about in livestock farming and the various methodologies and adaptation measures that will be needed to face the challenge of climate change. Knowledge sharing across farming communities both within the state and among those rearing livestock in other hilly areas of the country will also help them in these adaptation measures. Along with the progress of the programme, the training need assessments of all the stakeholders will also be revised from time to time. As the need arises, suitable changes will be incorporated into the programme.

Scientific research in the livestock domain with respect to the mountain states is very limited and limited efforts have been made towards initiating hill-centric research. Hence, major efforts need to be made in order to carry out even baseline surveys so that potentially exploitable opportunities can be identified within this sector for the benefit of the farmer. In addition to this, R&D of fodder varieties for the rain-fed areas of the hills and technologies to address fodder and feed shortages need to be developed for year-round availability.

In addition to this, a better people-to-science interface will have to be established by setting up knowledge centres for sharing scientific information amongst all role players. The present system of setting up Krishi Vikas Kendras (KVKs) has not been effective with regard to sharing of knowledge pertaining to animals. Hence either the KVKs will have to be strengthened further or a new initiative will have to be launched. The setting up of a dedicated 24 × 7 helpline and dedicated audio-visual programmes, using the print media, organizing village-level knowledge seminars, development of the human resources of the Department of Animal Husbandry for better extension, etc. are some of the methods that will be adopted towards attaining this objective.

At present, monitoring of all livestock programmes is done by the department, for which it is ill equipped. The routine production parameters of milk, meat, eggs and wool in the various seasons are noted periodically by the department according to the guidelines of the GoI through its statistical cell and field institutions dedicated to this purpose. Livestock populations are enumerated every fifth year by the officers and staff of the department and are compiled by the statistical cell.

The progress of schemes is monitored in terms of achievement of targets of the activities being implemented, but no effective deliverables and outcomes are ever measured. Hence the creation of a complete monitoring and evaluation mechanism within the project management unit of the department will have to be made. Measurable outcomes will have to be decided and monitoring and evaluation done along these lines so that subsequent impact assessment of the activities proposed can be done. In addition to this, documentation of all success stories and failures also needs to be an important part of the programme.

The sequel to an effective monitoring programme will automatically lead to documentation of all the outcomes. A common knowledge-sharing platform will have to be created for sharing these outcomes. The platform may be through people-to-people interaction; through an interactive Web portal; through electronic and print communications; or through seminars and workshops.

Livestock farming is the endeavour of the poor, landless and marginal people and with respect to the hill districts of Uttarakhand; it is a women-centric activity. The share of livestock has been projected to be 50%–75% of household incomes in rain-fed and mountain ecosystems (12th Five Year Plan Approach Paper, Planning Commission). Livestock can adapt and develop resilience with efficacy and ease as they can move around and can be taken from one place to another, as opposed to crops. The efficacy of supporting livelihoods is also very high, as can be ascertained by the fact that more than 80% of the self-help groups formed have expressed an interest in pursuing activities related to the livestock sector.

The role of the private sector with regard to this sector is ill defined. Except for the milk unions of U S Nagar and Lalkuan, which sell any excess liquid milk to Mother Diary, most of the livestock products are consumed within the state. Certain districts are importing milk, butter, ghee, live animals and poultry for slaughter and for eggs from outside the state. Hence there is a demand–supply gap for several products from livestock, which is area specific and hence opportunities do exist. Only in the case of commercial poultry farming does the private sector have a role to play, which it is already doing by supplying genetic inputs, technical backstopping, farm advisory services and marketing backup.

The cost of livestock is increasing day by day and a lack of institutional credit has hampered the growth of this sector very negatively. Several schemes providing credit subsidies either directly or back-ended by the National Bank for Agricultural and Rural Development (NABARD) are yet to achieve their targets. This has been largely due to the limited capacity

of the often illiterate and poor farmer to understand the modalities for even applying for a loan and his inability to put forth collateral. Hence the staff of the department will have to play a proactive role in facilitating the farmer for preparation of project reports and processing loan applications.

As the cost of livestock is increasing day by day, any livestock enterprise, even if it be very small, cannot be initiated without institutional credit and easy access to it. Owing to its delicate nature, it will also have to be protected through suitable insurance packages and once again easy access to them will have to be made a priority.

Voluntary organizations and NGOs have been playing a key role in livestock-centric livelihood schemes in the state and have delivered yeoman service. They will form the organic link between the department and livestock owner and help bridge gaps and provide ancillary support during the various projected interventions.

The United Nations–funded International Livestock Research Institute (ILRI), based at Nairobi (through the Sir Ratan Tata Trust), a local NGO (Himothan) and the department are providing technical support in certain areas. Their expertise will be harnessed for identifying R&D for grey areas and evolving suitable programmes for the same.

*****

8 Disaster Management

8.1 Overview—Characteristics and Status

Climate change is recognized as being the biggest threat that the earth and human race face today. Climate change is driven by an increase in the average global temperature (global warming) and results in changes in cloud cover and precipitation, particularly over land, melting of ice caps and glaciers and reduced snow cover, an increase in the frequency of extreme climate events and increases in ocean temperatures and oceanic acidity due to absorption of heat and carbon dioxide from the atmosphere by seawater. It thus encompasses all the environmental changes that are likely to have detrimental effects on nature as also on socio-economic aspects of our lives.

The impacts of climate change are all the more visible in vulnerable and sensitive regions and the Himalaya represents one such region. The Himalayan region has its own significance as far as India is concerned. It forms a formidable physical barrier that has played a major role in stabilizing the south-west monsoon over the sub-continent. Precipitation caused by the south-west monsoon is the primary mechanism of fresh water delivery in the sub-continent and is the lifeline of the economy of the region. It thus has a direct bearing upon the ecology and economy of the region. About 10% of the world's population depends on mountain resources and a much larger percentage draws on other mountain resources, including water.

The Himalaya also acts as a massive fresh water reservoir and a number of perennial rivers and their tributaries have their source in this region. Two of the largest river systems of the sub-continent, the Ganges and the Indus, originate in the glaciers of this region and are fed by myriad lakes, glacial melts and streams. These perennial rivers provide water for household, industrial and irrigation purposes and are also the primary source of energy in the region. These bring huge quantities of silt and clay that get deposited in the Indo-Gangetic and Indus plains and thus regularly replenish the soil fertility. It is because of these river systems that these plains are in a position to sustain a dense population.

The state of Uttarakhand is located in the central Himalayan region. The terrain of the state is predominantly mountainous and the forest cover accounts for 71% of its geographical area. Most of the northern portion of the state forms a part of the Great Himalayan Range and is studded with a number of snow-clad peaks and glaciers.

Increasing uncertainty in the precipitation patterns in the state is amply highlighted by the fact that in both 2007/08 and 2008/09, the state faced severe drought conditions. In 2007/08, nine districts of the state (out of a total of 13 districts) were officially notified as being drought affected, while in 2008/09, 10 districts were notified as being drought affected. On both these occasions, the state government had to seek central assistance mounting to ₹ 241.5 crores and ₹ 200.1 crores, respectively, to manage the situation. Completely opposite was the case in 2010, when the entire state witnessed excess monsoonal precipitation and massive losses were reported from across the state due to repeated floods, flash floods, landslides and cloudburst events and the state government had to seek central assistance amounting to ₹ 653 crores.

During 15 to 17 June, 2013, cloud bursts and heavy to very heavy rainfall hit several parts of the higher reaches of the state. The onset of monsoon came was 15 days prior to its expected arrival. This unprecedented rainfall resulted in a sudden increase in water levels giving rise to flash floods in the Mandakini, Alakananda, Bhagirathi and other river basins and also caused extensive landslides at various locations. Adding to this, melting of the Chorabari glacier caused waters in the Chorabari Lake to rise. The lake's weak moraine barrier gave way and a

huge volume of water along with large glacial boulders came down the channel to the east devastating Kedarnath town, Rambara, Gaurikund and other places in its way. According to official sources, over 9,00,000 people have been affected by this natural calamity in the state. A total of 580 human lives were lost; over 5,200 people were reported as missing; 4,200 villages were affected; 9,200 cattle/livestock lost; and 3,320 houses were fully damaged. This event also left over 70,000 tourists and 1,00,000 local inhabitants stranded in the upper reaches of the mountain terrain, who were rescued.[34] Hundreds of mules were stranded on the yatra routes. The total estimated reconstruction costs for the state is at ₹ 3,964 crores. (Further information can be found in Annexure 3).[35]

The changes in the climatic parameters are at the same time affecting the biodiversity of the region and a large number of species have started to clearly show signs of distress due to the climatic variability–induced changes in their habitats. These conditions are fast making the native species extinct or threatened and allowing invasive species to establish themselves, thereby promoting change in the ecology and microclimate of the region.

The effect of climate change is bound to affect the communities in this region because they are still largely dependent on nature for their basic needs and their economic activities, be they farming or tourism. Both are largely dependent on climatic conditions.

Traditional knowledge is a precious national resource that can facilitate the process of disaster prevention, preparedness and response in cost-effective, participatory and sustainable ways. There is much to learn from indigenous, traditional and community-based approaches to natural disaster preparedness. Indigenous people have been confronted with changing environments for millennia and have developed a wide array of coping strategies, and their traditional knowledge and practices provide an important basis for facing the even greater challenges of climate change. Although their strategies may not succeed completely as they will undoubtedly need support to adapt to climate change, yet they have expertise to offer on coping through traditional time-tested mechanisms. Hence a blend of approaches and methods from science and technology and from traditional knowledge opens avenues towards better disaster prevention, preparedness, response and mitigation. Globally, there is an increasing acknowledgement of the relevance of traditional knowledge as a valuable and under used knowledge reservoir, which can be a powerful asset in environmental conservation and natural disaster management. Communities have been using traditional knowledge since time immemorial to monitor climate and other natural systems and establish early warning indicators for their own benefit and for future generations.

8.2 Vulnerability to climate change

No detailed climate vulnerability risk assessments are currently available from the standpoint of disasters. Nevertheless, the Disaster Management Department has been carrying out a range of related activities. The following are the main initiatives of the Department:

- Assessment of the impact of natural disasters upon the masses, particularly women.
- Assessment of the people's perception of climate change and documentation of their adaptation strategy through primary data collection in various regions of the state.
- Assessment of the changes being introduced in the geo-environment due to climate change through primary data collection in various regions of the state.

[34] August 2013, India Uttarakhand Disaster June 2013 – Joint Rapid Damage and Needs Assessment Report
[35] August 2013, India Uttarakhand Disaster June 2013 – Joint Rapid Damage and Needs Assessment Report

- Study of the impact of changing weather patterns and extreme weather events on natural resources and the livelihoods of people.
- Documentation of best practices in traditional coping methods, possible interventions to meet present demands and promotion of the same.
- Documentation of the indigenous technical knowledge (ITK) of the masses.

8.3 Issues, Challenges and Priorities

8.3.1 Issues and Challenges

Under the influence of climate change, the geo-environment of Uttarakhand is increasingly getting more susceptible to a number of problems that include soil erosion, landslides, prolonged dry spells, glacier recession, erratic precipitation, extreme climate events and rapid loss of habitats and biodiversity. These have a direct implication upon the issues related to the livelihoods of people in the state and adjoining regions.

Despite still being an economically developing state, Uttarakhand is amongst the most densely populated mountain eco-systems and even a slight disturbance in the ecology of the region is sure to jeopardize the life support strategy of a large number of people living in the region as also in the downstream areas. It therefore becomes important to keep a close watch even upon small signs of distress in the ecosystem of the region so as to understand their long-term implications on the region and to frame appropriate strategies in a timely manner for mitigating the same.

Mystic charm of the Himalaya has always attracted people since time immemorial and people from far and wide have been coming and settling down in the region. The region has acted as a melting pot of diverse cultures. The state of Uttarakhand has also been inhabited by people of diverse ethnic and linguistic backgrounds, including many tribes and minority communities. Owing to the inherent inaccessibility of the region, people have traditionally been dependent on nature for satisfying their various needs. The culture of the region is thus intricately interwoven around nature and the indigenous people ensured adherence to the principles of ecological conservation by invoking religio-magical rites as also social sanctions. Accumulated knowledge and experience of the generations thus gave rise to a rich repository of indigenous technical knowhow that was passed on orally to the next generation.

Rain-fed agriculture of a subsistence nature, together with animal rearing, has been the mainstay of the economy of Uttarakhand. The state of Uttarakhand receives approximately 90% of its annual rainfall during the monsoon season. A slight change in the monsoon pattern can significantly affect the food productivity and even destabilize the hydrological cycle. A reduction/enhancement in the total amount of rainfall by a mere 20%–30% in a season can cause agricultural droughts or severe floods. The monsoon and its timing therefore play an important role in ensuring food security in the region.

8.3.2 Priorities

The traditional practices of resource management have been responsible for the cultural diversity and prosperity of the region. The absence of written records of traditional practices and poor efforts to conserve this knowledge are however resulting in the loss of many invaluable practices. The documentation of traditional knowledge is therefore of utmost importance. The implementation of the Biological Diversity Act, 2002 has enabled the documentation of biodiversity along with the traditional knowledge in the form of People's Biodiversity Registers (PBRs).

Driven by differential appreciations in the price of traditional coarse crop products and the finer cereals and a lack of adequate quality support from the government, the cropping pattern in the region has witnessed a major change, which in turn has had a direct impact upon the local climate and soil. The masses, at the same time, are ill equipped to cultivate input-intensive crops. Integrated with changing climate, this has resulted in reduced agricultural productivity in the state. The ensuing reduced farm biodiversity and the depletion of the gene pool in mountain agriculture are a major cause of concern today.

Climate change–driven fluctuations in the precipitation pattern have increased uncertainty in the farm output and recurring crop failures have left little incentive for the masses to continue with the same. Labour-intensive hill farming has thus been rendered unsustainable and the region is presently threatened by food insecurity. The repercussions of this are clearly reflected in large stretches of hitherto regularly sown agricultural lands being left barren. Climate change is thus taking its toll on hill farming, agricultural diversity and the overall well-being of the people.

At the same time, the region does not have alternative gainful employment opportunities and climate change–driven uncertainly in mountain agriculture has forced people to migrate from the hills in search of employment. A large proportion of the males/able-bodied persons of the region have thus resorted to migration to urban and proto-urban centres in the plains in search of alternative employment opportunities. The mountainous areas are thus left with women, the elderly and children, who are amongst the most vulnerable section of the society. The overall situation has resulted in the farming hands being depleted in the region, which has further led to deterioration of the state. This harsh ground reality of the region is clearly reflected in the census statistics. Therefore, ensuring and exploring livelihood options in the hills is of utmost importance.

Climate change–induced societal adjustments have thus added to the drudgery of the hill women, who have to share additional responsibilities in taking care of agriculture-related work besides their routine household chores, which include collection of fuel wood, fodder and water, besides cooking, cleaning and looking after children and the elderly. Climate change–related resource depletion has at the same time made the primary resources scarce and hill women have now to devote more time to managing these. They are thus left with little time to look after their health and entertainment-related needs, leave alone engaging themselves in some gainful economic pursuits.

Climate change has thus trapped the Himalayan region, its people and the economy in a vicious circle and unless serious attempts are made to break the impasse, there seems no respite. With the passage of time, the situation is only going to deteriorate and solutions are going to become more complex. We are thus left with no option but to act now if we do not wish to witness a total meltdown. We need to decrease the vulnerabilities and develop a more resilient community and this can be done by building the capacity of the people by utilizing the existing resources and past experiences. It is important to seriously take note of the magnitude and dimensions of this problem so as to formulate appropriate interventions aimed at improving the scenario.

Appropriate changes have also to be incorporated in the existing legal and policy frameworks, together with establishment of new ones to assist the masses to adapt better to the changes being introduced in their surroundings by climate change. This would assist informed and judicious decision making with a vision of sustainable development and a resilient country.

8.4 Relevant Existing Initiatives

The Disaster Mitigation Management Centre (DMMC), Dehradun has been carrying out a number of initiatives in the field of disaster management and mitigation. These include the following:

- Preparation of a database of indigenous traditional knowledge (ITK).
- Preparation for assessing the impact of climate change upon the life support strategy of the masses and their perception of the changes being introduced in their surroundings.
- Land use/land cover change studies were carried out for the cities of Nainital and Haridwar using high-resolution satellite imagery (IKONOS and WV 2).
- Landslide and environmental risk assessment were carried out for the cities of Nainital and Mussoorie.
- Socio-economic vulnerability assessment was carried out for the city of Nainital.
- Dam break and inundation studies are being carried out for the area downstream of Tehri Reservoir.
- Training and capacity building:
    - Training departmental officials in vulnerability assessment.
    - Training departmental officials in the use of GIS and RS tools for effective resource management.
    - Training of engineers in retrofitting existing structures.
    - Training of engineers in safer construction practices.
    - Training of masons in safer construction practices. This is an important initiative as most constructions in the state are non-engineered.
    - Training of formal first responders in search and rescue and first aid.
    - Training of community members on search and rescue. Details of trained persons are available at http://srtraining.dmmcuttarakhand.org/.
    - Training of state government officers in post-disaster needs assessment.
    - Training of media personnel in reporting disaster-related issues.
    - Training of government officials in preparation of disaster management plans.
    - Training of government officials in post-disaster response and utilization of ICS (IRS) principles.
    - Training of school teachers in vulnerability assessment and school disaster management plan preparation.
    - Training of doctors in mass casualty management and hospital disaster management plan preparation.
    - Mock drills and tabletop exercises involving nodal officers of various government departments.
- Awareness generation: Various modes are being utilized for mass awareness. These include the following:

  - Print media
  - Electronic mode
  - Folk theatre
  - Films
  - Tele serials
  - Video and audio spots
  - Meetings and workshops
  - Competitions, both face-to-face and online
- School safety: The following activities are being organized.
  - Vulnerability assessment; both structural and non-structural
  - School disaster management plan preparation
  - Training of teachers in school disaster management plan preparation
  - Search and rescue and first aid training
  - Mock drills
  - Competitions
- Hospital preparedness and safety: The following activities are being undertaken.
  - Structural safety assessment
  - Assessment of non-structural safety
  - Preparation of hospital safety and mass casualty management plans
- Emergency preparedness
  - Emergency Operations Centre
  - SMS alert service
- Structural vulnerability and risk assessment:
  - The vulnerability of the building stock of Mussoorie, Nainital, Bageshwar, Haridwar, Dehradun, Rudraprayag, Pauri, Srinagar and Joshimath were assessed using rapid visual screening.
  - A detailed vulnerability assessment of four important buildings in Nainital was carried out.
  - Vulnerability assessment of lifeline structures is being carried out.
- Preparation of disaster management plans
  - State plan
  - District plan
  - Tehsil and block plans
  - Nyaya Panchayat plan
  - Village plan
  - Tehri Dam

- Value-added services
  - GIS and remote sensing
  - Mapping
  - Surveying
  - Database preparedness
  - Training
  - DM plan preparation.

8.5 Sectoral Strategies

8.5.1 Sectoral Vision and Commitment

The Department of Disaster Management is committed to the cause of a disaster-resilient state. Climate change is making extreme climate events more frequent and incidences of landslides, flash floods and droughts are on the rise. In the long run, this is sure to adversely affect the water and energy sectors, besides others. The department is thus committed to (i) assessing the vulnerability of various sectors to these changes, (ii) monitoring some of the critical parameters, (iii) educating the respective departments on likely problems they might face, (iv) preparing mitigation/adaptation plans, (v) ensuring implementation of these plans through various departments, (vi) bringing forth mass awareness on this important issue, (vii) preparing community-based mitigation/adaptation plans, (viii) ensuring capacity building of both departments and masses, (ix) suggesting appropriate changes in the techno-legal regime and (x) monitoring and evaluating the progress. The department's activities under the UAPCC will be closely linked to the overall institutional framework at the state level for close co-ordination and a response across the sectors and regions of the state; as such, a close working coordination will be established with several line departments and other agencies, such as the armed forces, for emergencies and emergency preparedness.

8.5.2 Strategies

The following initiatives are planned to be undertaken for improving the scientific knowledge and evidence base and understanding climate change and its impacts:

- *Study of recent changes in climate parameters:* Speleothems (deposits in limestone caves) are increasingly being used for reconstructing changes in the various climate-related parameters. A study of the same will be undertaken in collaboration with the Indian Institute of Science (Bangalore) and the Physical Research Laboratories (Ahmedabad).
- *Documentation of adaptation strategies of the masses.* Various adaptation strategies and traditions being used by the masses to ward off or minimize the climate change–related impacts will be documented. This will ensure protection of intellectual property rights relating to the same where applicable.
- *Land use/land cover change in the previous decade.* Temporal satellite data will be utilized to assess the changes in the land use/land cover pattern.
- *Monitoring of various climate parameters.* A series of automatic weather stations will be installed at critical locations in the high reaches of the state so as to monitor the changes in various climate parameters.

- *Mass balance of Gangotri Glacier.* Mass balance studies will be carried out for Gangotri Glacier in collaboration with the Wadia Institute of Himalayan Geology (WIHG) (Dehradun).

Towards improving governance mechanisms, institutional decision making and convergence, in accordance with Section 14 of Disaster Management Act, 2005, the State Disaster Management Authority (SDMA) has been constituted under the chairmanship of the Chief Minister, Uttarakhand. SDMA has the mandate to plan for all disaster-related contingencies and ensure implementation of the same. SDMA is thus an appropriate forum for ensuring inter-departmental coordination and convergence.

The following initiatives are planned to be undertaken to build adaptive resilience and reduce vulnerability across communities and sectors:

i) *Capacity building for effective planning.* Planning is the key to mitigating effects of various climate-induced contingencies. Various stakeholders from amongst the community as also from various sectors will be trained in assessing their vulnerabilities and to prepare plans in the light of the various contingencies that they might face.

ii) *Planning at community level.* Community-based plans will be prepared for tackling better any contingency that might take place in the future.

iii) *Administrative planning.* Sections 23 and 31 of the Disaster Management Act, 2005 make the SDMA responsible for preparing plans for the state and districts for effectively tackling all hazard-related situations and ensuring implementation of the same. State and district plans will therefore be prepared accordingly.

iv) *Planning for schools.* Plans will be prepared for each school of the state for tackling better any contingency that might take place in the future.

v) *Planning for hospitals.* Mass casualty management plans will be prepared for all the major hospitals in the state.

vi) *Planning for government infrastructure.* The entire public infrastructure will be mapped under the GIS environment and the vulnerability of the same would be assessed. This will help in developing adaptive resilience plans, including retrofitting where required.

vii) *Preparation of disaster management plan for all major reservoirs in the state.* In the case of extreme precipitation or GLOF events in the catchments of major reservoirs, the possibility of flash floods in the downstream areas cannot be ruled out. Various possibilities have therefore to be simulated and based upon these, appropriate plans have to be developed for tackling these situations.

viii) *Raising quick response teams at the grassroots level.* In case of any disaster situations the people at the grassroots level are the first responders and in most events response activities are over before the arrival of formal responders on the scene. It is therefore critically important to raise quick response teams at the grassroots level. These will be raised in every village so as to effectively manage any contingency. Certified training in search and rescue and first aid will be imparted to selected volunteers.

ix) *Vulnerability assessment of all lifeline structures in the state.* The vulnerability of all the lifeline structures will be assessed and this will help the respective sectors to undertake appropriate measures for vulnerability reduction.

x) *Retrofitting of lifeline infrastructure.* After assessing the vulnerability of the infrastructure, the beneficiaries will be asked to undertake retrofitting of their infrastructure.

xi) *Landslide and flash flood vulnerability assessment.* This investigation will help in the identification of human habitations and critical infrastructure that are likely to suffer losses in the future.

xii) *Relocation of critical infrastructure.* The infrastructure and critical facilities falling in an identified high-risk zone will be advised to relocate. This will at the same time act as a disincentive for infrastructure development in the high-risk zone.

xiii) *Relocation of threatened habitations.* More than 233 villages have already been identified as being chronically affected by extreme weather events that have rendered these unsafe for human habitation. The state government has already come forward with a rehabilitation policy. Efforts will be made for relocating these villages to other safer locations.

xiv) *Promoting green and disaster-resilient construction technologies.* Certified training programmes will be organized for the engineers of the various engineering departments for promoting green and disaster-resilient construction technologies.

xv) *Assessment of urban vulnerability, particularly in the case of extreme precipitation events.* Major urban agglomerations of the state having a population of more than one lakh each will be studied under this programme.

xvi) *Vulnerability assessment of all industrial units in the state.* The vulnerability of all the industrial units will be assessed and this will help the individual agencies to undertake appropriate measures for vulnerability reduction.

xvii) *Simulation of extreme precipitation scenario in major river basins of the state and planning for the same.* Extreme precipitation/sudden breaches of landslide dams can lead to devastating situations in the downstream areas. It is therefore important to simulate various scenarios and accordingly plan for effectively managing these contingencies.

xviii) *Mapping of glacial lakes and planning for GLOF situation in the state.* There are a number of glacial lakes in the state and recession of glaciers poses a grave threat of their breaching suddenly. It is therefore important to identify these lakes and assess their devastation potential so as to plan for this contingency well in advance.

xix) *Review of various techno-legal regimes.* The techno-legal regime has an important bearing in reducing the risk of disasters. Various techno-legal provisions will therefore be reviewed and appropriate amendments to the same will be suggested.

xx) *Promotion of risk transfer mechanisms.* Risk transfer is increasingly being seen as an important tool for reducing the burden of disasters upon public exchequer. Various risk transfer instruments will therefore be developed and the same will be promoted through various modes.

The following activities are planned for education and awareness regarding this important issue.

i) *School curriculum.* Disaster management has already been included in the school curriculum. Appropriate material will subsequently be developed for various climate change–related issues and the same would be introduced in the school curriculum.

ii) *Online education.* Online self-education modules on various disaster management–related issues are currently being developed. Similar modules will be developed on climate change and adaptation-related issues and offered online.

iii) *Online competitions.* The department has developed an online quiz on disaster management that is being promoted through Facebook. Some other products are currently being developed. Similar products will be developed on climate change–related issues and offered online.

iv) *Development of information and education material.* The department has developed considerable amounts of information material in the vernacular and the same is being promoted through Facebook. Similar products on climate change–related issues will be developed and offered online.

v) *School awareness programme.* Awareness programmes are being organized regularly by the department for school children. Climate change will be included in these programmes and these will be made a regular feature in all the schools of the state.

vi) *Awareness programme for officials.* It is urgently necessary to sensitize the government officials on this important issue. The department is regularly organizing sensitization programmes for government officials at the state, district and tehsil/block levels. Various key issues related to climate change will be included in these training programmes.

vii) *Training programme for vulnerability assessment and risk reduction.* For better appreciation of vulnerability and risk assessment reports as also for undertaking independent assessment exercises and special training programmes will be organized for the representatives of various sectors.

In order to connect science, practice and policy, the department is working in close collaboration with various centres of excellence and universities including WIHG (Dehradun); IIRS (Dehradun); the Central Soil and Water Conservation Research and Training Institute (CSWCRI) (Dehradun); IIT (Roorkee); National Institute of Hydrology (NIH) (Roorkee); Central Building Research Institute (CBRI) (Roorkee); and the Kumaon, Garhwal, Pantnagar and Doon universities. Details of practical research being undertaken by these institutions are regularly being made available to the relevant departments. A number of other agencies in the state are active in various areas of disaster management and mitigation, including training—these include Lal Bahadur Shastri National Academy of Administration (LBSNAA), Advanced Training Institute and the Forest Research Institute. Linkages and close co-ordination with these agencies will be established to avoid overlap of functions and activities and to enhance impact.

A robust monitoring framework will be put into place and both financial and physical monitoring of the various activities will be resorted to. Besides in-house monitoring, independent third-party monitoring will be undertaken.

Towards documenting, sharing, learning and dialogue across the Indian Himalayan Region, the department has a dedicated autonomous centre (DMMC), which has the mandate of ensuring disaster resilience in the state. Besides producing a number of reports on vulnerability and risk assessment, post-disaster needs assessment and others, DMMC have produced a large volume of IEC material. Besides physical dissemination, these are being made available through Facebook and the website of the centre. It is planned to develop DMMC into a centre of excellence for all the Himalayan states, which share similar socio-economic and hazard characteristics. This centre will provide value-added services to these

states and help with knowledge management in the field of disaster management and climate change. This centre will also assist these states in capacity building in critical areas.

Development priorities of the country/state are often derailed by disasters and therefore it is important to dovetail various risk reduction strategies with developmental planning. Moreover, depending upon their resilience, communities are differently affected by disasters. The most vulnerable sections include the poor, women, the elderly, children and differentially abled persons. Poverty is often a direct function of the available gainful employment opportunities. Bereft of the gains of development, hill communities in the state face the brunt of forced migration. This results in women taking care of agricultural chores besides routine household chores. Agriculture, which is the main economic activity of the region, is being adversely affected by changing weather patterns. Bereft of farming hands, large tracts of hitherto agriculture lands are being left barren. This is a serious concern as it threatens livelihoods and the well-being and food security of the masses in the region. It therefore becomes important to quantify this problem in discrete terms and solutions to the problems have then to be devised accordingly. The following activities will therefore be undertaken by the department:

i) Assessment of the socio-economic vulnerability of the masses in various remote locations of the state, with particular emphasis upon gender, class, caste, ethnicity, physical ability, community structure, existing decision-making processes and the other local factors.

ii) In the absence of any authentic study, as on date both the magnitude of the problem related to migration and its impact is poorly quantified. Data on population movements (migration) across the region, primary and secondary data at the regional level and data on the impact of migration on poverty alleviation are proposed to be collected and compiled.

iii) Documentation of best practices for livelihood and adaptation strategies and promotion of the same through various modes including policy interventions.

iv) A study on migration and its possible impacts (considering that there is significant migration within the state).

v) Traditional knowledge is a precious national resource that can facilitate the process of disaster prevention, preparedness and response in cost-effective, participatory and sustainable ways. There is much to learn from indigenous, traditional and community-based approaches to natural disaster preparedness. Indigenous people have been confronted with changing environments for millennia and have developed a wide array of coping strategies, and their traditional knowledge and practices provide an important basis for facing the even greater challenges of climate change. Although their strategies may not succeed completely as they will undoubtedly need support to adapt to climate change, yet they have expertise to offer on coping through traditional time-tested mechanisms. Hence a blend of approaches and methods from science and technology and from traditional knowledge opens avenues towards better disaster prevention, preparedness, response and mitigation. Globally, there is increasing acknowledgement of the relevance of traditional knowledge as a valuable and under used knowledge reservoir, which is a powerful asset in environmental conservation and natural disaster management. Communities have been using traditional knowledge since time immemorial to monitor climate and other natural systems and establish early warning indicators for their own benefit and for future generations. Community risk assessment and promotion of the community-based disaster

management (CBDM) approach, which directly involves vulnerable people in planning and implementation of mitigation measures as the community is the best judge of its own vulnerability, can make the best decisions regarding its own well-being.

- Assess the risk with the help of the community.
- CBDM.
- Development of community-based risk reduction strategies (coping mechanism. etc.).
- Training of community volunteers in search and rescue and first aid as preparedness for emergency situation.

vi) Gender-based studies to identify the role of women as the first and most responsible responders in disasters and train women leaders. The studies will also help understand the impact of the increase in predominantly women-headed households in the mountains.

vii) Gender mainstreaming and gender-sensitive approaches in regions affected by food shortages and decreased agricultural production based on approaches and methods developed by traditional knowledge.

viii) Training sessions on livelihood options including small-scale business, animal husbandry and agriculture, with a focus on the adaptation and coping mechanism.

Possibilities will be explored for collaboration with the private and co-operate sectors. The department is already working in close collaboration with the Tehri Hydro Development Corporation, Oil and Natural Gas Commission and other industrial units in the state. Special emphasis will be laid on collaboration in the following sectors:

i) Housing and infrastructure, health, education—Safe housing is the most important aspect as far as disaster management and housing are concerned. Promotion of earthquake-safe construction technology will be targeted through training of engineers, architects and masons working in private housing projects.

ii) Advocate and convince the private sector in disaster prevention, reconstruction and rehabilitation.

iii) Mobilize private sector resources for investment in various disaster prevention measures.

iv) Explore the opportunities for risk reduction in the design and construction of new systems and those available for risk reduction in the retrofitting of existing lifeline structures such as hospitals, schools and other important buildings.

v) Study the social and economic consequences of critical infrastructure failure in various disasters and use various approaches to estimate direct and indirect losses from infrastructure service failure, with emphasis on the comparison of the expected scale and distribution of losses related to infrastructure failure, along with the costs of strengthening and other strategies for risk reduction.

vi) Many infrastructure systems are owned and managed by the private sector. Therefore, opportunities will be explored for promoting standards of design, construction, maintenance and operation according to routine practice.

Appropriate public policy interventions are very important for reducing socio-economic vulnerabilities. Increased access to resources, increased employment opportunities, increasing

macro-economic stability and other conscious policies made to improve quality of life are necessary. The following measures will be explored.

i) *Mitigation/vulnerability reduction fund.* Emergency funds that are usually given to households after a disaster should be used to reduce risks. They can be used to subsidize insurance in an area or encourage re-insurance. Governments can withdraw this facility once the situation has improved and the insurance companies can manage the risk exposure.

ii) *Self-insurance.* Households can take a conscious decision to share some risk of loss. By agreeing to share losses, individuals and companies become conscious of the need to implement mitigation measures.

iii) *Group-based insurance programmes.* A group-based insurance programme can enlarge a risk pool and provide insurance at an affordable price. A large number of policy holders (a) reduces the potential of adverse selection, in which claims are higher than expected because only high-risk households purchase the insurance and (b) increases the likelihood that the variance of actual claims will be closer to the expected mean used in calculating premiums. Other advantages of group insurance are that it is faster to get membership by insuring groups rather than individuals. It also reduces the cost of administration and it provides appropriate mitigation incentives to the community—people come together and initiate improvements in their physical surroundings in order to qualify for the insurance.

iv) *Micro credits.* Microfinance and rural banks are important sources of credit for the poor. However, these institutions may be overwhelmed with credit demands at the time of a disaster.

v) *Informal credit markets.* These credits are repaid on the basis of a random schedule of production. A free flow of information in this informal system helps in the process of scheduling repayments, fixing interest rates and plays a direct role in insuring against the risk. This system is effective at protecting households from risks but not at the village level.

vi) *Natural disaster insurance.* Disaster insurance spreads the risk over a larger group, provides better cost efficiency, discriminates between the needs of the different insured people and encourages loss reduction measures as a condition of insurance. It also monitors the activities of the insured.

vii) *Funds for skills—transfer relevant to mountain areas.* Migrants acquire new ideas, skills, perceptions and technologies, which they carry back to their home country. They stimulate the flow and exchange of views and ideologies, which often challenge traditional structures. Such new human capital is a powerful factor in modernization and social change.

viii) *Social protection.* Weather-indexed crop insurance, employment guarantee schemes, cash transfers and pensions for elderly people will be studied and actions will be taken accordingly.

Civil society has an important role to play in bringing forth awareness amongst the masses and in propagating green technologies. The department is working in close collaboration with various civil society organizations. Initiatives under the UAPCC include the following:

- Civil society organizations will be approached as bridges between the centre and the people.

- Information and data of the civil societies will be used and further research will be carried out through or with the help of these organizations.
- Advocacy programmes will be conducted through local NGOs.
- Knowledge sharing will be promoted.

International agencies will be approached for technical assistance for various activities, ongoing as well as planned. They will also be approached for capacity building of people working in various projects at the centre or associated with various activities and for initiatives related to knowledge sharing.

The state is endowed with natural resources which form the life line of not only people living here but also people living down the plains. In view of this, the state has to tread on the path of development with adequate concern for the environment. In order to achieve sustainable development, free of environmental disasters, the state will have to adopt the model of green economic growth.

*****

9 Human Health

9.1 Overview

There is strong evidence that climate change affects human health. The effects can be direct, such as through increased heat stress and loss of life in floods and storms, or indirect, through changes in the range's disease vectors, such as mosquitoes, water-borne pathogens and water and air quality. The overall health effects of a changing climate are likely to be overwhelmingly negative. Climate Change affects the fundamental requirements for health—clean air, safe drinking water, sufficient food and secure shelter. Giving the complexity of factors that influence human health, assessing health impacts related to climate change poses a difficult challenge.

Public health depends on people having enough food and safe water, a decent home, protection against disasters, a reasonable income and good social and community relations. Climate change is projected to affect all these factors. Thus climate change will have a negative and large health impact on many population groups, especially the poorest. These include direct health impacts such as heatstroke and higher risks of mortality from the impacts of a large-scale loss of livelihoods. The strategy to fight the impacts involves strengthening the public health systems significantly. To make it a priority needs the right political backing.

9.2 Vulnerability to Climate Change

No detailed reports are currently available that document climate vulnerability and risk to the health sector in Uttarakhand. However, a range of studies have shown that climate change is bound to affect the basic requirements for maintaining health. It leads to extremes and violent weather events and the resurgence of disease organisms and vectors. It affects the quantity and quality of air and water. It also affects agriculture and the stability of the ecosystems on which we depend.

9.2.1 Direct Impacts

Direct impacts of climate change on human health could include the following:

- Exposure to thermal extremes, leading to morbidity and mortality due to thermal extremes, such as cardiovascular and respiratory diseases.
- Altered frequencies and/or intensities of other weather events, leading to injuries, psychological stress and damage to public health infrastructure by floods and other natural calamities.

9.2.2 Indirect Impacts

Indirect impacts of climate change on human health could include the following:

- Effects on range and activity of infective vectors and parasites, leading to changes in geographic areas and incidences of vector-borne diseases, e.g. malaria, dengue fever and several types of encephalitis.
- Altered local ecology of water-borne and food-borne infective agents because of higher temperatures, leading to changed incidences of diarrhoea and other infectious diseases such as cholera. Higher ambient temperatures foster the growth of pathogens that thrive in or on food, e.g. *Salmonella*.

- Altered food (especially crop) productivity, due to changes in climate, weather events and associated pests and diseases, leading to malnutrition and hunger and consequent impairment of child growth and development.
- High levels and biological impacts of air pollution, including pollen and spores, leading to asthma and allergic disorders, other chronic respiratory disorders and deaths.
- Climate change affects water availability through increased evaporation, leading to less availability of fresh water, in turn leading to lack of hygiene and thus an increase in the incidence of water-borne diseases.
- Increasing traffic and exhaust as well as industrial emissions are raising concentrations of SO_2, NO_x, O_3, leading to health hazards.

9.3 Issues, Challenges and Priorities

9.3.1 Issues and Challenges

- Climatic change leads to extremes and violent weather events.
- Climatic change causes a resurgence of disease organisms and vectors and a broadening altitudinal distribution of vectors, especially mosquitoes.
- Climatic change affects the quantity of air, food and water and the stability of the ecosystems on which we depend.
- The increase of chlorofluorocarbons in the atmosphere, leading to global warming, will increase UV radiation in the atmosphere, affecting the immune systems and leading to infectious diseases.
- Increasing traffic and exhaust as well as industrial emissions are raising concentrations of SO_2, NO_x, O_3 and suspended particulate matter, which are known to be damaging to human health.
- The impact of climate change on water availability is likely to be one of the most significant impacts for the health of populations
- Difficult hilly terrain.
- Lack of human resources.
- Poor road connectivity.
- Poor health awareness.
- Inadequate health facilities.

9.3.2 Priorities

- Strengthening laboratory/diagnostic facilities
- Monitoring drug resistance, insecticide resistance
- Integrated behaviour change communication activities
- Public–private partnership
- Sentinel surveillance for dengue and Japanese encephalitis
- Integrated vector management

- Capacity building of medical and paramedical staff, including frontline workers.

9.4 Sectoral Strategies

9.4.1 State Vision and Commitment

The Medical Health and Family Welfare Department of Uttarakhand is committed to the health and well-being of all citizens and visitors to the state. As such, the department will take the necessary steps to gear up for the potential health impacts from climate change, while continuing to contribute to the achievement of the National Health Targets Plan for 2012–2017.

9.4.2 Strategies

In line with the overarching principle of improving the scientific knowledge and evidence base and understanding climate change and its impacts on human health, the Medical Health and Family Welfare Department will begin building a strong evidence base including collecting, compiling and analysing relevant data and information in terms of the perceptions of affected people and communities.

Towards improving governance mechanisms, institutional decision making and convergence, the department will, as an immediate measure, review the State Health Policy to incorporate climate change concerns to human well-being and health and to initiate response mechanisms or preparedness for response mechanisms. Other initiatives will include the following:

- Undertaking measures to manage vector-borne and waterborne diseases.
- Better approaches to deal with heat wave conditions.
- Dealing with the physical and psychological impacts after extreme weather events.
- Addressing drought, malnutrition and food security issues.
- Addressing food safety issues arising due to increased ambient temperatures and extreme events.
- Traditional knowledge related to human (including livestock) healthcare needs to be studied, documented and appropriately promoted in the context of climate change adaptation.

Towards building adaptive resilience and reducing vulnerability across communities and sectors, the department will initiate mechanisms to build adaptive capacities both within the department and, potentially, among the citizens by:

- Undertaking reviews of the state's health infrastructure and potential climate change–related vulnerabilities and risks (and where such infrastructure is found to be at high risk, retrofitting to make these more climate resilient).
- Making it mandatory for construction of Green Buildings for all future government hospitals and offices and examining options for retrofitting existing buildings to 'green' these.

The department will initiate a range of capacity building measures including the following:

- Creating awareness among people about health hazards from climatic change, covering all areas such as rain water harvesting, energy efficiency, health hazards, water conservation and protection from extreme climate conditions.

- Information, education and communication efforts.
- Behavioural change communications interventions in relation to the impacts of climate change.
- Training and sensitization sessions for department personnel.
- Capacity building of all the medical personnel of the district, the team of the Integrated Disease Surveillance Programme, the Disaster Management Cell, auxiliary nurses and midwives, anganwadi workers and members of ASHA and all the medical NGOs in the district to identify the early signs of extreme climatic effects on the population and their remedy.
- Exploring and promoting the scope for and piloting a tele-medicine services network in the light of the fact that the state has a hilly and inhospitable terrain and there is a serious scarcity of medical experts in the state.
- Developing and strengthening disaster management teams in every district hospital specifically to respond to the effects of extreme climate changes and to increase co-ordination between the health sector agencies in the state and the disaster management department.

The department also recognizes the need to mount an extensive health surveillance and analysis exercise integrated with monitoring of the climate and other environmental conditions that facilitate the outbreak of diseases. It will work towards developing such a framework. In addition, the department will initiate mechanisms to carry out the necessary research and other activities necessary to integrate climate concerns into public health emergency response strategies of the state. Where appropriate, the department will coordinate research efforts with various universities and other academic centres for excellence and collate lessons and pointers to inform policy and practice.

As part of the overarching strategy of documenting, sharing, learning and dialogue across the IHR, the department will initiate dialogues with its counterpart departments in other states of the region to exchange information, experiences and best practices, as well as examine the possibility of inter-state exchanges and capacity building initiatives.

The department also recognizes that climate change can have especially disproportionate adverse health impacts on the poor, women and children and can therefore also adversely impact livelihoods. As such, it will begin planning investments in information and education programmes, designing them with a gender perspective, including gender-disaggregated data, etc. Traditional health care system is missing, which is a simplest and cheapest mode of delivering health facilities to masses especially rural masses. Traditional knowledge related to human and cattle healthcare needs to be given due place in this chapter and its documentation and application should be one of the strategy for climate change adaptation.

The private sector already plays a significant role in the health sector of the state, in terms of bringing in health care financing, management and service provision. A number of PPP projects in the health sector have been conceptualized, developed and implemented over the period 2008–2011. Additional planned measures include the following:

- Strengthening the existing 108 ambulance service, boat and air ambulance services, cardiac ambulances, etc.
- Strengthening mobile health vans.
- Strengthening cardiac and nephrology units with a public-private partnership.

The department, in close coordination with the PPP Cell of the Uttarakhand Government, will begin exploring the possibilities of incorporating climate-related health concerns into such projects and also the possibilities of private sector involvement in new initiatives to address the emerging challenge of climate change and its impacts on human health.

*****

10 Urban Development

10.1 Overview—Characteristics and Status

Urban areas in Uttarakhand consist of largely small to medium towns, with some having major transitional/migratory populations and having geographically difficult and hilly terrain. Uttarakhand has an area of 53,483 km², with an urban population of around 31 lakh. There are 72 urban local bodies (ULBs) in the state, as well as nine cantonment boards.

Uttarakhand's cities and towns were originally rural settlements, subsequently converted into towns, initially due to the fact that these were stopping points and centres for pilgrims visiting the major pilgrimage centres of the state during the '*yatra* season'. Eventually, owing to the growth of commercial activities, these developed into small towns and these grew from small towns to medium towns. Some of these grew to become the state's larger cities. Urbanization and urban expansion in the state have largely been unplanned processes, resulting in the typical issues that these result in, including the lack of civic amenities in proportion to the population density. Today, many urban areas in the state are heavily impacted upon by the transient population, comprising mainly pilgrims and tourists.

10.2 Vulnerability to Climate Change

Currently, no detailed climate vulnerability and risk assessments or community perceptions for urban centres of Uttarakhand are available. However, it is known that climate change is likely to negatively impact infrastructure and worsen access to basic urban services and worsen the quality of life in cities.

10.3 Issues, Challenges and Priorities

Unplanned development, together with rapid urban growth and the inflow of tourists and pilgrims, has made critical impacts on the urban environment of Uttarakhand. Most of the towns in Uttarakhand have grown in an unplanned manner, causing immense pressures on the urban infrastructure and services, resulting in degradation of the urban environment and of natural resources. Population pressures on the cities not only cause an unavoidable burden on the available infrastructure facilities but also hinder the social and economic development process of the cities. On the other side of the coin, tourism is contributing much to the state's economy. Cities have now become the hubs of capitalization of the state as well. Thus, the urban growth in Uttarakhand is impacting it both positively and negatively.

Major environmental concerns associated with such unplanned urban development are depletion of forest area, loss of biodiversity, potential urban pollution in the form of air, water shortages and water quality, noise pollution, issues of solid and liquid waste management and landslides. Unplanned urban development, industrial activities and the virtual absence of adequate and appropriate wastewater treatment facilities in the state continue to result in untreated sewage entering drains and rivers, including the Ganga, from the various townships. These rivers also act as major drainage outlets for the towns and are often used as a convenient means of solid waste disposal. Lakes and water bodies, which are also attractions for tourists, are polluted due to the uncontrolled discharge of wastewater and disposal of solid wastes. There is a need to assess and examine the root cause of the problems and identify the strength of the state by means of balanced systematic planning in consensus with ULBs and citizens of the native towns to get rid of all these issues.

10.4 Relevant Existing Initiatives

The cities of Dehradun, Haridwar and Nainital are covered under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and thus, as mission cities, get the benefit of a range of urban development interventions, including the development of city sanitation plans. In addition, the Asian Development Bank (ADP) is currently supporting the Uttarakhand Urban Sector Development Investment Program (UUSDIP). The UUSDIP seeks to improve infrastructure and operational sustainability of the water supply in five towns and sewerage infrastructure in two towns; in addition, it seeks to ensure that people, especially vulnerable households, will have increased access to better-quality and sustainable urban infrastructure and services in 31 urban towns. SWM plans have been developed and approved for the three JNNURM mission towns and SWM action plans for the remaining ULBs are to be prepared under UUDSIP.

Other initiatives include the proposed Uttarakhand Plastic Usage and Disposal of Non-biodegradable Waste Act-2012, the Nirmal Nagar Puraskar Yojna, implemented in the state to encourage ULBs for sanitation works, under which ULBs are to be rewarded annually for the best performances and development of detailed plans for Dehradun to be proposed under JNNURM Phase II. The Uttarakhand Peyjal Nigam is involved in water supply projects, as also developing sewerage systems in some of the larger cities/towns, such as Dehradun, Nainital and Mussoorie. At the same time, out of 72 townships (ULBs), JNNURM is addressing merely 3. Plans are to be prepared under UUDSIP for other ULBs.

Through the ambitious *Sparsh Ganga* programme, a thrust is being given to keeping the River Ganga clean by not allowing untreatable urban waste into the Ganga as it flows through townships such as Uttarkashi, Tehri Garhwal, Devprayag, Rishikesh and Haridwar. The *Sparsh Ganga* Board has been constituted by the state government to monitor activities to keep the Ganga clean. The state has also banned the manufacture and use of polythene of size 40 micron and below. The state is also considering a complete ban on the manufacture and use of polythene on lines similar to Himachal Pradesh. This will definitely be expected to have a positive impact in making the environment of the state sustainable.

10.5 Sectoral Strategies

10.5.1 Sectoral Vision and Commitment

The Urban Development Directorate (UDD) recognizes that cities have the potential to act as centres of innovation and can advance clean energy systems, sustainable transportation and waste management to reduce greenhouse gases as well as develop climate-resilient infrastructure and as such, the directorate is committed to taking all necessary steps towards this under the UAPCC.

10.5.2 Strategies

Towards improving the scientific knowledge and evidence base and understanding climate change and its impacts, the UDD will take necessary steps towards collating available data/information on impacts of climate change on cities and their systems, infrastructure and people. It will begin the process of developing the necessary systems, databases and protocols for collecting and collating the necessary evidence base on an ongoing basis.

Towards improving governance mechanisms, institutional decision making and convergence, the UDD will initiate the formation of a climate cell within the directorate and notify sectoral focal points in all ULBs. It will take steps to improve our understanding of climate change

and its effects, to impart education and awareness and develop and strengthen partnership and co-operation. It will also initiate processes for developing the necessary co-ordination mechanisms, sectoral policy initiatives, institutional arrangements, etc. to ensure that urban agglomerations and urban populations in the state build their capacity to be resilient to the risks and impacts of climate change through implementing adaptation measures and contributing to mitigation of greenhouse gas emissions.

Towards building adaptive resilience and contributing to reduction of greenhouse gas emissions, in addition to strengthening urban infrastructure systems under the various projects of the JNNURM and UUDSIP, the UDD will proactively seek to develop plans for developing interventions aimed at improving traffic conditions, reducing journey times and improving the safety of all users, particularly the most vulnerable (pedestrians, cyclists and motorcyclists), through a combination of investments. These will generally focus on major roads and include (i) road widening and strengthening to create greater road capacity, thus relieving congestion and easing traffic flows; (ii) car parking restrictions and provision of multi-storey car parks and bus and truck terminals, where possible, through PSP to improve passenger convenience and increase road space; (iii) providing pedestrian subways and footpaths to improve pedestrian movement and safety; (iv) improving traffic management and (v) improving street lighting for improved traffic and pedestrian safety and security. These initiatives towards 'green transportation' will be encouraged with the help of the Transport Department both in the government as well as in the private sector.

The concept of 'green buildings' will be promoted in both the public and private sectors to save energy and water and reduce/recycle waste. Instructions will be given to the development authorities/Nagar Panchayats to enforce water and energy savings in the housing sector. 'Rain water harvesting' will be promoted, especially in the housing sector.

The UDD also plans to promote energy efficiency and appropriate use of solar energy is going to be promoted in street lighting. Adequate use of compact fluorescent lamps (CFLs)/light emitting diodes (LEDs) will be encouraged to save energy. Solar water heating will be encouraged through Uttarakhand Renewable Energy Development Agency (UREDA).

Emphasis will be given to 'greening' the towns. Work has already begun in the state capital, Dehradun under the caption 'Green Dun, Clean Dun!' The co-operation of the Forest Department will be sought in the greening campaign. An appropriate awareness campaign will be launched for a clean environment.

For improving storm and wastewater management, the UDD will, in co-ordination with other relevant departments, examine the existing drainage and wastewater handling situation in all the 72 cities and towns and develop appropriate plans for ensuring that (a) adequate storm water drainage infrastructure is available and (b) all wastewater streams are appropriately treated before they are discharged into water bodies and rivers in the state.

Provision of rainwater harvesting tanks in all ULB buildings and new constructions in municipal limits will be taken up. Cleaning/conservation/beautification of water bodies situated within the ULB limits, retrofitting of municipally owned and controlled buildings and facilities with energy efficiency and renewable energy measures that significantly reduce energy use, creating jobs and serving as local demonstration projects; establishing official or informal energy building codes that reflect the state of the art in energy efficiency and investing in district heating and cooling systems with higher densities that provide or facilitate the provision of a full range of energy efficiency measures to the local community will be other programmes to be developed under the UAPCC.

The UDD will develop and deploy a range of awareness and capacity-building programmes for municipal officials for promoting appropriate measures towards climate resilience in their respective ULBs, along with similar programmes for building awareness about climate change and its impacts for urban populations. The UDD will also seek to converge such efforts with other sectoral initiatives such as health, education, housing and water and foster inter- and intra-departmental co-ordination.

Towards documenting, sharing, learning and dialogue across the Indian Himalayan Region, the UDD will seek to learn from the experiences of other cities and towns in the IHR, as well as document and share its own lessons and best practices as these begin to emerge.

Under a JNNURM submission, namely the Basic Services for the Urban Poor and Integrated Housing and Slum Development Programme; approximately 7000 pucca dwelling units are being constructed in place of thatched roof houses/mud houses/kaccha houses for the urban poor in 3 mission towns and 19 non-mission towns. Additionally, under the Swaran Jayanti Shahri Rozgar Yojna, the following schemes are being implemented for poverty alleviation:

- Urban self-employment programme.
- Skill training for employment promotion among urban poor.
- Urban women self-help programme (40 SHGs constituted in ULBs).
- Urban wage employment programme.

At the same time, the UDD will also take appropriate steps to identify and assess all slums and ensure that all unauthorized encroachments are removed/dealt with appropriately.

The ever-increasing urban population has placed tremendous pressures on the budgetary resources of states/ULBs, underscoring the necessity of private sector participation in urban development. The unbundling of services and technological innovations has opened up areas to private sector participation. As such, the UDD will proactively explore private sector participation options in various fronts including (but not limited to) the following:

- Housing.
- Water supply augmentation and efficiency improvements.
- Door-to door collection of municipal and household solid waste, secondary storage, development of transfer stations and transportation, treatment and processing, disposal, including development of sanitary landfills and integrated municipal SWM systems (with a combination of the above).
- Wastewater collection, handling, treatment and disposal, including storm water drainage, sewerage systems including treatment plants, decentralized wastewater treatment units, sewage gas-based power generation, etc.
- Beautification of parks.
- Communications and advocacy including awareness campaigns for clean city concepts.
- Hoarding policy (including operation and maintenance of street lights).
- Partnerships for green transportation.

With proper monitoring, PPP ensures innovation, efficiency and an improved level of services, together with compliance to environment, health and safety regulations. PPP allows involvement of users and other stakeholders and inculcates the habit of user charges through service delivery. As such, the UDD will examine the possibility of involving the private sector in relation to the proposed activities under the UAPCC.

11 Water Resources

11.1 Overview—Characteristics and Status

Uttarakhand has two distinct hydro-geological regimes, viz. the Gangetic alluvial plain and the Himalayan mountain belt. The former is covered with a vast expanse of alluvium and unconsolidated sedimentary material of varying size fractions (ranging from boulders to clay) and is a promising zone for groundwater development. The latter zone, being predominantly hilly, offers much less potential for large-scale development of groundwater. Groundwater in the hilly region occurs mostly in fissures/fractures and emerges as springs. The springs are amenable to small-scale development of groundwater resources in the state.

Precipitation takes the form of rain, sleet and hail in the valley and lower reaches, while it falls as snow in the higher reaches. Glaciers in the Himalayan region give rise to rivers such as the Ganga, Yamuna and Kali. Rain-fed seasonal rivers drain the lower Himalayan and Shivalik ranges. Glaciers melt naturally during the summer under stable climatic conditions and are replenished by winter precipitation in the form of snow. The major glacier-fed Himalayan rivers, along with glaciated catchments, have regional importance—the water from the glacier melt sustains the stream flow in these rivers through the dry season. The 'frozen water' in the Himalaya is crucial for the people inhabiting the mountain areas as well as those inhabiting the downstream regions.

The Yamuna and the Ganga—the two major rivers in the western Himalayan region—directly impact the lives of a large population living in the northern part of India and even beyond the national boundaries. In many higher arid and semi-arid areas, people are dependent on the amount of ice melt and the timing of the water flow. The melt season is often the warmest, driest time of the year, providing a large volume of runoff for irrigation. However, snowfall is gradually decreasing and increased summer and winter temperatures are causing glaciers to retreat. Basic information on the major glaciers of Uttarakhand is provided in Table 18.

Table 18: Major glaciers in the Uttarakhand Himalaya

Ganga Basin	No. of Glaciers	Glacier covered Area (km^2)	Ice Volume (km^2)
Yamuna	52	144	12.20
Bhagirathi	238	755	67.02
Alaknanada	407	1,229	86.38
Total	**697**	**2,128**	**165.6**

Source: Raina and Srivastava, 2008[36]

The main drainage systems of Uttarakhand have been grouped into six catchments, viz. the Yamuna Catchment, Bhagirathi Catchment, Alaknanda Catchment, Mandakini Catchment, Pindar Catchment and Kali Catchment. The LSD has divided Uttarakhand into 8 catchments, which are divided into 26 watersheds, which are divided into 110 SWS and finally into 1,110 MWS. Uttarakhand also has 31 natural lakes, covering an area of about 300 ha. Till March 2010, 17,847 hand pumps had been installed in the state. The springs are amenable to small-scale development of groundwater resources in the state. The yield of tube wells in the Shivalik formation ranges from 50.4 m^3/h to 79.2 m^3/h; in Bhabhar formations the yield is up to 332.4 m^3/h. In the Tarai belt, the yield of tube wells ranges from 36 m^3/h to 144 m^3/h and

[36] Himalayan Glaciers: A State-of-Art Review of Glacial Studies, Glacial Retreat and Climate Change, MoEF

in the Indo-Gangetic plain the yield varies from 90 m^3/h to 198 m^3/h. The groundwater data for the state is given in (Table 19).

Table 19: Groundwater in Uttarakhand[37]

Dynamic Groundwater Resources	
Annual replenishable groundwater resource	2.17 BCM
Net annual ground water availability	2.07 BCM
Annual ground water draft	1.05 BCM
Stage of ground water development	51%
Groundwater Development and Management	
Over-exploited	NIL
Critical	1 block
Semi-critical	5 blocks
Ground water user maps	13 districts
Artificial recharge to ground water (AR)	Feasible AR structures: 500 springs, 500 check dams, 500 sub-surface dykes
	AR schemes completed during IX Plan: 1
Groundwater Quality Problems	
Contaminants	Nitrate (>45 mg/l)
Districts affected (in part)	Dehradun, Hardwar, Udham Singh Nagar

The total number of hand pumps installed (up to March 2010) was 17,847; in addition, there are a number of unaccounted private tube wells for drinking, irrigation, commercial, industrial and other use. There has been an 82% increase in the number of government drinking water tube wells and a 59% increase in the number of hand pumps during the last decade. Exploitation of deeper aquifers (up to 250 m) is being done in the last 5 years due to the availability of advance drilling techniques. It is to be noted that the state has yet to enact any groundwater legislation to control the development of this resource.

11.2 Vulnerability to Climate Change

No in-depth climate vulnerability and risk analyses currently exist for the state. Nevertheless, a range of studies have examined various aspects of the vulnerability of water resources to climate change and its impacts. Climate change can affect the hydrological regime, changing water flows, global and regional precipitation levels, evaporation and snow cover. Rising temperatures can also cause rapid glacial melt, consequently impacting the fresh water supply and quality. These changes will in turn impact the communities adversely as the pressures on natural resources and environment will compound; water availability in the rivers will be affected; crop yields could decrease, therefore jeopardizing food security and lead to health concerns due to extreme events such as floods and droughts. While some regions will receive excess precipitation, there might be a reduction in other regions (adversely affecting arid and semi-arid areas); increased evaporation and changes in the runoff and available surface flow, also causing changes in the groundwater recharge. The patterns of seasonal distribution of rainfall can shift and these can cause significant problems, especially for hill agriculture.

Recent studies by scientists have tried to determine the impacts of de-glaciation on the water resources of the Himalayan region through the development of a hydrological model that can depict how local water discharges can respond to future climate scenarios. These studies have come out with conceptual models that show increased water availability in some river basins

[37] "Groundwater Profiles – Uttarakhand", Central Ground Water Board, accessed 14 May 2014, http://www.cgwb.gov.in/gw_profiles/Uttarakhand.html,

and decreased water supplies in other regions in the coming decades. The glacier-fed rivers of Uttarakhand are an important resource for the Ganga basin, with many rivers contributing to the irrigation potential of some of India's most densely populated states such as UP, Bihar, Delhi and Haryana. Uttarakhand is the source of water for most of northern India. Despite the immense availability of water in the state, water is scarce for the local people, both for drinking and domestic use and for irrigation.

The Gangotri glacier, in Uttarkashi District of Uttarakhand, has been receding at a rate of 20–22 m annually, with grave implications for water availability downstream and hydropower generation. Glacial melting can lead to the formation of GLOFs and heavy flows, initially followed by dry spells. As discussed previously, the state has witnessed a long-term decreasing trend of stream discharges, declines in the capacities of lakes, increases in surface runoff on hillsides, increases in floodwater, decreases in base flow water in channels and rivers and recurrent soil erosion and landslips.

Further, extreme precipitation events have geo-morphological significance in the Himalaya, where they may cause widespread landslides. The response of hydrological systems, erosion processes and sedimentation in this region could alter significantly due to climate change. An increase in rainfall is likely to cause fresh floods, landslides and damage to the landmass. Increases in the flooding, varying between 10% and over 30% of the existing magnitudes are expected in all the regions. This has a very severe implication for the existing infrastructure, such as dams, bridges and roads, for the areas and will require appropriate adaptation measures to be taken up. In the three years from 2008 to 2010, Uttarakhand received less-than-normal rainfall, which affected harvests and adversely affected the livelihoods of the majority of the state's population. Winter precipitation has become extremely erratic and unpredictable.

11.3 Issues, Challenges and Priorities

Uttarakhand is a disaster-prone state. Landslides, forest fires, cloudbursts and flash floods are seasonal in nature and strike very frequently. Frequent cloudbursts in hilly regions of the state cause a great deal of damage to life and property in the hills. There are frequent droughts in the state that affect the mainstays of the economy such as agriculture and each year many districts face drought-like conditions that result in failure of the crops.

When drought-like conditions prevail, most of the remotely located springs in the hills start drying up or the discharge is reduced to such a level that they are unable to satisfy the basic needs of the residents. There is also a drastic reduction in the flow of the major rivers in the state. In the Himalayan region, *naulas* (12 m deep wells, mostly lined to get water from seepage), *dharas* (spout springs) and hand pumps (at a few places) are the main sources of water for irrigation and household consumption because the rural water supply (if it is available) is either irregular or unwholesome. Except the spout spring, which delivers water at the ground surface naturally, these are artificial methods to extract water from aquifers. As such, understanding the hydro-geology of such aquifers is critically important to the state, especially in the hill districts.

The perennial or non-perennial nature of these water sources depends upon the aerial coverage of the discharging aquifer. In turn, these aquifers are recharged by rain or by snowmelt water, which infiltrates through the land surface and percolates to join the aquifers. The natural rate of groundwater recharge is reckoned to be 31% of the total annual rainfall. Therefore, the soil characteristics and land use play a major role in recharging sloped aquifers. Deforestation, grazing and trampling by livestock, erosion of fertile top soil, forest fires and development activities (e.g. road widening, mining and building construction) cause

a reduction in the infiltration rate and sponge action of the land and thus the failure of the watershed, which results in an unchecked flow of water during the monsoon to cause a sudden swelling of streams and rivers, so that there are floods in the foothills and even in the plains and there are droughts in the villages located on the slopes of the mountains.

Of the 63 urban locations in the state, only a third have a near-adequate supply of water. There are 15,165 villages in the state and nearly 20% of them have a varied range of problems impeding the availability and provision of drinking water. At present, officially, 189 villages do not have any designated source and 1,108 villages are only partially covered.

The concerns over water resources in the state emerge at various levels:

- Significant variations in glacial melt volumes and a lack of information to estimate reliably the quantum of water available.
- Lack of a water management policy that reflects the intimate relationship between water resources and forests.
- Lack of groundwater legislation.
- Poor water supply systems in urban and rural areas with ever-changing systems of management.
- The discharge of the water sources has shown a considerable depleting trend during the last decade, due to which rural drinking water supply schemes under maintenance of Uttarakhand Jal Sansthan have been badly affected.
- The natural rate of groundwater recharge is reckoned to be 31% of the total annual rainfall. Therefore, the soil characteristics and land use play a major role in recharging slop**py** aquifers—deforestation, grazing and trampling by livestock, erosion of fertile top soil, forest fires and development activities (e.g. road widening, mining and building construction) cause a reduction in the infiltration rate and sponge action of the land and thus failure of the watershed, which results in an unchecked flow of water during the monsoon, causing a sudden swelling of streams and rivers, so that there are floods in the foothills and even in the plains and there are droughts in the villager located on the slopes of the mountains.

11.4 Relevant Existing Initiatives

As has been mentioned in earlier sections of the UAPCC, The state has already identified watersheds at macro, meso and micro levels and many are being treated/managed. The state identified 8 catchments, 26 watersheds, 110 sub-watersheds and 1,110 micro watersheds through its LSD. Out of the 1,110 micro watersheds, 584 are under treatment and 302 cannot be treated because of locations being in snowy and highly precipitous areas.

Inclusion of rooftop rainwater harvesting in buildings by laws has been made compulsory in the state.

11.5 Sectoral Responses

11.5.1 Sectoral Vision and Commitment

The UAPCC recognizes the critical importance of water resources to the state and the need to safeguard these through a comprehensive multi-pronged response process. As such, it is committed to taking the necessary steps to examine all related issues through a consultative process.

11.5.2 Strategies

The UAPCC recognizes that the scientific knowledge and evidence base on the impacts of climate change to the water sector is limited. As such, a comprehensive water database in the public domain and assessment of the impact of climate change on water resources through the various agencies responsible for different aspects of water resources management in the state will be developed, updated and analysed on an ongoing basis. Strategies towards this will include the following:

- Review of network of hydrological observation stations.
- Review of the network of automatic weather stations and automated rain gauge stations.
- Collection of necessary additional hydro-meteorological and hydrological data for proper assessment of impacts of climate change in the Himalayan region, including other improvements required in the hydrometric networks to appropriately address the issues related to climate change. Such data will include the following:
    - Hydrological and hydro-meteorological data for low-rainfall areas.
    - Hydrological and hydro-meteorological data for areas above the permanent snowline, glaciated areas and seasonal-snow areas in the Himalayan region.
- Improved network for collection of evaporation and rain gauge data using automated sensors.
- Establishment/strengthening of groundwater monitoring and geo-hydrology networks.
- Conservation of *naulas*, *dharas* and other kinds of springs.
- Collection of data about river morphology for monitoring erosion and carrying capacity.
- Surface and groundwater quality data collection, etc.

Other initiatives will include adoption/development of modern technologies for measurement of flows in hilly areas, developing inventories of wetlands, development of a water resources information system and re-assessment of the basin-wise water situation, apart from projection of the availability of water resources after the impacts of climate change, which will inter alia include the likely changes in the characteristics of water availability in time and space. Other necessary studies to improve our understanding of climate impacts to the sector will also be carried out from time to time and robust data mechanisms will be established.

Currently, Uttarakhand does not have a state water policy. As such, it will be a priority agenda for the state to develop an appropriate policy framework, with explicit cognisance of climate concerns. The state will also take other necessary steps, including incentivizing water harvesting and encouraging non-agricultural-type developments in which not much water is required, incentivizing or encouraging leakage control programmes, developing regulations/frameworks for in-house water withdrawals of industries, through royalties and licenses, extending subsidies and incentives for recycling and recovery, revision of the water tariff based on the cost recovery principle, promotion of water-efficient fixtures, incentivization for recycling waste water, etc.

Steps will also be taken to foster integrated water resources development and management planning and seeking convergence among the various water resources programmes and organizations such as the WMD, Jal Sansthan, Jal Nigam, SWAJAL and Irrigation Department through a consultative process.

It is expected that various measures will be carried out for building adaptive resilience and reducing vulnerabilities in the sector. These will include the following:

- Promotion of citizen and state action for water conservation, augmentation and preservation for efficient utilization of available resources.
- Catchment area treatment.
- Augmentation of storages over the surface as well as under the ground through active participation of all stakeholders (a review of existing storage systems will be carried out and where appropriate, location-specific augmentation of storage will be carried out for lean-season use based on the results of vulnerability assessments, especially from the standpoint of drought risk).
- Review of water resources projects, particularly multipurpose projects (MPPs) with carry-over storages (in the light of changes in peak flows, precipitation pattern shifts and sediment loads).
- Review of minor irrigation schemes including schemes for groundwater development.
- Mapping of all drinking water sources and identification of scarcity zones.
- Promotion of traditional system of water conservation, including expeditious implementation of programmes for repair, renovation and restoration of such systems.
- Increasing the capacity of minor tanks.
- Conservation and preservation of wetlands.
- Demarcation of groundwater resources into different zones in the state and regulations for exploitation in different zones.
- Examination of options for adopting a landscape approach to water resources management from a sustainable eco-systems and biodiversity conservation standpoint.
- Empowerment and involvement of Panchayati Raj Institutions (PRIs), urban water bodies and primary stake holders in the management of water facilities.
- Systematic approach for coping with floods, including mapping areas likely to experience floods, establishing hydraulic and hydrological models and developing comprehensive schemes for flood management.

Capacity development, education and awareness are high-priority agendas for the sector and as such, initiatives will be taken up including (but not limited to) the following:

- Interactive sessions with policy makers for sensitization.
- Development and deployment of capacity building for professionals from various departments/organizations associated with water resources development and management including Panchayati Raj functionaries.
- Promotion of ‘do-it-yourself’ action by citizens through intensive social communication.
- Conducting mass awareness programmes including through school/college/university curriculum development and deployment.

In view of the above, appropriate measures for mitigation of the impacts of climate change on water resources, as also adaptive measures are to be undertaken by various state departments and agencies. A water resources and climate change ‘secretariat’ will be explored for the necessary convergence, co-ordination and monitoring mechanisms.

Documenting sectoral responses, learning what worked and what did not, dialogue and sharing of data and information, etc. will be carried out as essential functions either by the individual agencies involved or collectively by a nominated agency. Such lessons can be valuable to other states, as will be learning from similar experiences in other states. As such, such learning-sharing mechanisms will be developed and put into place.

The gender dimensions of water use and management are fairly well documented. It has long been noted in the gender and environment literature, for example, that women and girls generally assume primary responsibility for collecting water for drinking, cooking, washing, hygiene and raising small livestock, while men use water for irrigation or livestock farming and for industries. These distinct roles mean that women and men often have different needs and priorities in terms of water use. Climate change may also lead to increasing frequencies and intensities of floods and a deteriorating water quality. This is likely to have a particularly harsh effect on women and girls because of their distinct roles in relation to water use and their specific vulnerabilities in the context of disasters.

In the context of climate change, the imperative will be to ensure that these policies and programmes draw on the existing body of knowledge on gender and water to inform interventions and scale these up. To support the integration of gender knowledge into policy and planning, it is proposed to train planners and raise their awareness of gender issues. Toolkits available from women's or gender networks will be used as a starting point and gender networking between experts will be strengthened. Coping with water scarcity as an important issue will be taken into account in adaptation planning and the equal participation of women and men will be advocated in planning. Additionally, gender experts will be consulted during the detailed planning process.

The private sector has considerable experience, expertise, technologies and innovation capabilities, as has been demonstrated in many other states in terms of increasing private sector involvement in the water sector, especially by way of PPPs and other projects. As such, it is expected that the role of the private sector will be actively examined in the Uttarakhand water resources context and, where appropriate, co-opted to bring in incremental gains for the sector.

11.6 Linkages with NAPCC

The strategies and related actions outlined above are in synchronization with and complementary to the NAPCC and its various national missions. In particular, these complement the imperatives of the National Water Mission through the incorporation of elements such as the collation and use of a comprehensive water database, assessment of the impacts of climate change on water resources and promotion of citizen and state action for water conservation, augmentation and preservation; focused attention to over-exploited areas; and increasing water use efficiency and promotion of basin-level integrated water resources management, among others.

*****

12 Tourism

12.1 Overview—Characteristics and Status

Leisure, adventure and religious tourism play a prominent role in Uttarakhand's economy, with Corbett National Park and Tiger Reserve and the nearby hill stations of Nainital, Mussoorie, Almora, Kausani, Bhimtal and Ranikhet being amongst the most frequented destinations of India. Uttarakhand has many other tourist spots as well, where tourists come from all over the world, such as Rishikesh, Hemkund Sahib, Nanakmatta, Auli, Chakrata, Bageshwar, Bhimtal, Kausani, Lansdowne and many others.

The state also has numerous peaks, mountains and pristine high-altitude lakes of interest to mountaineers, trekkers and outdoors enthusiasts. Other national wonders include the Valley of Flowers, which along with Nanda Devi National Park and Biosphere Reserve forms a UNESCO World Heritage Site. The state has always been a destination for mountaineering, hiking and rock climbing in India. A recent development in adventure tourism in the region has been white water rafting and other adventure sports. Ecotourism, agri-tourism, freshwater angling and cultural and rural tourism have also found new grounds in many villages of the state.

Uttarakhand is also home to some of the holiest Hindu shrines and for more than a thousand years, pilgrims have been visiting the region. Gangotri and Yamnotri, the sources of the Ganga and Yamuna, are located in the upper reaches of the state and together with Badrinath and Kedarnath form the *Char Dham*, one of Hinduism's most spiritual and auspicious pilgrimage circuits. Haridwar, meaning 'Gateway to God', is also a prime Hindu destination. Haridwar hosts the Kumbha Mela every 12 years, in which millions of pilgrims from all parts of the India and the world take part. Rishikesh, near Haridwar, is known as the pre-eminent yoga centre of India. The state is also known for the typical architecture of most of these temples. The ancient temples at Jageshwar (a complex of 124 temples in a Deodar woodland) are historically the most prominent for their distinct architectural features. Hemkund, nested in the Himalaya, is a prime pilgrimage centre for the Sikhs. Tibetan Buddhism has also made itself felt with the recent reconstruction of Mindroling Monastery and its Buddha stupa, south-west of Dehradun.

Uttarakhand ranks eighth among the states of India in terms of tourist arrivals, which are expected to grow exponentially (see Table 20). These growth rates, if achieved, will translate into almost doubling of both domestic and foreign tourist visits by 2017.

Table 20: Tourism arrivals in Uttarakhand—current and projected (in million)[38]

Year	Domestic	Foreign
2010	32.645	0.174
2011	37.378	0.202
2012	42.238	0.227
2013	47.729	0.254
2014	53.933	0.284
2015	60.945	0.318
2016	68.867	0.356
2017	77.820	0.399

[38] 'Life ahead for Uttarakhand: Rebuilding Infrastructure & Reviving Economy', PHD Chamber of Commerce and Industry, 2013 (Statistics compiled from Uttarakhand Tourism Master Plan 2007-2022.

The existing tourism infrastructure in terms of accommodation is managed by multiple agencies, predominantly the Garhwal Mandal Vikas Nigam (GMVN) and the Kumaon Mandal Vikas Nigam (KMVN), both state-owned enterprises that manage tourism in the Garhwal and Kumaon regions of the state. 'Uttarakhand at a Glance 2012–13[39]' provides the following details about the accommodation infrastructure (Table 21):

Table 21: Tourism infrastructure in Uttarakhand[40]

Items	Year/Period	Number
Tourist places	2011–2012	264
Tourist rest houses	2011–2012	185
Raien Basera (night shelters)	2011–2012	36
Hotels and paying guest houses	2011–2012	3,676
Dharamsala	2011–2012	864

12.2 Vulnerability to Climate Change

As on date, no detailed climate vulnerability analyses and risk analyses exist for Uttarakhand. Likewise, no record of community perceptions of impacts of climate change on tourism appears to have been documented. However, analyses carried out elsewhere hold true in general for Uttarakhand as well.

The tourism industry and destinations are clearly sensitive to climate variability and change. The climate defines the length and quality of tourism seasons and plays a major role in destination choice and tourist spending. In many destinations, tourism is closely linked with the natural environment. The climate affects a wide range of the environmental resources that are critical attractions for tourism, such as snow conditions, preservation of wildlife and biodiversity and water levels and quality. The climate also has an important influence on the environmental conditions that can deter tourists, including infectious diseases, wildfires, insect- or water-borne disease and extreme events. As such, mountain destinations such as in Uttarakhand are considered particularly sensitive to climate-induced environmental change, as are nature-based tourism market segments. Considering the current and potential scope of tourism, climate change poses a direct economic threat to not only the sector but also the state.

12.3 Issues, Challenges and Priorities

12.3.1 Issues and Challenges

The unplanned growth of places as centres of tourism has had a severe and negative impact on the environment. The inflow of tourists places tremendous pressures on existing resources and infrastructure—in 2010, for example, Uttarakhand received as many as 31.1 million tourists—about 300% of the population of the state. A range of other issues beset the state's tourism sector:

- Many natural areas reflect man-made influences and virtually all urban environments are of very poor quality in terms of overall appearance.

[39] Uttarakhand at a Glance, 2012-13; http://uk.gov.in/files/Uttarakhand_at_a_glance_in_english_2012-13.pdf
[40] Ibid

- Pollution/waste management, health/safety and urban design/congestion are serious threats and do little justice to the natural environment.
- There is almost no interpretation of the natural environment in general; and many popular tourist spots such as Gangotri lack conservation management.
- Limited design quality in development of tourism facilities and lack of efficient public transportation.
- Inadequate understanding and participation in tourism by communities and poor environmental awareness among the population, domestic tourists, resort owners and developers.
- Over-development at certain scenic or religious spots, coupled with inadequate management planning, increases in traffic and pollution and continued poor maintenance of roads.

12.3.2 Priorities

The Tourism Policy of the state focuses on placing Uttarakhand on the tourism map of the world as one of the leading tourist destinations and making Uttarakhand synonymous with tourism; developing the manifold tourism-related resources of the state in an eco-friendly manner, with the active participation of the private sector and the local host communities; and developing tourism as a major source of employment and income/revenue generation and as a pivot of economic and social development in the state. Key priorities include conducting carrying capacity studies, promoting more responsible and equitable tourism, distributing income from tourism, including retention of tourism income in local areas of the state and promoting low-key, community-based tourism.

12.4 Existing Initiatives

Some of the initiatives that the Tourism Department has been undertaking include the following:

- Creation of multiple tourist-friendly locations to decongest existing tourist locations.
- Providing appropriate wayside amenities at all locations.
- Promoting adventure tourism (water sports, trekking, mountaineering and skiing) and integrated and inclusive tourism.
- Providing better amenities to pilgrims and religious tourists.
- Engaging professional consulting companies and individuals for conceptualization, design and development of tourism projects.
- Community involvement and capacity building.
- Solid waste and water management at all sites.
- Solar power usage in remote areas for tourism infrastructure.

The Forest Department is also promoting eco-tourism and responsible travel to natural areas to conserve the environment and sustain the well-being of local people.

12.5 Sectoral Responses

12.5.1 Sectoral Vision and Commitment

As is articulated in the state's tourism policy, Uttarakhand is committed to promoting tourism in an eco-friendly manner, with the active participation of the private sector and the local host communities and developing tourism as a major source of employment and income/revenue generation and as a pivot of economic and social development in the state. It is also committed to taking all possible measures to minimize the sector's 'footprint' while building adaptive resilience.

12.5.2 Strategies

Towards improving the scientific knowledge and evidence base and understanding climate change and its impacts, the Tourism Department will set into motion processes for tracking and documenting impacts of climate change on the sector, its infrastructure and the linked economic, social and environmental continuum to build an improved understanding and evidence base. This will be carried out on an ongoing basis by the department and its partners and other organizations such as the GMVN and KMVN. It is anticipated that as the knowledge and experience base grows, increasing responsive and efficient measures can be adopted for both adaptive resilience building and mitigation.

For improving governance mechanisms, institutional decision making and convergence, the Tourism Department will develop a Climate Change Cell, tasked with overseeing climate change–related issues and initiatives. It will, in addition, work with GMVN and KMVN to establish similar cells, in addition to seeking partnerships with and encouraging associations of tour operators and other private sector tourism service providers in the state to undertake similar measures. At the same time, the department will also seek convergence opportunities with linked departments (especially the Forest Department and its eco-tourism initiatives) for shared/co-ordinated responses to climate change wherever possible.

To build adaptive resilience, several options will be explored, including stimulating product and seasonal diversification; improving insurance cover in the face of extreme events and natural disasters (e.g., avalanches); promoting industry partnerships; educating and raising awareness among tourists about the impacts of global environmental change on the state; improving water use and protecting watersheds; improving emergency preparedness and warning and evacuation systems and collaborating more proactively with local communities to showcase tourism itself as an adaptive resilience building option to other occupations.

For contributing to mitigation, options that will be examined and adopted appropriately include in-depth assessment of the potential impacts of market-based instruments and levies on the different components of the tourism industry (accommodation, tour operators, travel agencies, etc.); encouraging partnerships between different transport and tourism stakeholders with the objective of reducing emissions by optimizing the value chain; promoting the use of public transport and energy conservation and efficiency in buildings and tourist attractions; using alternative fuels (e.g., bio-diesel) and renewable energy sources (e.g., wind, photovoltaic, solar, thermal, geothermal, biomass and waste) and supporting initiatives related to recycling.

Awareness building will be taken up on a large scale in a phased manner for the public in general and communities in tourism locations/destinations. Additionally, it is anticipated that specific tailor-made awareness and capacity building programmes will be undertaken for department personnel, personnel of GMVN and KMVN, staff from government tourism

facilities, as well as staff from tour operator groups/associations, etc. for effectiveness. It is also anticipated that such programmes will be repeated and that capacity and awareness building will remain ongoing activities.

A robust monitoring and evaluation framework and protocol will be developed to support programme implementation, in line with the overall monitoring structure.

As tourism destinations and tourism potential are similar in many states of the IHR, efforts will be made to document and share experiences with the tourism departments of other states. The department will also consider the idea of developing and hosting Himalayan Mountain Tourism conclaves, with participation from other states and B2B sharing of learning as a part of such conclaves.

Tourism is an excellent adaptation mechanism and an alternative livelihood option, with the potential to stem the large-scale migration from villages, if managed effectively. As such, considering the sheer scale of the tourism potential in the state, the sector can be a significant factor in combating poverty as well as in enhancing livelihoods. The department also recognizes that production and consumption of freshwater, food and fuel, land use and transport are gender-specific responsibilities. Owing to their comparative lack of financial resources and roles as providers of food, water and energy, women may be hit harder than men by increasing food, water or energy prices. This will be considered in all activities of tourism promotion and all opportunities to use tourism development to further gender equity will be used, while any discrimination of women through the course of tourism development will be avoided. Participatory strategies of tourism planning and development, including gender-sensitive indicators, will be used actively to achieve sector goals and the involvement of women's organizations, co-operatives, consumer associations, tourism companies, media and marketing experts will be sought.

June 2013 Disaster has been a great setback to the tourism industry in Uttarakhand. The state incurred heavy loss in terms of human and livestock lives along with heavy damage to the infrastructure. Rebuilding of infrastructure and future development for the sector will have to be based on the experience learnt from this massive natural calamity.

The department sees significant roles for the private sector in implementing and supporting implementation of the sector goals under the UAPCC. In addition to the already substantive private sector presence in the sector, new partnerships, potentially in the form of PPPs, will be sought to develop new climate-resilient and friendly green infrastructure and facilities, while studying the possibility of revamping and retrofitting existing tourism facilities to meet climate-resilient and energy-efficient standards, etc. The private sector will also be a potential source of collaboration for the introduction of new tourism products, management solutions and techniques and innovative technologies. Likewise, the departments also envisage similar collaborations with the financial sector to leverage sector gains.

With their close links to communities and the grassroots, civil society and voluntary organizations will be seen as critical partners in sector development and processes and will be consulted/co-opted on an ongoing basis in all aspects of implementation under the UAPCC.

International agencies are likely to be significant partners in helping the state achieve its tourism sector goals. The department is already partnering the ADB for tourism infrastructure development/revamping and other similar collaborative partnerships are likely to emerge.

*****

13 Energy

13.1 Overview—Characteristics and Status

The state power sector has an installed capacity of 2,455 MW, representing 1.4% of the total installed capacity in the country. Eighty percent of the generation capacity is based on hydro-power, while thermal power and renewal energy sources account for 13 and 6%, respectively. The installed capacity of power production in the state is given in Table 22

Table 22: Installed capacity (in MW) in Uttarakhand (March 2011)[41]

Sector	Hydro	Thermal				Nuclear	RES	Total
		Coal	Gas	Diesel	Total		(MNRE)	
State	1,252	0	0	0	0	0	134	1,386
Private	400	0	0	0	0	0	12	412
Central	304	261	69	0	331	22	0	657
Total	1,956	261	69	0	331	22	146	2,455

The current status of the renewable energy sector in Uttarakhand is summarized in Table 23.

Table 23: Status of renewable energy sector in Uttarakhand[42]

Sector	Units
Solar	
Village electrification	728 kW
Power generation (grid and off-grid)	5,200 kW
Standalone lighting systems	3.30 MW
Solar water heating systems	12.94 lakh LPD
Bio-energy	
Co-generation power plant (grid and off-grid)	72.10 MW
Biomass gasifier (thermal)	1.80 MWth
Waste-to-energy biogas plant	50,500 m^3
Family-size biogas plants	6,382 m^3
Hydro-energy	
Power generation from MHPs	4.01 MW
Improved watermills	1,131 Nos.

The power infrastructure in the state is spread between the Uttarakhand Jal Vidyut Nigam (UJVN) on the generation front, the Power Transmission Corporation of Uttarakhand Limited (PTCUL) on the transmission front and the Uttarakhand Power Corporation Limited (UPCL) on the distribution front. The UREDA oversees renewable energy development. The Electricity Act 2003, under reforms modalities, streamed the separation of the transmission and trading functions with the creation of PTCUL on 1 June 2004. Since the inception of PTCUL, the distribution business rests with UPCL, which is committed in its pursuit of excellence to providing a 24 × 7 quality power supply to about 15,00,000 electricity consumers. It takes all efforts towards attaining the highest consumer satisfaction level. UREDA has been designated as the nodal agency for implementation of the Renewable

[41] Source: Central Electricity Authority. Installed capacity also includes allocated shares in joint sector and central sector utilities.

[42] "Department of Renewable Energy - Govt. Of Uttarakhand, Last Updated on 24-03-2014, accessed 14 May 2014, http://www.ureda.uk.gov.in/pages/display/128-achievement-of-re-programmes

Energy and Energy Conservation Programme in Uttarakhand. UREDA is also the state agency for accreditation of renewable energy projects under the REC (renewable energy certificate) framework established by the GoI. The UREDA has been nominated the designated agency for the construction of DDG (decentralized distributed generation) projects under the Rajiv Gandhi Grameen Vidyutikaran Yojana Programme.

13.2 Vulnerability to Climate Change

Detailed climate vulnerability assessments for the power sector in Uttarakhand are currently not available. However, it has been noted that a reduction in snow cover in the Himalayan glacial systems, from where perennial rivers such as the Ganga, Yamuna and Kali originate, will result in a decreased discharge in the rivers and hence lower generation, which will ultimately widen the power supply demand deficit in Uttarakhand. Extreme weather events are also likely to pose some threats to physical infrastructure assets.

13.3 Issues, Challenges and Priorities

The power supply position prevailing in the country is characterized by persistent power shortages. The northern region in particular, which includes Uttarakhand, has a deficit of 7.7% against a requirement of 22,332 MU while against the peak demand of 36,684 MU, the deficit is 9.6% and the situation is expected to worsen. It is quite clear that the northern region, which is already experiencing a severe power deficit, is in the grip of an acute power shortage in the 11th plan and beyond, even after accounting for benefits from the ongoing projects and from other schemes cleared by the Central Electricity Authority. The anticipated power supply position of Uttarakhand during 2011–2012 shows an energy deficit of 20.2%, while the peak demand deficit has shot to 10.6%.

As power plants located in Uttarakhand are largely run-of-the-river-based hydro-power plants, changes in the climate and increases in temperature across the Himalayan region will have a direct impact on energy generation, with increases in energy consumption in households/industries and increases in irrigation needs. A rise in the THI will lead to more energy consumption in cities, thereby increasing the supply–demand deficit. During winters, the problem is aggravated as the discharge in the rivers falls due to freezing, leading to generation dropping to one-third in comparison with the summer months and increased demands due to heating loads. Thus, the overall impact in Uttarakhand will be a supply–demand deficit. The geographical conditions in the state, with many villages in remote and far-flung areas, make access difficult. Further, there are frequent natural calamities such as landslides and cloudbursts.

Priorities include electrification of villages and hamlets through micro hydro-projects, upgrading watermills, harnessing the potential of solar energy in the state through the Jawaharlal Nehru National Solar Mission, harnessing the potential of biogas and biomass energy in industries and energy conservation under the National Mission on Enhanced Energy Efficiency (NMEEE).

13.4 Existing Initiatives

UPCL, PTCUL, UJVN and UREDA have been carrying out a range of salient initiatives. For example, at UJVN, diesel consumption on account of operation of DG sets has been reduced to minuscule levels because of the use of solar photovoltaic (SPV) power plants in buildings. UJVN has entered into a joint venture with GAIL (Gas Authority of India Limited) for developing a gas-based power station with an installed capacity of around 850 MW. In the field of enhanced energy efficiency, UJVN has taken another step by going for complete

modernization and upgrading of its major power plants for making them more energy efficient. At present modernization and upgrading of UJVN Limited's power plants are in progress. Likewise, a range of other initiatives are being carried out by UJVN.

Similarly, UPCL, in order to promote use of renewable energy, is providing a rebate of ₹ 100 per month for each 100-litre installed capacity of solar water heaters. As a part of initiatives under the Solar Mission, in order to reduce the peak hour demand, it proposes to install a 50,000 m^2 area solar water heating system by 2015. The 'Bachat Lamp Yojana' is under implementation by UPCL, under which four conventional light bulbs will be replaced by CFLs at ₹ 15/- each in each household. Five lakh consumers will be covered under this scheme and 60 MU energy per year is likely to be saved after the project is implemented. UPCL is committed to completing its renewable purchase obligations as per the directives issued by Hon'ble Uttarakhand Electricity Regulatory Commission (UERC). Several other such initiatives are being undertaken by UPCL, notably its substantive efforts towards demand-side management (DSM).

Likewise, UREDA has derived CDM benefits on 29 MHPs of 3.115 MW composite capacity in a bundled approach. It has projects registered (as on 3 December 2010) with UNFCCC for ₹ 8,668/- CE per year, declared a Renewable Energy Policy in the state, undertaken construction of about 40 MHPs and up-gradation of more than 800 traditional watermills as well as installation of biogas and biomass power projects in the industries and institutions. As part of the initiatives of the Solar Mission, the sector is taking up the installation of solar energy projects for generation of up to 5 MW, which is likely to increase to 30 MW in the next 25 years.

PTCUL too is undertaking several salient measures, including the use of new and efficient transmission line technologies to minimize tree cutting, damage to land and agriculture, etc., through the Uttarakhand Integrated Transmission System (UITS). New technologies that are used by PTCUL include the use of bundle conductors, reducing the width of the gallery required for constructing transmission lines, which will considerably reducing tree cutting; using gas-insulated switchgear technology, by virtue of which land requirement will be reduced by one-third compared with conventional substations, ultimately reducing damage to the land and requiring less tree cutting, the use of the uneven leg design technology during tower design, reducing earth cutting, providing revetments on hillsides, etc.

13.5 Sectoral Strategies

13.5.1 Sectoral Vision and Commitment

The vision of the power sector is to strive for improved energy security for Uttarakhand through multiple strategies for improving generation, transmission and distribution and scaling up the use of renewable energy. UJVN will address erratic monsoon patterns through MPPs and smaller hydropower schemes and support other means of power generation, as well as improve energy efficiency. UPCL is committed to improving energy efficiency through fostering DSM. The Renewable Energy Programme in Uttarakhand has been expanding rapidly. This programme of UREDA covers a wide range of energy sources, products and technologies. The sustained efforts of UREDA have resulted in the creation of widespread awareness of the benefits of renewable sources of energy among the various government and private organizations and the public and it is hoped that additional scaling up will take place under the UAPCC. Likewise, PTCUL too is committed to harnessing state-of-the-art technologies and constantly striving to reduce the environmental footprint of its operations.

13.5.2 Strategies

The Uttarakhand energy sector agencies will continue to create awareness and are committed to going in for state-of-the-art technologies for improving the scientific knowledge regarding direct and indirect parameters of environmental impact. Key scientific knowledge base improvements that will be taken up include collection of hydrological data on the major rivers of Uttarakhand and their associated tributaries and regular petrographic analysis of the major rivers of Uttarakhand for knowing the state of erosion and analysing its causes, apart from regular monitoring of the isoceraunic conditions of the region. The above data will be analysed on a regular basis and a study of impacts on the efficiency of the system will be carried out. Towards this end, UJVN is planning to set up automatic weather stations for measuring meteorological data and gauging stations for river discharge measurements, in consultation with IIT (Roorkee). Apart from that, UJVN is also pursuing other agencies, viz. the Central Water Commission, Irrigation Department, etc., for obtaining historical discharge data. A data bank library is also being planned for establishing a permanent evidence base. A special cell comprising engineers from UJVN and professionals from IIT and CWC will be entrusted with analysis of the data collected in the data bank library and will keep a continuous vigil on the issues related to climate change and its impacts. Similar initiatives will also be planned and undertaken by UPCL, PTCUL and UREDA.

Each energy agency will be tasked with evolving specific objectives spanning the remaining years of the 11th Plan and period of the 12th Plan (2012/13 to 2016/17). Comprehensive documents detailing the objectives, strategies, plan of action, timelines and monitoring and evaluation criteria are being developed by UJVN and other agencies and will be finalized in accordance with the adopted SAPCC. The agencies will periodically review the progress of these and the annual performance, if so desired, will be presented to the concerned state agency through the Energy Department.

Building public awareness will be vital in supporting implementation of the SAPCC. This will be achieved through state portals, media engagement, civil society involvement, curricula reform and recognition/awards and detailed plans for these will be developed by UJVNL, UPCL, PTCUL and UREDA.

At the level of the state government, several agencies will need to enlarge and redefine their goals and areas of operation. For instance, the State Electricity Regulatory Commissions will need to concern themselves with regulatory decisions that ensure higher energy efficiency, greater use of renewable energy and other low-carbon activities that will ensure energy security, reduced local pollution and increased access to energy in areas where distributed and decentralized forms of energy production will be economically superior to conventional methods. The state government may also employ fiscal instruments to promote appropriate options and measures. Efforts will be undertaken to ensure that such co-ordination takes place. Not only the energy sector agencies but all other state departments and even the private developers will need to create capacity for regulatory measures, particularly for ensuring energy efficiency in new buildings as well as a programme of retrofits.

Public awareness about climate change will be spearheaded and driven by the agencies at all levels, with an emphasis on schools and colleges.

A number of MPPs are being planned to meet future needs of the population for not only Uttarakhand but also adjoining states such as Haryana, UP, Delhi and Rajasthan. The dams in the MPPs store excess water during the monsoon period, thus facilitating flood control and utilize the same in a controlled manner during the rest of the year, thus contributing to conservation of water, which may be used for drinking and irrigation purposes besides

generation of electricity. The reservoirs of these MPPs also enhance the level of the water table in the geographical region, which in turn increases the green belt in the area The existing powerhouses are being taken up for renovation, modernization and upgradation to increase their energy efficiency. At the same time, the state will take all measures to ensure that the minimum environmental flow in the rivers will be strictly prescribed and adhered to. To meet the power deficit in the state, gas-based power stations are being planned by UJVN in partnership with GAIL, which will contribute to green energy.

While UJVN Limited and UREDA are already promoting the use of solar power, especially in offices and for lighting in open areas, a significant additional thrust will be given to promoting/fostering solar energy usage, setting up of new solar energy projects and expansion of existing initiatives. Significant emphasis will be given to developing additional measures for DSM, especially under UPCL.

The following DSM measures will be immediately emphasized:

- Promoting the use of energy-efficient pumps and motors in the state.
- Promoting energy-efficient lighting, including CFLs and LEDs.
- Investing in building consumer awareness about energy-efficient equipment and energy conservation measures.

The state will also proactively seek to increase incorporation of policies and actions that are in sync with the relevant national missions under the NAPCC such as the Solar Mission and the Mission for Enhanced Energy Efficiency, as well as to promote elements such as the 'green building concept', in line with the National Mission for Sustainable Habitats. Energy efficiency improvements and adoption of improved technologies at all levels will be proactively promoted. Setting up mini/micro hydro-projects, upgrading traditional watermills, installation of off-grid/grid-based solar power/thermal power projects under the Jawaharlal Nehru National Solar Mission and installation of waste-to-energy, biogas and biomass projects in industries will also be given additional emphasis.

The energy sector agencies will also examine the option of setting up a joint climate change cell and will also increase efforts to boost CDM projects. The energy sector agencies will also identify and carry out a number of sector studies and take up periodical capacity building and training of their staff/personnel. Plans have also been made to organize workshop/training programmes for capacity building of the community/energy committees involved in the construction, operation and maintenance of RE projects, apart from ongoing efforts to sensitize end users and communities in general. Additional emphasis will be placed on climate change and its impacts in future efforts in this direction.

Each energy sector organization will develop rigorous monitoring protocols for implementation of initiatives under the UAPCC. A state-level committee to take a cumulative review and provide future directions for the power sector is also being mooted. The committee, besides monitoring, will issue guidelines with respect to water harvesting, green building concepts, etc. and will issue green practices certificates to various projects through regular check mechanisms.

The unprecedented natural disaster in the state during June 2013 has raised a new issue of the role of big hydro projects in contributing to natural calamities. This is being debated a lot in the country and the matter has reached the apex court. The issue needs to be carefully studied and has to be appropriately addressed, based on scientific evidence.

Several studies clearly show gender differences in energy production, energy use, access to energy and the participation of women in energy-related planning and decision making.

Especially in rural areas of developing countries, a lack of energy services is evident. A lack of access to energy mainly affects women in their role as household managers because they are usually responsible for providing energy for the household. Without access to convenient, affordable fuels for cooking and heating as well as efficient cooking devices, women have to spend large amounts of time and physical energy obtaining traditional fuels (such as wood, charcoal, dung and agricultural waste) to heat water and cook meals. Furthermore, energy is often a precondition for income-generating activities.

Energy poverty is also a growing problem, affecting poor households in particular. The share of female-headed (single mothers or elderly women) poor households is notably high. Indoor air pollution, a result of extensive use of fuel wood and other biomass or household energy, is a major problem affecting the health of women. The level of participation of women in energy planning and decision making is extremely low. Therefore, the state will develop a separate equity focused strategy to address rural energy security including substitution efforts for reducing fuel wood consumption. Such a strategy will involve incorporating gender analysis at each step of policy making and project planning and implementation and will help identify gender-related impacts, develop the right questions for further research and data collection and make gender a standard consideration for planners and decision makers.

*****

14 Roads

14.1 Overview—Characteristics and Status

Uttarakhand has a total road length of 41,041 km. The road density in the state stands at 767.4 km per 1,000 km^2 and 406 km per lakh population. The state has 2,042 km of National Highways (NH) and 1,576 km of State Highways (as on 31 March, 2010). PPPs in the pipeline include four-laning of the Haridwar–Dehradun section of NH-58 and NH-72 on a build–operate–transfer (BOT) - annuity basis and the 80 km long Muzaffarnagar–Haridwar section of NH-58 on a BOT - toll basis. The total project cost is estimated at ₹ 478 crore and ₹ 754 crore, respectively.

14.2 Vulnerability to Climate Change

Currently, no detailed climate vulnerability and risk assessments are available for the roads sector. It is expected that such an assessment will be carried out as part of the larger initiative for the state under the UAPCC.

14.3 Issues, Challenges and Priorities

Points/factors influencing the alignment and stability of roads in the Himalayan region are topography, lithological characters, geological structures, joints, faults, weathering and groundwater conditions. Some geological problems arise after road construction such as frost action as well as erosion problems. There are a large number of ecological problems associated with road construction in hilly areas. Some of these are summarized in the following.

Deforestation: The association between deforestation and slope instability has been a subject of considerable research. That deforestation brings about erosion and soil movement is generally accepted, but opinions differ as to its impact. Deforestation leads to loss of the mechanical strength imparted by the rock system. The reinforcing power of roots is also demonstrated by the results of *in situ* block shear tests, which show that the shear strength increases with increase in root density. At higher altitudes, the top green layer is very thin and takes hundreds of years to develop. A large number of trees along the roadsides fall down due to road construction—improper road construction results in soil erosion, which may lead to uprooting of large trees and destruction of lower plants. This leads to serious ecological imbalances, affecting adversely the runoff factors, temperature gradient, surface radiation, etc. Owing to loss of vegetation, the velocity of the runoff also increases and that in turn results in soil erosion and hence of soil fertility.

Disturbance of geological strata: Operations such as blasting, excavation and chipping of mountain slopes to the desired accessibility are involved during road construction in hill areas. These operations often create geological disturbances in the mountains and set into motion dynamic forces causing the movements of slip zones, cracks, fissures and weak planes.

Hill face disturbance: Natural inclinations of hill faces are disturbed by road-cutting operations and downhill movement of landslide material and disposal of excavated mass from road construction degrades and defaces natural landscapes. The growth of vegetation is also affected by the loss of topsoil, which causes ecological imbalances.

Drainage pattern interruption: The velocity of runoff downhill increases to a very large extent due to construction of bridges and culverts on the road as well as due to cutting for

establishing proper communication systems. This leads to erosion of banks and is a threat to the existence of trees and vegetation on the hill slopes. Sometimes lakes are formed by accumulation of debris from the excavated material and landslides. Such lakes that are formed divert the flow of water, causing significant destruction. In this way, natural drainage patterns are disturbed by road construction, which sometimes results in flash floods.

Water resources disturbance: Natural water resources get disturbed due to blasting during road construction activities. Moreover, improper disposal of fuel and lubricants used in the process contaminates surface water and groundwater.

Siltation problem: A large quantity of excavated material disposed on the downward slopes is carried by rivers and gets accumulated in dams and reservoirs, reducing their life span. For example, the siltation rate of the Bhakhra Dam is very high due to large-scale road construction in the Sutlej catchment. Proper 'muck' disposal is very important aspect of road construction that is neglected quite often.

Impact on flora and fauna: Wildlife gets disturbed due to blasting, hauling of machinery, the sound of road rollers and the noise of vehicles moving uphill. Destruction of key habitats such as resting sites, hollow trees, feeding and breeding grounds occurs due to road construction. Some of the *flora* and *fauna* get destroyed outright due to intrusion into forests for road construction.

Pollution: Tremendous pollution is created due to accumulation of debris below slopes. Moreover, heating of bitumen in hot mix plants produces a large number of air pollutants such as oxides of sulphur, nitrogen and carbon. Long-chain aliphatic hydrocarbons and aromatic compounds are other by-products of this heating process and they have carcinogenic (cancer producing) properties. Special precautions must be taken for protecting labourers working under such conditions on road construction sites. The temperature in the vicinity gets increased and the atmospheric humidity is lowered due to the movement of machinery and vehicles, altering the physiological processes of the plants and thereby affecting their growth pattern. The alterations in the surrounding conditions interfere with micro-organism living in the soil.

Destruction of medicinal wealth: In the hill areas, some species possess various medicinal properties. Hundreds of plants have ethno-botanical importance. There are about 150 species of aromatic plants which are found in the state used in different kinds of cosmetics and having different medicinal properties. But due to improper planning in road construction and processes involved in it, the natural wealth worth crores of rupees gets destroyed.

14.4 Sectoral Responses

14.4.1 Sectoral Vision and Commitment

The Lok Nirman Vibhag (LNV) is aware of the implications of climate change and its impacts and as such it is committed to taking the necessary steps to improve its operations through multiple measures to minimize, wherever possible, the environmental footprint of the roads sector.

14.4.2 Strategies

In order to maintain a balance between the road construction activities and the environment, protective measures will be taken, including environment impact assessment (EIA), geological investigations, carrying out studies on the state of the wildlife, avoidance of unstable and fissureal zones, minimizing disturbance to natural streams and gradients, using

appropriate work methods, minimizing blasting operations, half tunnelling, provision of suitable drainage systems, restoration of natural springs and waterways and the use of cold emulsions. Other proposals under consideration include rebuilding of the environment through plantation and compensatory afforestation etc.

The following mitigation measures will be adopted:

- Appropriate road construction materials and designs will be adopted to ensure increased climate resilience.
- After road construction, a breast wall will be constructed along loose strata or where necessary to protect hillside slopes and thus reduce the occurrence of landslides.
- Elevated expressways on pillars instead of cutting of hills slopes will be promoted. This will not only reduce distance and disasters but will also save fuel, thus contributing to reduction in CO_2 emissions. Construction of flyovers over the forest canopy will help maintain corridors and the integrity of the ecosystem. Road construction should not involve blasting of rocks; instead better technologies of drilling and cutting need to be adopted.
- Environmental awareness programmes will be organized for local communities so that quarrying in roadside hill slopes and grazing cattle on unstable areas will be controlled.
- Maintenance of the slope protection measures and drainage works.
- Soil conservation activities such as community forestry will be promoted in the rights-of-way and vulnerable areas beyond the road alignment.
- Minor landslides and mass wasting will be cleared immediately and the slope restored with appropriate technology (bio-engineering).
- Proper disposal of muck will be ensured.
- Check walls will be constructed in a stepped manner along water course on hillsides to reduce the velocity of storm water, reduce erosion of soil and increase slope stability.
- Carrying out capacity development, education and awareness-raising activities amongst the local population will be made a part of the monitoring framework of the government.
- To minimize the impact, it is proposed to close the side drains, especially near towns and maintain them regularly to avoid blockage and stagnation of water.
- Roadside drain water will not be discharged into farmlands or environmentally sensitive locations.
- Regular cleaning of roadside channels will be done to avoid any blockage of water.
- Maintenance of smooth discharges across culverts and cross-drainages by cleaning and maintaining them regularly so that water logging does not occur on adjacent lands.
- Drains will be provided along roads and the required cross drain work, such as construction and maintenance of scuppers and culverts, will be carried out.
- Noise, air and water pollution: All construction vehicles and equipment will be properly tuned and maintained in good operational condition without any leakage.
- Before repairing or reconstructing culverts canals will be cleared upstream and downstream to avoid stagnation of water during construction.

- Exposed areas will be re-vegetated using rapidly growing grass species or covered with suitable coverings during rainy days.
- Road safety: The required delineators, safety signs, road bumps, etc. will be used as required along the road.
- Road safety awareness programmes will be conducted, including the propagation of educative hand-out material in the local language.
- A road safety audit system will be adopted.
- The concept of Green Roads will be promoted in the state.
- Wherever feasible, tunnelling and ropeways would be promoted in lieu of roads.
- Green Buildings that are energy and resource saving will be promoted.

GREEN ROADS

The concept called "Green Road" has emerged in hill road construction practices and has evolved from the lesson learnt in the past and decade long experiences in hill road constructions and maintenance. This is an environment-friendly and labour-based construction technique which utilizes mass balancing approach. It is a low cost solution which focuses on the use of locally available materials and techniques in a sustainable way by maintaining the existing landscapes. Appropriate soil bioengineering techniques are applied to stabilize the roadside slopes and to reduce soil erosion.[43]

The Green Road concept aims to:

- Develop rural road and trail networks that reduce transportation costs.
- Use a participatory approach with local authorities and stakeholder communities from the preparation phase onwards, to promote a sense of local road ownership for its operation and maintenance. The beneficiaries make the decisions on the selection of the project, its alignment, labour management, group formation, and resource distribution and utilisation.
- Use environment-friendly road construction and maintenance techniques that protect the natural environment, its agricultural potential, and its natural resources against excessive erosion.
- Use locally available resources in terms of labour, material and finances.
- Generate short-term, off-farm employment opportunities especially for local people by using manual labour intensive road construction and maintenance techniques.

Other green technologies used in road construction should also be propagated to ensure that the surrounding ecology and environment are not affected. Several technologies exist and practised by the Central Road Research Institute (CRRI), New Delhi such as Cold Mix Technology (Cationic Bitumen Emulsion based), slurry seal[44] and plastic roads[45] (using recycled plastic) may be encouraged. Other indigenous techniques such as The Heat and Cool Method[46] (to replace blasting) may also be encouraged to minimise the deep fractures and internal fissures caused in the rocks by blasting.

[43] Acharya et al (2013), "Green Road: an ecological road construction method for the preservation of mountain environment and landscape in Nepal"

[44] Central Road Research Institute, New Delhi Further information on the benefits of Cold Mix Technology can be found on http://pmgsy.nic.in/cationic.pdf .

[45] Civil Engineering Department (CED) of Bokaro Steel Plant and has developed a technique for using discarded plastic material in roads. Further information can be found on http://pmgsy.nic.in/WM_RR.pdf .

[46] This method has been developed by Rural Community Infrastructure Works (RICW) Programme, Nepal to offset the fractures caused deep in the rocks (which lead to landslides) by blasting. A large fire is built under the rock face to heat the rock. When the workers pour cold water on the hot rock, it usually cracks, and is easier for the workers to manually break apart.

GREEN BUILDINGS

Green Building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation and demolition.

Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation[47]

A report by the Indian Green Building Council found that in 6 green buildings, due to substantial reductions in operational cost, the total cost of ownership of green buildings is invariably lesser than conventional buildings[48].

In India, guidelines have been put in place to ensure that energy efficient buildings are propagated. Several policy and regulatory mechanisms to address the urban challenges, implemented through national plans and programmes have been devised. The Ministries and agencies at the Centre have designed frameworks such as the Environmental Clearance to ensure efficiency in resource use for large projects (i.e. more than 20,000 sq. m built up area), the Energy Conservation Building Code (ECBC) applicable to air conditioned commercial buildings with connected load more than 100 kW and the Solar Buildings Programme for Energy Efficient Buildings and for implementation by the designated state agencies and municipal bodies.

To aid in the rating of buildings and in raising awareness and popularizing green design, GRIHA (Green Rating for Integrated Habitat Assessment), is the National Rating System of India. It has been conceived by TERI and developed jointly with the Ministry of New and Renewable Energy, Government of India. It is a green building 'design evaluation system', and is suitable for all kinds of buildings in different climatic zones of the country. GRIHA certified buildings are provided with various incentives by the GoI.[49] The benefits of following the GRIHA rating system are: up to 30% reduction in energy consumption; limited waste generation due to recycling; less consumption of water; reduced pollution load & liability

This tool, by its qualitative and quantitative assessment criteria, is able to 'rate' a building on the degree of its 'greenness'. It is a rating tool that has been tailor made for India and helps people assesses the performance of their building against certain nationally acceptable benchmarks. It evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'.

Road construction in mountainous areas can result in deterioration of livelihoods of the rural people living in an agricultural subsistence economy. Use of land to provide the road formation width, the construction of side drains, retaining walls and breast walls, the degradation of cultivated land due to side casting and the effects of spoil spillage on downside land areas are all factors directly affecting the livelihoods of the people. Project affected families are the victims of road construction while many of their neighbours are the project beneficiaries. Many of the road construction programmes of the past have had a positive impact on poverty, but the benefits have been unevenly distributed. The poorest have benefited least and have sometimes been worse off after road construction.

In addition to the loss of land, the effects of mass wasting and sedimentation triggered by road construction has contributed to the degradation of the quality of land, resulting in a decrease in productivity, especially in sections with greater cross slopes and longitudinal gradients. All these factors can seriously affect the livelihoods of local people. Excessive use

[47] Environmental Protection Agency, http://www.epa.gov/greenbuilding/pubs/about.htm
[48] Indian Green Building Council, Frequently Asked Questions http://igbc.in/site/igbc/faq.jsp
[49] GRIHA Incentives, http://www.grihaindia.org/index.php?option=com_content&view=article&id=109

of explosives during construction has triggered a high rate of mass wasting and sedimentation, especially in the geologically unstable locations found so often in hilly areas. By mobilizing local labour groups rather than using contractors will help ensure the use of environmentally sound practices in road construction. Also, since the labourers belong to the local communities and are from families directly affected by projects, they feel a sense of ownership, always trying to minimize the bad effects of road construction by optimizing the vegetation clearance area and side-casting activities and by building low, dry stone walls for spoil management control to the extent possible.

PPPs with private construction firms will be sought for implementing technology in construction of **Green Roads** and **Green Buildings** that follow the philosophy of minimum disruption to existing vegetative cover. Presently the cost of construction of a road in the hills is about ₹ 40 lakh/km; if the harm caused to the environment has to be mitigated, the cost will go up. The role of the financial sector and institutions becomes extremely important in such a case. So, financial institutions such as NABARD, ADB and World Bank could be important in supporting such initiatives. Given the meagre resources of the state, at least the additional expenses incurred in 'green technology' should be made available to the state by the GoI.

*****

15 Industries

15.1 Overview—Characteristics and Status

In recent years, Uttarakhand has emerged as one of the most attractive industrial destinations in India. The state has a favourable investment climate including the following:

- Capital investment subsidy of 15% with a maximum of ₹ 30 lakh for the establishment of new industrial units and substantial expansion of new industrial units, up to 31 March 2013.
- Interest incentive of 3% with a maximum of ₹2 lakh per annum per unit to new SSIs.
- Income Tax exemption of 100% for the first 5 years and 30% for the next for companies and 25% for others.
- Literacy rate of 79.6%, indicative of abundant availability of quality human resources.
- The total hydro-power potential in the state is 25,000 MW, out of which only 3,135 MW has been harnessed so far.
- Huge potential for tourism in the form of pilgrimage tourism, nature and eco-tourism (with three well-known national parks), adventure tourism (the Himalaya and adventure sports), etc.
- Excellent industrial infrastructure in the state—two industrial estates, one growth centre, one pharma city and one information technology park.

Key industries of Uttarakhand include auto and auto-components, agro and food-processing, paper, machinery and equipment, pharmaceuticals, consumer goods, tourism and hydro-power.

According to the Annual Survey of Industries 2008/09, Uttarakhand contributes 2.5% to the industrial output of the country, with a share of 2.1% and 2.2% of fixed and invested capital, respectively, generating a share of 7.3% in the total profits in India. The state is home to over 1,900 industrial units. The number of SSIs in the state increased by 5% in 2009-10 and Khadi Udyog / Gramodyog units increased by 66% during the same period. The total number of employees in both the industries also witnessed a significant increase. This increase in scale of SSIs in Uttarakhand can be attributed to the industrial policy of 2003, which also provides scope for PPPs.

15.2 Vulnerability to Climate Change

Currently, no climate vulnerability, risk assessment or community perception studies are available for the industries sector and there is an urgent need to initiate these.

15.3 Issues, Challenges and Priorities

Uttarakhand had very few industries in 2000, when it was carved out of Uttar Pradesh as the 27th state of India. Only 2,114 acres of land was available in industrial areas/estates. After the sanction of a concessional industrial package by the GoI in 2003, the state has witnessed rapid industrialization. The aim was to provide a comprehensive framework to enable a facilitating, investor-friendly environment for ensuring rapid and sustainable industrial development in the state and through this to generate additional employment opportunities

and to bring out a significant increase in the production and eventually widen the resource-based state.

Even after this promotional package was introduced, the investor who visited the state with an intention to invest in the early days was not very optimistic. The available industrial infrastructural facilities were not up to the mark and it seemed a Herculean task to develop the kind of industrial infrastructure the industrialists were looking for before making any investment decision. Therefore, threats to the sector's profitability and viability, such as climate change, may have significant consequences for development.

By the end of 2004, some prominent industrial houses were approached and convinced to invest in Uttarakhand. They were assured that all necessary clearances and facilities will be provided and that an investment-friendly climate will be the top priority for the state government. As a result, some of the auto giants such as Tata Motors, Bajaj and Ashok Leyland, along with their vendors and ancillaries, have developed this area as a vibrant auto cluster. Besides these, Nestlé, Britannia, Dabur and Parle have also established their units in the state.

The priority was to promote and encourage private sector participation in the development of industrial infrastructure. Forty-five industrial areas have been developed in the state with the participation of the private sector. Over 12,400 acres of land in industrial areas has been developed within a span of 4–5 years. Extension of the promotional package by the GoI for some more time will sustain the rate of industrial growth. The state government is strongly pursuing the matter with the GoI to have the package continued so that this newly created Himalayan state will maintain its industrial and economic growth. However, significant challenges exist, including the current lack of information on the environmental footprint of industries and industrial development activity in the state.

15.4 Relevant Existing Initiatives

The present approach of the state government is governed by the special integrated industrial development policy 2008. The main objective is to promote non-polluting industries for the remote and hilly area for sustainable economic development and the policy also looks at providing single-window facilitation in the state to expedite project clearances and to provide an investor-friendly climate. It also seeks to provide and facilitate expeditious land availability for setting up industrial ventures and infrastructure projects.

The policy aims to provide assured, good quality, uninterrupted and affordable power for industries and to simplify and rationalize labour laws and procedures in line with current requirements while ensuring that workers get their due share in the economic prosperity of the state. It will also assist SSIs, cottage, khadi and village industries, handicrafts and the silk and handloom sectors in modernization and technological upgrading and provide necessary common facilities and backward and forward linkages, including product design and marketing support so as to make them globally competitive and remunerative.

The State Infrastructure and Industrial Development Corporation of Uttarakhand Limited (SIDCUL), a government of Uttarakhand enterprise, was incorporated as a limited company in the year 2002 to promote industrial development in the state. It provides financial assistance to promote industries and develop industrial infrastructure in Uttarakhand directly or through special-purpose vehicles, joint ventures, assisted companies, etc. Most of its major industrial infrastructure has been developed in the plains, with a limited extent in the hills. Its major projects include the Integrated Industrial Estate at Bharat Heavy Electricals Limited in Haridwar, the Integrated Industrial Estate at Pantnagar, an IT park in Dehradun, Pharma City

in Selaqui (Dehradun), the Growth Centre at Pauri and the Integrated Industrial Estate at Sitarganj. SIDCUL enables industrial projects to be set up in a short time. The corporation administers all promotional schemes of the government for industries and uses the single-window system.

The Department of Industries is pursuing a range of adaptive practices to respond to current and potential disruptions related to climate change. These practices are intended to protect the value of existing or potential environmental assets. These best practices are aimed at:

- creating value through technological innovation and collaborative initiatives that address the changing needs of companies and communities affected by climate change, including value protection—a few leading companies have taken significant measures to adapt internal management structures in ways that facilitate proactive adaptive and integrated management of climate change impact;
- identifying risk to include climate change—leading companies are modifying their risk-identification and mitigation exercises to incorporate the effects of climate change;
- designing comprehensive water management measures—companies are identifying and developing access to new water sources to ensure a sustained adequate supply, increasing the efficiency of water use through conservation practices, developing processing technologies that reduce consumption and seeking advanced opportunities for reuse and recycling;
- Value solutions: These practices offer examples of how companies are creating solutions that contribute to the ability to pursue new revenue-generating opportunities and to collaborate with other stakeholders to meet both corporate and community needs in the context of climate change. Technical innovation to provide integrated solutions for climate change—many companies are developing ranges of solutions to help stakeholders and communities address changing climactic conditions.
- Many industries have shifted to alternate sources of energy such as CNG and hydrogen. Major initiatives have been taken up to ensure material transfer from suppliers in returnable pallets, thus ensuring a reduction in the use of plastic and wood for packing and contributing to the environment.
- Investment in renewable energy technologies and alternative fuels—many companies are investing in better ways to manage energy supplies, costs and financial risks due to regulation. They are also taking advantage of new revenue streams from carbon credits.
- Waste recycling programmes—companies are exploring ways of profiting from emissions and other waste while addressing supply shortfalls.

15.5 Sectoral Strategies

15.5.1 Sectoral Vision and Commitment

The Industries Department is committed to helping Uttarakhand move towards being a low-carbon/carbon-neutral state and will take all necessary measures in the industries sector to achieve this.

15.5.2 Strategies

Towards improving the scientific knowledge and evidence base and understanding climate change and its impacts, the department will commission cluster-wise studies to estimate the

carbon footprint of the three major industrial clusters in the state (viz., Haridwar, Pantnagar and Selaqui). This will include a baseline study, as well as periodic studies.

In line with the overarching state objectives of improving governance mechanisms, institutional decision making and convergence, the Industries Department, together with SIDCUL and in partnership with various industries associations, will initiate the following:

- **Carry out** a review of the current industrial policy and strengthen it with reference to climate change, including explicit incorporation of climate concerns and the institutional and governance framework for climate change initiatives vis-à-vis industry are enshrined in a proposed new industrial policy.
- **Constitute** a state-level task force, comprising representatives of the state government and industry and technical experts to drive mitigating measures for industry and set up task forces at the cluster level at Haridwar, Pantnagar and Selaqui. The role of both the levels of task forces will be to conduct a baseline study, conduct ongoing studies, set targets for reducing the carbon footprint and develop a plan for achieving the same. The task force will also oversee the implementation of the plans and having representation of all relevant stakeholders will ensure the buy-in of all and help in working out practical solutions and therefore better implementation and compliance. Each task force could be supported by a budget allocated from within the industry and the SIDCUL budget.
- **Incentivize** on the lines of the subsidies available for patenting and ISO; fiscal incentives to be made available to companies, especially MSMEs, going in for the following:
  - Environmental certifications relating to climate change [e.g., ISO 14064, ISO 50001]
  - Green Building certifications (following the Indian Green Building Council (IGBC) guidelines)
  - Installation of equipment that helps in reducing the carbon footprint (energy efficiency, renewable energy sources, fuel switching, etc.).
- **Create** a website for the state dealing with climate change–related policy, initiatives, actions and results.

Climate change does impact the industry. For example, incessant rains disrupted production schedules in 2011. Food processing companies will get impacted by changes in agricultural produce. Therefore, it is important to conduct detailed vulnerability and risk studies to understand the vulnerabilities of industry in the state to the various aspects/impacts of climate change. The department will commission a state-level study, preferably cluster-wise, on the vulnerability of industries in Uttarakhand to climate change. The study will also make recommendations on what specific measures can be taken to reduce these vulnerabilities.

On the basis of the baseline study, the ongoing studies (once every 2 years) and the state industry policy, a roadmap for reducing the carbon footprint and an action plan will be prepared. The action plan will lay down specific, time-bound targets in terms of reduction of GHG emissions and improvements in energy efficiencies, set targets for energy efficiency and energy use (including renewable energy) and also set targets for waste management—become low waste generation and maximum waste recycling/reuse state. The task forces will be responsible for working out the plan and implementing the same. The department will, in collaboration with various industries associations and other appropriate agencies, explore the interest levels in financial institutions (banks, etc.), multilateral and bilateral agencies, development co-operation organizations and donor agencies in promoting a low-carbon development for the state. The department will, in addition, develop Green Building

guidelines and implement a code for Green Buildings for the state, applicable to buildings above a certain threshold size.

The department will, in partnership with various industries, associations and/or other specialist agencies, take up various programmes for capacity building of industry—especially MSMEs—and government through training programmes, study missions, best practice sharing sessions and recognition—state-level awards for energy efficiency, conservation and practices that lead to reduction in the carbon footprint.

The department proposes to partner both CII and UCOST to scale up the existing UCOST-CII Annual Environment Summit with a day dedicated to deliberations on industry and climate change. More such activities will be proactively planned and implemented on an annual basis.

Rigorous methodologies and protocols will be developed for monitoring activities to be undertaken by the Industries Department and its partners under the UAPCC. The cluster-level task forces will be the monitoring bodies. Terms of reference will be developed for this. At the state level, the state-level task force will guide and oversee the cluster-level task forces. Periodic external (third-party) reviews and evaluations will also be planned and undertaken.

Towards documenting, sharing, learning and dialogue across the Indian Himalayan states, the department proposes to institute a biennial conference with participation from all Himalayan states on industries in the IHR in collaboration with various industries, associations and other potential strategic partners. In addition, the department will institute an annual summit-cum-exhibition to provide a platform for all stakeholders to come together and discuss various aspects of climate change for industry in the state, learn about the latest developments, showcase good practices and share experiences. The department will also initiate a process of documenting, collating and sharing/disseminating best practices widely in the state and across the IHR.

*****

16 Transport

16.1 Overview—Characteristics and Status

The Uttarakhand Transport Department was constituted in 1945 under the provisions of Section 133 A of the Motor Vehicles Act 1939. It was headed by the Transport Commissioner, UP, when Uttarakhand was a part of UP, before 9 November 2000, i.e. the date of reorganization of UP. As Uttarakhand state came into existence, the Transport Department of Uttarakhand, headed by the Transport Commissioner, Uttarakhand was formed.

The other main constituent of the Transport system is the State Road Transport Corporation, which has also been re-organized in Uttarakhand as 'Uttarakhand Transport Corporation' (UTC). UTC began to work on 31 October 2003 and is providing services on nationalized routes as well as on inter-state routes. Presently, 1,000 (approximately) buses are being plied by UTC on 35 nationalized routes, along with many other non-nationalized routes. Around 3,000 buses are being plied by private transport operators on non-nationalized routes, along with a few inter-state routes of Uttarakhand and UP.

Buses plying on the major hill routes of Uttarakhand have a 166-inch wheel base with an overhang not more than 50%. Buses plying on plains routes have a wheel base greater than 166 inches, a greater seating capacity and an overhang up to 60%.

Statistics of on-road vehicles in the state are given in Table 24.

Table 24: On-road vehicles in Uttarakhand (2010-11)[50]

Vehicle category	Number of vehicles
Two-wheelers	8,58,997
Cars/jeeps	1,70,548
Buses	9,673
Trucks	19,034
Four-wheelers/delivery vans	22,560
Taxis/maxis	21,402
Autos/tempos	14,265
Tractors	54,479
Trailers	3,905
Others	1,846
Total	11,76,709

Data related to annual vehicle registration show that the total number of vehicles has been growing steadily (Table 25).

Table 25: Vehicles registered annually in Uttarakhand[51]

Vehicle type	Year									
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2010/11
Two-wheeler	27,396	32,306	40,587	44,467	54,042	58,090	67,974	67,850	65,391	1,09,363
Car/jeep	4,274	4,539	5,430	7,956	9,163	10,323	12,031	16,471	16,385	29,367
Bus	266	259	195	361	670	1,096	387	544	348	650
Truck	818	570	917	1,215	1,042	3,426	1,411	1,146	850	1,669

[50] "Statistical Data", State Transport Department Government Of Uttarakhand, Last Updated on 06-05-2014, accessed 14 May 2014

[51] Ibid

Vehicle type	Year									
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2010/11
Four-wheeler Truck/delivery van	482	533	701	1270	1,401	3,436	1,524	2,866	3,066	3,881
Taxi/maxi	1,530	1,721	1,165	899	1,038	2,953	1,824	2,405	2,486	3,427
Auto/tempo	901	797	529	577	291	1,271	949	1,512	2,220	2,527
Tractor	1,692	1,332	1,318	1,418	1,686	2,168	3,417	2,994	2,372	3,348
Trailer	61	44	117	190	295	529	902	581	215	189
Others	230	46	601	175	462	103	635	536	118	245
Total	37,650	42,144	51,560	58,533	70,090	83,395	91,054	96,905	93,451	1,54,666

During the last two decades, the number of registered vehicles has been greater than 13 lakh. An overwhelming majority (around 90%) of these are used for personal transport.

16.2 Vulnerability to Climate Change

No climate vulnerability and risk assessments have been carried out for the transport sector yet. However, there are frequent media reports on the state of traffic congestion and vehicular pollution, which is on the rise.

16.3 Issues, Challenges and Priorities

The rapid growth in the number of vehicles in the state has been accompanied by concomitant problems, including congestion and traffic snarls, a lack of adequate parking space, high accident rates, a rise in environmental vehicular pollution and inadequacy of road space for efficient public transportation. The Transport Department has to not only cater to the public transportation needs of its 1 crore+ population but also to that of the enormous floating population in the state, partly owing to the movements of tourists and pilgrims.

16.4 Sectoral Strategies

16.4.1 Sectoral Vision and Commitment

The Transport Department is committed to augmenting and improving the quality of the public transportation in the state as well as to make it commuter and environment friendly by providing efficient, safe, environment friendly and affordable multi-modal transport system in order to discourage the use of personal vehicles. This objective will also be complemented through the use of non-motorized transport solutions through appropriate transport and traffic engineering, with effective enforcement of traffic regulations. Other complementary measures will include increasing training facilities in order to reduce the number of accidents and reduce vehicular pollution.

16.4.2 Strategies

Keeping the above vision and commitment in mind, initiatives will include the following:

1. *Control of vehicular pollution with the following objectives:* (a) To control pollution caused by motorized vehicles plying in the state; (b) to create awareness amongst the motoring public in particular and the public at large on the effects of vehicular pollution; (c) to provide pollution-checking facilities at petrol pumps and workshops; (d) to enforce the standards of various pollutants according to the relevant rules including the Motor Vehicles Act and (e) to facilitate enforcement of environmental pollution control in the state.

Various activities will be taken up to pursue these objectives, including mass awareness campaigns through various media, computerization and Internet facilities at pollution checking centres, better enforcement through new technologies including remote sensing to detect particulates and NO_x emissions, setting up a Planning and Monitoring Cell to collect and compile transport statistics and analyse these for policy formulation, publication of relevant reports, etc.

2. *Direct rail routes and alternate transportation:* Direct rail route from Kalsi to Tanakpur is required to save distance by unnecessarily routing through Moradabad and Rampur. This will reduce distance, traffic, time, fuel and reduce CO_2 emissions. Daily services between Tanakpur and Kalsi needs to be started. Helicopter and small flights to different regions of the state can considerably reduce hill journey and disastrous traffic. Feasibility studies of setting up Ropeways and Gondola's to promote safe transportation and augment also needs to be looked into.

3. *Public transportation system:* UTC will need to phase out its older vehicles and replace them with Bharat Stage 3–compliant vehicles; in addition, it is proposed to purchase 800 new buses to meet the increased demand for efficient public transportation.

4. *Driver training for safety and fuel efficiency:* The objective of this initiative will be to impart training in driving skills to potential drivers and to upgrade the skills of existing drivers on scientific lines by employing modern equipment and highly trained instructors.

   While private driving schools exist in the state, the quality of the training imparted is poor. Similarly, the facilities for skill testing available with the licensing authorities are also inadequate. Three new premier motor training facilities have been set up by the department with state-of-the-art facilities in a PPP mode at Pauri and Almora. All heavy vehicle driving licence holders will necessarily have to undergo refresher training at these institutes before getting their licenses renewed. There is also a need to upgrade the curriculum on an ongoing basis.

5. *Alternative fuels:* The Transport Department will also proactively consider the promotion and use of alternative fuels such as CNG and bio-diesel in the state for not only the public transportation system but also private vehicles.

*****

Part C: Action Plan and Budget

Action Plan and Budgets

Agriculture

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
Promotion of Sustainable Agriculture	Increase area under organic farming	Identification of area and providing of timely inputs; Promoting making of organic manure	-	2500.00	Adaptation
	Area expansion under local crops	Identification of area and providing timely inputs	-	991.75	Adaptation
Soil and Water Conservation	Area expansion under life-saving irrigation through water harvesting programmes	Creation of additional irrigation facilities and water harvesting structures	-	2500.00	Adaptation
Capacity Building and Research	Strengthening of agri-extension with coordination of NGOs for development of commodity-based clusters	Organising of workshops and seminars and strengthening *Krishi Vikas Kendra's* (KVKs), promoting local trainers by ToT programmes	-	500.00	Enhancing Knowledge Base
	Research Projects	Developing climate resistant cultivas Assessing potential of local cultivas; preservation and storage of genetic materials	-	1500.00	Enhancing Knowledge base
Total				**7,991.75**	

Forests and Biodiversity

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
Increasing the existing area under forests and trees and improving the quality and density of degraded forests	Management intervention in scrub forests (1 km^2/year)	Advance soil work, raising of plants, plantation and maintenance and associated site-specific activities	There is almost 270 km^2 of scrub-forests in Uttarakhand. The majority of these areas may not be suitable for management intervention.	331.54	Some of these areas may be suitably improved with regards to conservation of biodiversity.
	Plantation of climate-resilient species also beneficial to local communities in open forests according to the principles of three-tier forests (250 km^2/year)	Advance soil work, raising of plants, plantation and maintenance and associated site-specific activities	The total area of open forests in Uttarakhand is 5,568 km^2. In 5 years, a little less than 25% of these areas may be better stocked.	55,256.31	This will enhance the carbon sink.
	Assisted natural regeneration in moderately dense forests (100 km^2/year)	Silvicultural operations, protection and associated activities	The area of moderately dense forests is 14,165 km^2. Five percent of this area may be taken up under assisted natural regeneration in 5 years.	7,183.32	Assisted natural regeneration is a promising silvicultural tool to enhance carbon sink.
Enhancing natural resources and livelihood options of the vulnerable sections	Providing livelihood options to local communities	Plantation of harar, behra, amla, chura, tejpat, timru, bamboos, etc. in community lands	There are significant areas of community lands that are not available for cultivation. The communities may be encouraged to grow useful species in these areas.	110.51	This will help in adaptation to Climate Change.
	Rangeland management	Mapping of all important rangelands using RS-GIS followed by ground truthing	There are rangelands in forests as well as community lands.	442.05	This will help in planning for rangeland management
		Conservation of bugyals through local and nomadic communities and related institutions (2500 ha per annum)	Bugyals are threatened ecosystems and need to be managed better with the help of local communities.	1,381.41	These ecosystems are good at carbon sequestration.
		Alternate livelihood options	New avenues for	828.84	This will lead to better

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
		for communities such as NTFP collection, community-based eco-tourism, biomass bricquetting, decentralized nursery establishment, cultivation of medicinal herbs (including yarsagambu, etc.)	alternate livelihood options are to be devised.		adaptation.
		Improvements in the variety of cattle	The idea is to lessen the biotic pressure on natural resources.	110.51	Conservation of the carbon sink.
		Protection and management initiatives towards regulated grazing	This will lead to scientific management of rangelands.	55.26	Conservation of the carbon sink.
	Agro-forestry/farm forestry	Mapping of all land areas with a potential of agro-forestry using RS-GIS	This will help assess the extent of areas suitable for agro-forestry.	276.28	Enhancement of carbon sink.
		R&D for varieties of different species for best commercial use and climate change concerns	Agro-forestry has the potential to contribute to climate change mitigation efforts.	55.26	Enhancement of carbon sink.
		Establishment of quality planting material production centres	Agro-forestry systems allow vulnerable smallholder farmers to cope with climate change better.	110.51	Adaptation.
		Training programs and extension activities	To facilitate stakeholders' participation	55.26	Adaptation.
Soil and water conservation	Close watch on glaciers	Minimizing human interference in the ecology of glaciers	Glaciers are threatened systems and must be preserved for the water security of the subcontinent.	55.26	Adaptation.
	Research	Vulnerable areas to be identified with the help of experts	The areas of water deficiency must be identified in order to preserve the life support systems.	55.26	Adaptation.
	Research	Strategic and scientific	The state is having	27.63	Adaptation.

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
		planning to be done for road cutting that results in minimal soil and water resources loss	many proposals for surface infrastructure development.		
	Maintenance of soil moisture regime	Large-scale rainwater harvesting structure to be constructed to reduce the water stress in moisture-deficient areas	Rainwater-harvesting structures are efficient in conserving water.	1,657.69	Adaptation.
	Vegetative approach to soil and moisture conservation	Soil and moisture conservation regime to be enhanced by introduction of three-tier forest plantations	The objective is to enhance the water security of the local communities.	1105.13	Adaptation.
		Rejuvenation of traditional chals, khals and tals with emphasis on indigenous traditional knowledge	As above	552.56	Adaptation.
Biodiversity conservation	Documentation of biodiversity	Establishment of Biodiversity Management Committees	This will enable local communities enumerate and monitor the local biodiversity.	50.00	Adaptation.
		Making Biodiversity Registers	As above	500.00	Adaptation.
	Habitat management	Management of invasive species (lantana, parthenium, eupatorium, etc.) and replacement with suitable species (bamboo, grass etc.) (We assume that we ought to take up 15,000 ha per year.)	This will improve the habitat as well as lessen man-animal conflicts	8,288.45	Adaptation.
		Creation of water holes/anicuts	As above	1,105.13	Conservation of biodiversity
		Maintenance of existing water holes/anicuts	As above	110.51	Conservation of biodiversity
		Conservation and maintenance of wetlands	Wetlands are important ecosystems with many co-benefits	243.13	
	Linking of protected areas to prevent habitat fragmentation	Establishing a task force to identify/prioritize corridors	Genetic in-breeding in isolated islands may lead to extinction of some species of	27.63	Conservation of biodiversity

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
			wildlife. The phenomenon will be accelerated in the face of changes in vegetation types as a result of climate change.		
		Involve all stakeholders to regulate change of land use	To facilitate the above	27.63	Conservation of biodiversity
		Maintaining cover through agro-forestry, preventing crop raiding in corridors through fencing	As above	276.28	Conservation of biodiversity
	Ex situ conservation of species	Maintenance and development of existing zoos, rescue centres for wildlife and botanical gardens	This is a no-regret policy.	138.14	Conservation of biodiversity
		Maintenance and development of biodiversity centres and biodiversity hotspots	This is a no-regret policy.	27.63	Conservation of biodiversity
	Minimize man-animal conflicts	Rapid response in cases of crop raiding and chance encounters of humans with animals, including ex gratia payments	This is to ensure that man-animal conflicts are not accentuated.	276.28	Conservation of biodiversity
		Rehabilitation of rescued wildlife	This is an important operation towards conservation of wildlife.	82.88	Conservation of biodiversity
Fire Management	Management of fuel load	Clearing and maintenance of fire-lines	This is an important silvicultural operation to minimize the possible damage due to forest fire.	690.70	Conservation of sink
		Controlled and cool burning	This is an important silvicultural operation to control the fuel load.	165.77	Conservation of sink
		Providing alternate energy sources to local communities	Reducing the independence of local	552.56	Conservation of sink

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
			communities on forest base resources		
	Fire control	Quick-response teams for fire fighting	Strengthening fire control and mitigative measures	663.08	Conservation of sink
		Daily monitoring of fire threat with the help of satellite imagery and information technology	To encourage the use of modern forest fire tools and technologies in combating fire hazards	55.26	Conservation of sink
Minimising Human Animal Conflict	Reducing monkeys and wild boars menace	Monkey Sterilisation, Fencing, Rescue Centres	Not much infrastructure is available at present	1000.00	Reduction in Man Animal Conflict and emigration
Research and capacity building	Monitoring and evaluation of carbon stock	Evaluation of total carbon stock and annual increment in Uttarakhand	Partner institutions may be involved	10.00	Enhancing knowledge base
		Monitoring the forest carbon flux	Already initiated in collaboration with IIRS	10.00	Enhancing knowledge base
	Conservation of biodiversity	Population dynamics and movement of wildlife	Partner institutions may be involved.	10.00	Enhancing knowledge base
	Silviculture	Development of climate-friendly silvicultural techniques	Partner institutions may be involved.	10.00	Enhancing knowledge base
	Fire management	Management of forest fires	Partner institutions may be involved.	10.00	Enhancing knowledge base
		Capacity building of different stakeholders	Partner institutions may be involved.	10.00	Enhancing knowledge base
Short-term research projects	Impacts and adaptation to climate change in forests and other natural ecosystems	Adapt and develop dynamic vegetation models relevant to tropical and sub-tropical forest types, plantations as well as other natural ecosystems such as wetlands and grasslands	5 years	10.00	Enhancing knowledge base
		Initiate focused short-term field ecological and physiological studies in selected forest type sites to generate parameters for	5 years	10.00	Enhancing knowledge base

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
		various plant functional types required for dynamic vegetation models			
		Initiate studies to assess the likely impacts of climate change on natural ecosystems and identify vulnerable and sensitive ecosystems such as montane grasslands, plantation systems and bugyals	5 years	10.00	Enhancing knowledge base
		Develop adaptation framework relevant to forest and grassland ecosystems and develop adaptation strategies, practices and management systems	5 years	10.00	Enhancing knowledge base
		Plan and implement pilot adaptation projects to demonstrate the effectiveness of adaptation practices	5 years	10.00	Enhancing knowledge base
	Socio-economic adaptation among forest-dependent people to climate change	Assess the vulnerability of forest-dependent communities to climate impacts	5 years	10.00	Enhancing knowledge base
		Develop programmes to enhance adaptive capacity of forest-dependent communities	5 years	10.00	Enhancing knowledge base
	Policy research to assist policy	Assessment of implications of REDD+, forest conservation and sustainable management of forests for India	5 years	10.00	Enhancing knowledge base
		Development of methodological understanding of carbon	5 years	10.00	Enhancing knowledge base

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
		stock changes under REDD+, forest conservation and sustainable management activities			
	Carbon inventory and mitigation studies	Developing models for assessing carbon sequestration and mitigation potential of different forestry and plantation activities	5 years	10.00	Enhancing knowledge base
		Developing rates of changes in carbon pools under different forest and plantation systems to assist development of CDM projects, based on cross-sectional studies	5 years	10.00	Enhancing knowledge base
		Developing emission factors for GHG inventories in land use sectors, forests, grasslands, wetlands, etc.	5 years	10.00	Enhancing knowledge base
	Assessment of the ecological and economic potential of bio-fuels and other species for climate mitigation and energy security	Assessment of the mitigation potential of different bio-energy technologies	5 years	10.00	Enhancing knowledge base
		Assessing the environmental impact of plantation of different bio-fuels and others crops	5 years	10.00	Enhancing knowledge base
		Estimating the land availability for biomass feedstock (woody biomass and oil seeds) production for energy	5 years	10.00	Enhancing knowledge base
		Competition for land for carbon sequestration vs. Bio-energy for fossil fuel substitution	5 years	10.00	Enhancing knowledge base
		Assessment of impacts of	5 years	10.00	Enhancing knowledge base

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
		climate change on sustainable biomass feedstock production for energy			
Research, facility and survey	Mapping of terrestrial floral and faunal species	• Inventorization of floral and faunal species in wetlands, meadows and moraines • Herbarium	5 years	1000.00	Comprehensive data availability
		• Mapping of aquatic floral and faunal species including fishes in the water body	5 years	1000.00	Changes in species composition in various forest types will be known
Facility development and management	Establishment of herbarium and museum for faunal specimens and digitization of samples	• Comprehensive herbarium in traditional format as well as in digitized form will be available. • Museum with faunal samples will be available.	5 years	1000.00	Species samples will be available.
Survey and restoration work	Desiltation of the waterbody to restore the original depth	•	5 years	1000.00	Adaptation
Soil conservation work, moisture management	Watershed development	•	5 years	1500.00	Soil Conservation and improvement
Nursery establishment and plantation of species (if required)	In situ conservation of indigenous and original floral species in the wetlands, alpine meadows and moraines	• Nursery establishment • Plantation of indigenous species	5 years	1000.00	Promoting indigenous species
Nursery establishment Subsidy to farmers Extension	Ex situ conservation of the floral species of economic importance and agro-forestry and		5 years	2000.00	Promotion of indigenous species

Major thrust areas	Activities	Sub-activities	Present status	Expenditure in 5 years (₹ in lakhs)	Expected outcome
	farm forestry				
Research	Soil mapping in wetlands	• Establishment of soil testing lab with micro nutrient testing facilities • Mobile soil and water testing lab	5 years	2000.00	Productivity enhancement and soil improvement
Documentation, travel and scientific standardization	Evaluation and standardization of traditional knowledge (TK)		5 years	1000.00	Enhancing knowledge base
Research	Establishment of centre for analysing impact of climate change on wetlands, meadows and moraines		5 years	1500.00	Enhancing knowledge base
Total				**97,101.65**	

Animal Husbandry and Livestock

Intervention	Intervention type	Activities required	Duration	Expenditure in 5 years (₹. In Lakhs)	Possibility of convergence	Institution responsible	Expected outcome
Setting up of project management unit	Institutional strengthening	• Setting up of CPMU at state level • Setting up of DPMUs • Setting up of district project management units	Up to 20 years	340.35		State, Divisional & District Units of the Department of Animal Husbandry	Better and effective project implementation, monitoring and evaluation Easier documentation, learning, sharing and dialogue
Human resource development	Training and capacity building	Providing training to all stake holders	Up to 20 years	1307.50	Rural Development Department Universities and NGOs	Department of Animal Husbandry, ULDB, USWDB, State and Central Research Institutes	Capacity enhancement of all stakeholders
Disease surveillance, forecasting and mitigation	Institutional strengthening Improving diagnostic Backup Direct	• Strengthening of Institutions • Mobile veterinary and diagnostic services • Organising intensive livestock health and infertility treatment • Strengthening of cold chain management system for vaccines	Up to 20 years	3388.83	Integrated Watershed Development Department	Department of Animal Husbandry, ULDB, USWDB State & Central Research Institutes	• Institutional strengthening • Decrease in the incidence of infertility and improving livestock health • Decrease in morbidity and mortality and incidence of diseases • Increase in productivity
Fodder development	Direct field action Farmers' demonstrations	• Establishing silvipasture on van panchayat lands • Pilot Project on silage production • Compact feed block manufacturing	Up to 20 years	3650.55	Department of Forests, Department of Agriculture - RKVY	Department of Animal Husbandry, ULDB, USWDB State & Central Research Institutes	• Mitigating the deficit of dry and green fodder • Better utilization of existing fodder and prevention of wastage

Intervention	Intervention type	Activities required	Duration	Expenditure in 5 years (₹. In Lakhs)	Possibility of convergence	Institution responsible	Expected outcome
		plants • Construction of concrete mangers for stall feeding in hills • Chaffing of fodder					
Other initiatives	Direct field action	• Providing shelter to transhumance livestock rearers in reserve forest areas	Up to 20 years	10587.50	Department of Forests	Department of Animal Husbandry, ULDB, USWDB State & Central Research Institutes	• Protection of shepherds and their flocks during migration
		• Construction of community owned biogas units of 85 m^3	Up to 20 years		Dep't. Of Non-Conventional Energy		• Reducing the use of wood for fuel
		• Setting up of Goat Units	Up to 20 years		NABARD Department of Agriculture - RKVY		• Enhancing livelihoods and employment generation
		• Setting up of Gau Sadans in Van Panchayat	Up to 20 years		Department of Forests		• Preventing damage to crops from stray cattle • Income generation • Reducing the use of wood for fuel • Promotion of organic agriculture
		• Backyard poultry development • Establishment backyard poultry units and parent stock • Construction of shed for parent stock	Up to 20 years		Department of Agriculture – RKVY, Rural Development Department		• Enhancing livelihoods by creating avenues for income generation • Improving the food basket of the rural resource-poor
Total				**19,247.73**			

Disaster Management

Interventions	Intervention type	Activities	Duration	Total cost (₹. in lakhs)	Possibility of convergence	Expected outcome
Vulnerability to climate change and community perceptions	Documentation and research	Assessment of: • Impact of natural disasters upon masses, particularly women • People's perception of climate change and documentation of their adaptation strategy through primary data collection in various regions of the state • Changes being introduced in the geo-environment due to climate change through primary data collection in various regions of the state • Study of the impact on natural resources and livelihoods of people due to changing weather patterns and extreme weather events • Documentation of best practices in traditional coping methods, possible interventions to meet present demand and promotion of the same • Documentation of the ITK of the masses	3 years	100.00	Forest, environment and agriculture	Database of ITK People's perception and their coping mechanism (If any) Impact of CC on livelihood and resources, Coping mechanism for future adaptation strategy
Improving scientific knowledge and evidence base and understanding climate change and its impacts	Research 1. Exploring the use of speleothems (deposits in limestone caves) in	1. Study of recent changes in climate parameters 2. Monitoring of various climate parameters 3. Study on mass balance of	5	5,000.00	In collaboration with IISc (Bangalore) and PRL (Ahmedabad) In collaboration	Data on changes in various climate-related parameters Monitoring the changes in

	reconstructing changes in various climate-related parameters 2. A series of automatic weather stations will be installed at critical locations in the high reaches of the state	Gangotri Glacier			with WIHG (Dehradun)	various climate parameters
Land use/land cover change studies	Research	Land use/land cover change studies for various towns of the state using high-resolution satellite imagery (IKONOS and WV 2)	2	50.00	Forest and agriculture	Land use/land change scenario
CBDM	Training and capacity building	• Community-based risk assessment • Preparation of disaster management plan • Training of community members on search and rescue	5	2,000.00	For community-level training: PRIs	Promotion of safe construction technologies More trained persons
Training and capacity building	Training and capacity building	Training of: • Departmental officials in vulnerability assessment • Departmental officials in the use of GIS and RS tools for effective resource management • Engineers in retrofitting of existing structures and safer construction practices • Masons in safer construction practices • Formal first responders in search and rescue and first aid • State government officers in post-disaster needs assessment (PDNA) • Media personnel in reporting disaster-related issues • Government officials in preparation of disaster management plans • Government officials in post-disaster response and utilization of ICS (IRS) principles	5	1,000.00		

Mock drills	Capacity building	Mock drills and table top exercises involving nodal officers of various government departments	5	100.00	District administration	
Awareness generation	Awareness	Knowledge sharing regarding disaster management through various media such as: • Print material • Electronic modes • Folk theatre • Films • Tele-serials • Video and audio spots • Meetings and workshops • Competitions, both face to face and online • Development of IEC material	5	500.00	Nagar Palika Parishads, PRIs	-
School safety		• Training of schoolteachers in vulnerability assessment and school disaster management plan preparation • Vulnerability assessments: structural and non-structural • Training and mock drills • Competitions • School curriculum • Online education and competitions • Awareness programme for officials	5	500.00	Department of Education and national and state schemes such as SSA	Safety of vulnerable sections and lifeline building
Hospital preparedness and safety		• Training of doctors in mass casualty management and hospital disaster management plan preparation • Vulnerability assessments: structural and non-structural	5	2,000.00	Department of Health and national and state schemes such as NRHM	Safety of vulnerable sections and lifeline building
Review of various techno-legal regimes		• Review of various techno-legal provisions • Suggestions for appropriate amendments	2	50.00	Department of Town and Country Planning, MDDA, Nagar Nigams/Palika	

Emergency preparedness	• Emergency Operation Centres (EOCs) • SMS alert system	Upgrading centres and training personnel	5	25.00		
Action plans at various levels	Preparation and updating of plans	• State and district plans • Tehsil- and block-level plans • Nyaya Panchayat and village plans • Preparation of DM plan for all major reservoirs in the state • Mapping of glacial lakes and planning for GLOF • Simulation of extreme precipitation scenario in major river basins of the state and planning for the same	5	500.00		Appropriate plans in case of extreme weather events/GLOF events
Vulnerability and risk assessment	Research	• Vulnerability assessment of lifeline structure and demonstrative retrofitting • Relocation of critical infrastructure • Relocation of a few threatened habitations • Assessment of urban vulnerability, particularly in the case of extreme precipitation events • Vulnerability assessment of all industrial units in the state • Landslide and environmental risk assessment	5	20,000.00	Respective sectors	
Socioeconomic vulnerability assessment	Research	• Assessment of the socio-economic vulnerability of masses in various remote locations of the state • Gender-based studies to identify the role of women as first responders to disasters and their training • Training sessions on livelihood options including small-scale businesses, animal husbandry and agriculture, with focus on adaptation and coping mechanism	5	500.00	Nagar Palika Parishads of the towns	Resilience building

Integration of DRR in development plans	Knowledge sharing and suggestions	Construction under SSA, IAY, RAY etc. Road construction under PMGSY Work under MNREGA	5	2,000.00		Safe buildings Better road cutting to have minimum impact on slopes for reducing instability Disaster management-related work such as construction of retaining walls
Contribution to reduction of greenhouse gas emissions	Promotion of greener construction practices	• Promotion of disaster-safe construction practices, retrofitting, vulnerability assessment, changes in techno-legal regime	5	2,000.00	Forest and environment	All collective actions will result in reduced toll of disasters and hence reduced reconstruction. This will contribute to reducing greenhouse gases.
Promotion of risk transfer mechanisms		Various risk transfer instruments will be developed and promoted through various modes	5	500.00		Important tool for reducing the burden of disasters upon public exchequer
Networking and collaborations		• Work in close collaboration with various centres of excellence and universities that include WIHG (Dehradun), IIRS (Dehradun), CSWCRTI (Dehradun), IIT (Roorkee), NIH (Roorkee), CBRI (Roorkee) and Kumaon, Garhwal and Pantnagar universities. • Documenting, sharing, learning and dialogue across the Indian Himalayan Region	5	100.00		The masses to be provided with technical knowledge in the vernacular and in an easily decipherable manner
Uttarakhand Council of Science and Technology (UCOST) AND Uttarakhand Space and Application Centre (USAC)		• Studies and Research in Climate Change	5	200.00		Emergence of new and innovative adaptive techniques
Total				**37,125.00**		

Human Health

Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹. in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcomes
Awareness of the people about health hazards from climatic change, covering all areas such as rainwater harvesting, energy efficiency, water conservation and protection from extreme climate	Strategic knowledge	1. IEC efforts 2. BCC interventions 3. Training sessions and sensitization for personnel of the department	5	800.00		Health Department media, broadcasting, Education Department, PRIs and other CBOs	
Integration and strengthening of Integrated Disease Surveillance Project (IDSP), National Vector Disease Control Program (NVDCP), non-communicable diseases, National Program of Health Care for Elderly (NPHC) and Disaster Management Cell as a response to extreme climate effects	Capacity building	Capacity building of all CMS/CMO/medical specialists and EMOS of the district, the team of IDSP, the Disaster Management Cell, ANM, AWW, ASHA and all the MNGOs in the district to identify the early signs of extreme climatic effects on the population and their remedy Developing and strengthening disaster management team in every district hospital, CHC and PHC specifically to respond to the effects of extreme climate changes Multipurpose health workers for National Vector Disease Control Program (NVDCP)—500 nos. Capacity building of hospital by providing necessary equipment and human resources and capacity building of medical and paramedical staff	5	1000.00	Poor and vulnerable population being targeted through 1. State Illness Fund 2. RSBY 3. No user charges	Health Department media, broadcasting, Education Department, PRIs and other CBOs	
Bio-medical management and SWM	Himalayan ecosystem	Proper segregation, collection storage, transportation, treatment	5	500.00	Pollution Control Board,	Health Department, Pollution Control Board	

Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹. in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcomes
		and disposal Equipment—plasma pyrolyzer			Municipal Board		
Building retrofitting of CFLS and LEDs	Enhanced energy efficiency	To be made compulsory in all government hospitals and offices	3	100.00			
Construction of Green Buildings (hospitals and offices)	Sustainable habitat	To be made compulsory in all government hospitals and offices Increase the green cover of all the Health Department premises	5	7200.00	Planning, finance, forest and Jul Sansthan		
Solar water in government hospitals and offices	Solar Mission	To be made compulsory in all government hospitals and offices	5	800.00	Planning, finance and Jul Sansthan	Selected agencies	
Total				**10,400.00**			

Urban Development

S.No.	Interventions	Intervention types	Activities	Duration (years)	Total cost implications (₹. in lakhs)	Possibility of convergence	Implementing department/ agency	Expected outcome
1	Comprehensive SWM programme in all ULBs	Facility and service	SWM DPR approved by the GoI for three mission towns. SWM action plan for rest. Sixty ULBs to be prepared under ADB scheme. Twenty-eight ULBs will be funded under ADB. Nirmal Nagar Puraskar Yojna implemented in the state to encourage ULBs for SWM work.	5	24000.00 (approximately 8 crores for each Nagar Palika Parishad) 15000.00 (approximately 5 crores for each Nagar Panchayat)	GoI missions such as JnNURM and ADB-funded schemes	ULB	Implementation of MSW Rules 2000, clean and green city, carbon credits

S.No.	Interventions	Intervention types	Activities	Duration (years)	Total cost implications (₹. in lakhs)	Possibility of convergence	Implementing department/ agency	Expected outcome
			ULBs to be rewarded annually for best performance.					
2	Extending producer responsibility for waste—Plastics should come under the purview of eco-system service fees or eco-cess		Uttarakhand Plastic Usage & Disposal of Non-biodegradable Waste Act 2013 will be prepared	5		Plastic Waste (Management & Handling) Rule 2011	UDD	Clean and green city
3	Policy intervention against companies using non-recyclable material in packing	Research & development	Uttarakhand Plastic Usage & Disposal of Non-biodegradable Waste Act 2013 will be prepared.	5		Plastic Waste (Management & Handling) Rule 2011	UDD	Environmental sanitation
4	Banning burning of municipal solid waste including plastics and leaf litter	Implementation of Plastic Waste (Management & Handling) Rule 2011		2		Plastic Waste (Management & Handling) Rule 2011	ULB	Reduction of toxic gases in atmosphere
5	Provision of rainwater harvesting tanks in all ULB buildings and new constructions in municipal limits	Reforms	Mandatory under building by-laws of all development authorities. Directions to be given to ULBs to adopt the same	2			UDD	Conservation of natural resources
6	Cleaning/conservation/beautification of water bodies situated within ULB limits	Research and extension	Data to be collected from ULBs	2			ULB	Clean and green city
7	Promoting use of LED street lights by adopting ESCO model to ensure savings in electricity and maintenance and to reduce CO_2	Partnership with ESCO companies		5		PPP	UDD, ULB, ESCO	Energy saving, CO_2 reduction in atmosphere

S.No.	Interventions	Intervention types	Activities	Duration (years)	Total cost implications (₹. in lakhs)	Possibility of convergence	Implementing department/ agency	Expected outcome
	emissions							
8	Promoting use of CFLs in all ULB buildings	Development	Directions given to ULBs	5			ULB	Save conventional energy
9	Promotion of eco-friendly generators	Enhanced Energy Efficiency Mission		5		GoI missions such as National Mission for Enhanced Energy Efficiency	ULB, UREDA	Reduce noise pollution and air pollution
10	Development and extension of green patches in urban wastelands with the support of the Forest Department	Dovetailing Green India		5		GoI missions such as National Mission for a 'Green India'	ULB, Forest Department	Carbon sequestration
11	Installation of paper shredders in all ULBs to ensure recycling of used paper for re-use	Dovetailing Green India		5	15.70 (@ approximately ₹25,000 for 63 ULBs) Shredder up to 10 gallon capacity and ISI marked	GoI missions such as National Mission for a 'Green India'	UDD	Reducing afforestation
12	Herbal gardens in each district with the support of the Herbal Research Development Institute	Dovetailing Green India		5		GoI missions such as National Mission for a 'Green India'	UDD, HRDI	Promotion and production of herbal medicine
13	Promotion of Green Buildings by giving concessions on Property Tax	Dovetailing Green India		5		GoI missions such as National Mission for a 'Green India'	UDD, Development Authority	Conservation of natural resources
14	Promoting installation of solar lights in all ULB buildings	Dovetailing Solar Mission		5		GoI missions such as National Solar Mission	ULB, UREDA	Save conventional energy
15	Promoting solar street lightning in urban limits	Dovetailing Solar Mission		5		GoI missions such as	ULB, UREDA	Save conventional

S.No.	Interventions	Intervention types	Activities	Duration (years)	Total cost implications (₹. in lakhs)	Possibility of convergence	Implementing department/ agency	Expected outcome
						National Solar Mission		energy
16	Promoting installation of solar geysers in all ULB guest houses	Dovetailing Solar Mission		5		GoI missions such as National Solar Mission	ULB, UREDA	Save conventional energy
17	Ensuring proper drainage system in all ULBs	Dovetailing Water Mission		5		GoI missions such as National Water Mission	ULB, Department of Water Supply	Elimination of water logging. control of road damage
18	Ensuring modernization of slaughter houses	Development		5	22 DPR for Nagar Nigam Dehradun submitted to the GoI for 2000.00 (₹ 500 lakhs each for ULBs having populations over 1 lakh, namely Haldwani,Rudrapur, Kashipur and Roorkee)	PPP	ULB	Prohibit environmental pollution. Hygienic meat supply
19	Ensuring regulation of dairies within municipal limits.	Development		5			ULB	Clean and green city
20	Promoting camps and other IEC activities to disseminate knowledge among urban people on climate change	Documentation, travel and scientific exposure visits		5	450.00 (10 lakh for each Nagar Palika Parishad and 5 lakh for each Nagar Panchayat)	GoI missions such as National Mission on Strategic Knowledge for Climate Change	UDD, ULB	Awareness for future
	Total				**41,465.70**			

Water Resources (Irrigation Department)

S.No.	Activity	Sub-activities	Duration (years)	Total cost of implementation (₹ in lakhs)	Identified agency	Expected outcome
1	Collection of comprehensive data and analysis	Installation of automatic rain gauges, automatic weather forecasting stations, etc. at important locations in the state	2	200.00	Irrigation Department	Availability of data for further studies
		Identifying important gadhera/streams and installing equipment to measure velocity, discharge, sediment concentration, etc. in the state	2	200.00	Irrigation Department	Availability of data for further studies
		Collection of data from above and compilation in exchange formats	Continuous process	100.00 annually	Irrigation Department	Availability of data for further studies
2	Development of software	Development of suitable models to analyse the collected data and validation of models	3	100.00	Outsourcing (research organizations)	To arrive at some conclusions
		Development of suitable models to carry out vulnerability assessment of impact of climate change on water sector and other fields and validation of models	3	100.00	Outsourcing (research organizations)	Help combat impact of climate change
3	Capacity building	To attend training courses/seminars/conferences on capacity building in India	Continuous process	20.00 annually		Help combat impact of climate change
		To attend specialized training courses/seminars/conferences on climate change in water sector in India and abroad	Continuous process	50.00 annually		Help combat impact of climate change
		To organize In-house training courses/seminars/conferences within department	Continuous process	50.00 annually		Help combat impact of climate change
4	Awareness campaign	Organizing events to create awareness among engineers/employees of the department	Continuous process	20.00 annually	Irrigation Department and other agencies	Help combat impact of climate change
		Organizing events to create awareness among farmers/people	Continuous process	20.00 annually	Irrigation Department	Help combat impact of climate change
	Total			**860.00**		

Water Resources (Uttarakhand Jal Sansthan)

S.No.	Interventions	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
1.	Metering of urban water connections	Metering of urban water connections	5	8428.00	—	Uttarakhand Jal Sansthan	Reduction in wastage of water, water audit. Increase in revenue.
2.	To monitor the water quality	Augmentation of state water quality testing lab at Dehradun to test the parameters as per BIS standards, including running cost	5	537.00	—	Uttarakhand Jal Sansthan	Close monitoring of the impact of climate change on the quality of water source
	Total			**8965.00**			

Tourism

S.No.	Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
1.	Research on existing policy/mechanism adopted by GMVN and KMVN for minimizing environmental impacts of their entire spectrum of tourism activities and operations and corrective measures required thereof	Research	Interaction, interviews, questionnaire surveys, site visits, documentation	1	100.00	—	Credible research and consultancy agency	Baseline findings to build upon
2.	Research on existing measures/mechanisms adopted by private sector service providers for minimizing environmental impacts of their entire spectrum of tourism activities and operations and corrective measures required thereof	Research	Interaction, interviews, questionnaire surveys, site visits, documentation	1	300.00	—	Credible research and consultancy agency	Baseline findings to build upon
3.	Workshops on climate change issues their impacts on tourism perspective for state tourism bodies—UTDB,	Research	Presentations, interaction, discussions,	3	500.00	With relevant central and state departments	UTDB with active support of relevant central/state government. agency,	Dialogue, information sharing, coordination, convergence

S.No.	Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
	GMVN, KMVN and private sector tourism service providers (state, national and international experiences to be shared)		documentation				leading university/academic institution/international development agencies	
4.	Awareness campaign on environment-friendly tourism for tourism service providers, tourists and host population	Awareness	Electronic and print media campaign	2	200.00	With forest and environment departments	UTDB with help of consultant and credible media agency	Mass awareness on climate change issues
5.	Framing and adopting sustainable tourism development guidelines for the state with the active participation of the private sector and the host population	Guidelines	Workshops, presentations, interaction, discussions, documentation	5	200.00	—	UTDB with help of international development agency/consultant	Guidelines and framework for the sector as a whole to move forward
6.	Establishment of Sustainable Tourism Development Unit (STDU)/Cell at UTDB to address all sustainable tourism development issues and serve as a nodal point for framing and implementation of sustainable tourism development policy and measures	Institutional, governance, monitoring	Institutional set up Staff deployment	3	100.00	—	UTDB	Proper institutional setup for day-to-day working and co-ordination and for serving as a nodal centre
7.	**Mitigation Measures** Reducing energy use Improving energy efficiency Increasing use of renewable energy Adoption of new technology	Research Awareness, education, motivation	Research, awareness, education, interaction, discussions, workshops, presentations, incentives	5	500.00	With relevant central and state departments and private sector	UTDB,GMVN, KMVN and private sector tourism service providers	Reducing greenhouse gas emissions
8.	Capacity development, education & awareness	Capacity development,	Capacity development,	3	200.00	With central schemes on	UTDB, GMVN, KMVN and tourism industry	Capacity development,

S.No.	Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
	programmes will be organized for UTDB, GMVN, KMVN, tourism industry associations, private sector tourism service providers, tourists and host population with proper identification of individual needs of the target group.	education and awareness	education and awareness programmes at various sites for target groups			capacity development, education and awareness for tourism sector	associations with active support from related central/state government body	education and awareness
9.	Development of monitoring framework	Governance, monitoring	Workshops, interaction, discussions, documentation	3	50.00	With relevant central and state departments	UTDB	Effective monitoring with regular feedback
10.	Participation in regional- and national-level seminars, meets and conferences organized by state tourism departments and private sector for sharing information on environment-friendly initiatives and practices adopted	Dialogue, information sharing	Presentations, interaction, documentation	5	200.00	With private sector	STDU/UTDB	Dialogue, information sharing, coordination, convergence
11.	Organizing seminars and conferences occasionally to provide a platform for sharing knowledge and experiences	Dialogue, information sharing	Event organization, presentations, interaction, documentation	5	300.00	With private sector	UTDB with active support from private sector	Dialogue, information sharing, co-ordination, convergence
12.	Relevant sectoral documents, reports and presentations to be collected and maintained properly at UTDB head office for future reference	Documentation, sharing, learning	Institutional set up Staff deployment	5	50.00	—	UTDB	Resource base with effective documentation for future reference
13.	Awareness and training programmes on 'Small Scale Tourism Enterprise Development'	Livelihood, employment generation	Awareness and training programmes at various sites for	5	200.00	With entrepreneurship development schemes department of	UTDB with active support of training institutions	Support for livelihood and employment generation

S.No.	Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
			target groups			industries, employment & training etc.		
14.	Incentives, awards, recognition for private tourism service providers adopting best environment-friendly practices	Motivation, recognition, awards, incentives	Guideline framing, certification, selection by jury	5	200.00	—	UTDB	Will act as motivation & ensure larger participation
15.	Loans through financial institutions, on attractive terms and conditions, to tourism service providers for developing mechanism and adopting new technologies for minimizing the causes for climate change	Motivation, loans, subsidy	Awareness, workshops, meets, interaction, discussions, facilitation, documentation	5	1000.00	With departments of forest, environment, etc.	UTDB with active support from financial institutions	Will act as motivation and ensure greater participation
	Total				**4,100.00**			

Energy (UPCL)

S.No.	NAPCC code	Sector	Sub-sector	Department/ board/corporation	Present annual targets	Present Annual Achievement against Climate Change Mitigation	Target 1st Year (₹. In lakhs)	Target 2nd Year (₹. In lakhs)	Target 3rd Year (₹. In lakhs)	Target 4th Year (₹. In lakhs)	Target 5th Year (₹. In lakhs)	Strategy	Assisting departments
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Enhanced energy efficiency	Energy	Building retro fitment of 33/11 KV S/s using CFLs and LEDs, illumination of switch yards and substation colonies using CFLS and LEDs	UPCL	—	—	60.00	80.00	80.00	120.00	60.00	Covering all 33/11 KV S/s in phased manner within 5 years.	Operations Wing
2.	Strategic knowledge for climate change	Energy	Specialized training programmes/seminars	UPCL	—	—	6.00	7.50	7.50	4.50	4.50	By imparting training to personnel and consumers	Human Resource Wing
			Sub-Total				**66.00**	**87.50**	**87.50**	**124.50**	**64.50**		
			Total								**430.00**		

Note: Government of Uttarakhand will provide finance

Energy (UJVN)

S. No.	NAPCC Code	Sector	Sub Sector	Dept./ Board/ Corporation	Present Annual Target	Present Annual Achievement against CCM	Target 1st Year (₹. In lakhs)	Target 2nd Year (₹. In lakhs)	Target 3rd Year (₹. In lakhs)	Target 4th Year (₹. In lakhs)	Target 5th Year (₹. In lakhs)	Strategy	Assisting Departments
1	Solar Mission	RE	1. Solar power plants at spare land near various HEP's				-	-	-				Planning
			2. Solar power plants at spare land near various HEP's under rooftop policy				-	-	-	5760	8640		
			3. Solar roof top plant at office buildings for captive use.				-	7.5	7.5	45	90		
			4. Installation of solar water heater at government guest house				-	-	0.5	3.5	6		
2	Enhanced Energy Efficiency	RE	1. Replacement of conventional street light by energy efficient (T-5/LED) lights.				-	-	12.5	100	137.5		Operations and Maintenance
			2. Replacement of conventional street light by energy efficient (T-5/LED lights in office buildings				-	-	1.25	10	13.75		
			3. Energy Audit of power houses while RMU to be done.				-	-	5	50	45		
3	Strategic Knowledge for Climate Change	RE	1. Organising seminars & training on water harvesting-green building concept & energy conservation				-	-					Human Resource
			2. Organising various short term in house T & D and awareness programmes.				-	-	1	4	5		
4	Himalayan Ecosystem	RE	1. Plantation in the open area near power house and colonies				-	-	0.5	2	2.5		Operations and Maintenance A&S
			2. Plantation in the open are near Ujjwal offices				-	-	-	0.5	0.5		
			Sub-Total				**0**	**7.50**	**28.25**	**5975.00**	**8940.25**		
			Total								**14,951.00**		

Energy (UREDA)

S.No.	NAPCC code	Sector	Sub-sector	Department/Board/Corporation	Present Annual Targets	Present annual achievement against CCM	Target 1st Year (₹. In lakhs)	Target 2nd Year (₹. In lakhs)	Target 3rd Year (₹. In lakhs)	Target 4th Year (₹. In lakhs)	Target 5th Year (₹. In lakhs)	Strategy	Assisting departments
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	Sustainable habitat	RE	Energy conservation, building construction Construction of MHPs	All government departments	—	—	3	3	6	9	9	As per proposal	Urban and Energy Development
2	Solar Mission	RE	1. Solar water heaters in government buildings 2. Solar power plants in all government buildings 3. Solar power plants by private developers	All government departments	—	—	10	20	20	30	20	As per proposal	Energy Department
3	Enhanced energy efficiency	RE	1. Building Retro fitment for CFLs and LEDs 2. Energy audit of 100 government buildings 3. Implementation of PAT	All government departments	—	—	3	2	2.5	2		As per proposal	Energy Department
			Sub-Total				**16.00**	**25.00**	**28.50**	**41.00**	**29.00**		
			Total								**139.50**		

Notes: The eight National Missions as per the Prime Minister's National Action Plan on Climate Change are the Solar Mission; Enhanced Energy Efficiency, Sustainable Habitat, including public transport; Water Mission; Himalayan Ecosystem; Green India; Sustainable Agriculture; and Strategic Knowledge for Climate Change.

Energy (PTCUL)

S. No.	NAPCC code	Sector	Sub-sector	Department/ board/corporation	Present Annual Targets	Present annual achievement against climate change mitigation	Target 1st Year (₹. In lakhs)	Target 2nd Year (₹. In lakhs)	Target 3rd Year (₹. In lakhs)	Target 4th Year (₹. In lakhs)	Target 5th Year (₹. In lakhs)	Strategy	Assisting departments
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Sustainable habitat	Energy	Construction of new Green Buildings and retrofitting old buildings	PTCUL	—	—	50	50	35	35		To be made compulsory in all department buildings	Civil
2	Enhanced energy efficiency	Energy	Building retro fitment using CFLs and LEDs, illumination of switchyards and substation colonies using CFLS and LEDs.	PTCUL	—	—	60	60				To be made compulsory in all department buildings, switch yards and substation colonies	Operation and maintenance
4	Strategic knowledge for climate change	Energy	Specialized training programmes/seminars	PTCUL	—	—	9	9	6	2	2	By imparting specialized training and nominating the interested persons.	Human Resource
			Sub-Total				**119.00**	**119.00**	**41.00**	**37.00**	**2.00**		
			Total								**318.00**		

***** As per the provisions of the Projects Scheme.

Notes:-

(1) PTCUL is the 100% state-owned transmission utility responsible for the transmission of electrical energy across Uttarakhand and evacuation of power from various hydro-generating units up to the pooling points within Uttarakhand.

(2) Finance will be provided by the GoUK.

Roads

S.No.	Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
1.	Construction of new road	Research, facility and service	• Hill side cutting • Construction of breast wall • Safe disposal of debris • Construction of drains, scuppers and check walls	5	3,60,000	—	PWD	Creation of Additional Infrastructure
2.	Improvement and re-construction of road network	R&D	• Metalling and pointing • Widening of roads • Improvement of drainage system	3	1,35,000	—	PWD	Improvement of Additional Infrastructure
3.	Maintenance of existing road network	Development	• Patch work • Repair of drains and walls	4	68,000	—	PWD	Maintenance of existing infrastructure
4.	Remedial measure of chronic slip zones	R&D	• Geological study • Remedial measure	5	50,000	—	PWD	Environmental improvement
5.	Planting and maintenance	Ecological development	• Planting trees • Fencing trees • Maintenance of trees	5	10,000	—	PWD	Environmental improvement
	Total				**6,23,000.00**			

Industries

S.No.	Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
1.	Awareness programme (capacity building of industries, especially MSMEs)		Holding seminars and workshops for MSMEs	3	60.00	With industrial associations namely CII, PHD Chamber of Commerce, KGCCI, AIU	Directorate of Industries/SIDCUL	
2.	Baseline study		Detailed study of the impact of industrial activities on climate change (covering all industrial clusters and areas)	2	100.00	—	Directorate of Industries/SIDCUL	
3.	Incentives for green practices		• Environmental certification subsidy relating to climate change (ISO 14064, ISO 5001, etc.)	5	300.00			
			• Green Building certification (following IBC guidelines)	5	500.00			
			• Installation of equipment/technologies that help reducing carbon footprints (e.g. energy efficiency, renewable energy sources, fuel switching)	5	1000.00			
4.	Recognition for good environmental practices		• Energy efficiency (by holding state-level seminars) • Energy conservation • Certificate for best practices and sharing them among industries	5 years	100.00			
5.	Strengthening the common treatment plants and solid-based disposal in industrial areas				1000.00			
6.	Knowledge sharing		Large industries to play anchor role in propagating green practices in MSME's	5	200.00			

S.No.	Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
7.	Establishment of Centre of Excellence for Research Development & Extension		• Centre to be established either in PPP mode or through industry chambers like CII, PHDCCI etc. • The centre to document all the research and prepare action plan and guide the industries in the Himalayan States	5	1000.00			
	Total				**4,260.00**			

Transport

S.No.	Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
1.	Check on vehicular pollution	Awareness and enforcement	• Creation of public awareness	5	200.00	—	Transport Department	
			• Computerization and Internet facility at pollution checking centres	5	360.00			
			• Use of remote sensing technology					
2.	Establishment of specially designated pollution-checking squads	Awareness and enforcement	• Procurement of vehicles • Deployment of officials • Procurement of testing equipment	5	200.00	—	Transport Department	
3.	Strengthening public transportation	Facility and service	• Procurement of new buses for UTC	5	12000.00	—	Transport Department/UTC	
4.	Implementation of BS standards	Awareness, enforcement and service	Procurement of 30 new pollution-checking equipment	5	60.00	—	Transport Department	
5.	Approval of pollution testing	Approval	• Amendment has been done in UK MV	0	0	—	Transport Department/Private	Enhancement of vehicular emission

S.No.	Interventions	Intervention type	Activities	Duration (years)	Total cost implication (₹ in lakhs)	Possibility of convergence	Implementing department/agency	Expected outcome
	centres		Rules 2011				testing centres	quality
6.	Use of alternative fuels	Awareness, enforcement and service	• Establishment of LPG filling stations	0	0		Civil Supply	
			• Establishment of CNG filling stations	0	0		Civil Supply	
			• Motivation of public for battery-operated vehicles	0	0		Transport Department	
7.	Planning and monitoring cell	Planning	• Study	1	60.00		Transport Department	
	Total				**12,880.00**			

Summary of Financial Outlay for Identified Sectors in UAPCC

S.No.	Sector	₹. in lakhs
1.	Agriculture	7,991.75
2.	Forests and Biodiversity	97,101.65
3.	Animal Husbandry and Livestock	19,274.73
4.	Disaster Management	37,125.00
5.	Human Health	10,400.00
6.	Urban Development	41,465.70
7.	Water Resources	9,825.00
8.	Tourism	4,100.00
9.	Energy	15,838.50
10.	Roads	6,23,000.00
11.	Industries	4,260.00
12.	Transport	12,880.00
	Total	**8,83,262.33**

Annexures

Annexure 1—Brief Notes on Proceedings of Stakeholder Consultation Workshops

Summary of Proceedings of the Workshop on Consultations for the Uttarakhand Action Plan for Climate Change, 26–27 March 2012, Doon University, Dehradun

Background

India has pursued a strong domestic agenda to counter climate change and has come up with a National Action Plan on Climate Change (NAPCC). While the central government remains the key actor in shaping the climate change policy and creating the necessary institutional mechanisms for its implementation, the involvement of state governments is crucial in addressing climate change. UNDP, through collaboration with the Ministry of Environment and Forests, aims at building and strengthening the capacities at the national and state/UT levels to address climate change issues. One of the major activities to be undertaken as part of this collaboration is facilitating the preparation of the State Action Plans and Strategies for addressing Climate Change (SAPCCs).

As part of this process, Uttarakhand is in the process of preparing a Climate Change Action Plan. An advance draft version of the Climate Change Action Plan for Lakshadweep was prepared last year after initial consultations at the state level. In order to improve the technical content of the draft action plan and to incorporate relevant additional information, the state is undertaking a series of activities including high-level orientation meetings, one-on-meetings of the SAPCC Consultant with a range of key Sectoral Line Departments and other agencies and consultative processes with scientific/academic research institutions, civil society and grassroots communities.

Uttarakhand, formerly Uttarakhand, is a scenic but poor mountainous state in north-western India, formed on 9 November 2000 after separation from Uttar Pradesh. Almost half of Uttarakhand's population lives below the poverty line, the majority in hill areas, where they depend on agriculture for their livelihoods. As agriculture is highly weather dependent, communities in the state are strongly affected by climate-related variability and change. The vulnerability of Uttarakhand's rural population to climate and socio-economic change stems from a number of factors, especially dependence on ecosystem services and high levels of persistent poverty, marginalization and social inequality.

The workshop

The workshop of 26–27 March 2012 was part of the stakeholder consultation process for developing the Uttarakhand SAPCC. Day 1 – 26 March – was dedicated to seeking voices/inputs from grassroots communities from across the Garhwal region of the state. A similar consultation for the Kumaon region was also held on 13 April 2012 at Kosi Katarmal, near Almora and jointly hosted by the G.B Pant Institute for Himalayan Environment and Development and the Uttarakhand Forest Department) on their perceptions of climate change and its impacts.

Likewise, Day 2 – (27 March and 14 April) – was dedicated to dialogue with scientific and academic institutions as well as civil society, with a view to soliciting inputs on (a) climate change and its impacts, (b) mechanisms for connecting science (both basic and applied) and civil society to practice and policy in the SAPCC for Uttarakhand.

Participants

Day 1 of the workshop saw attendance from around 60 participants, predominantly farmers and grassroots community representatives from the Garhwal region of the state. Similarly, Day 2 was attended by a smaller number of participants, primarily because these were drawn from scientific/research institutions and NGOs from the Garhwal region. A list of participants at the meeting is attached to this summary of proceedings. The schedule of the workshop is also appended.

Summary of Day 1

Day 1 was exclusively devoted to a sharing of perceptions, experiences and apprehensions on climate change by farmers, elected public representatives, Pradhans and Pramukhs from the Garhwal region. Around 35 persons from the region shared their inputs and these covered diverse topics such as perceptions of change with respect to temperature, rain and snowfall patterns; snowfall; perennial water sources; changes in agricultural crop patterns and yields; insects, pests and various diseases; livestock and fodder availability issues; crop depredation by wildlife; migration; etc. Some selected experiences narrated are given below:

- *'Water scarcity is being experienced even after the rainy season. Climate change is taking place and community forests should be involved in measures for adaptation'. —* Manveer Singh Rawat, Karanprayag
- *'Hydro-power projects are causing severe impacts—blasting on land surface is impacting on water resources; dust and stone particles are polluting the air, crops are destroyed by this as the dust layers are impacting adversely apple and other crops. Last year apple flowers appeared in December and yields have come down; it is matter of great concern. Large-scale tree felling is also causing climate change, trees have fallen and roads after Chamoli are shade-less, huge impact of climate change is visible'. —* Sangram Singh Rawat, Raini, Chamoli
- *'Earlier, mosquitoes could not be seen above Joshimath. Today, they are there in higher elevations as well. Very high winds this year, with extreme cold in winter. Rajma production has dropped significantly; apple and potato crop yields and size has also reduced' —*Kedar Singh Rana, Joshimath
- *'There is increasing incidence of forest fires, leading to a lot of air pollution. Vegetable production has dropped to the extent that growers who used to supply the market are now buying from the market' —*Rajendra Singh Thapliyal, Tehri Garhwal
- *'These days, sal forests, which used to shed their leaves, are not shedding at all. Many of the traditional crops such as masoor dal and other pulses are reducing dramatically. There is significant weed growth as well these days. Fodder and fuel have become critical—if people are expected to protect forests, then provide alternative sources/arrangements for fodder and fuel' —*Gulfam Ali, Dehradun District

The participants also observed that rainfall has reduced/become erratic (the overall rainfall was thought to have declined, but at the same time, there were more periods of high-intensity rainfall), especially the non-seasonal rains that used to occur regularly, severely impacting rain-fed agriculture. Snowfall in the higher reaches, which used to be moderate to heavy, was reported to have declined both in terms of the length of the season but also in terms of intensity. This is reported to have increased pest attacks. Participants also observed that the availability of fodder was on the decline and crop depredation by wildlife was on the increase. Many participants reported early flowering of rhododendron trees.

Summary of Day 2

Day 2, which was dedicated to dialogue with scientific and research institutions/universities and civil society, began with a videographic compilation of voices from the field, put together by ICIMOD during their study on perceptions of climate change in the Himalaya. This was followed by a short presentation by WWF-India, featuring the key points that emerged from their consultations on the SAPCC from 2011, centred on the development of a set of recommendations, with focus on high-altitude regions, which can be built into the SAPCC of Uttarakhand. The recommendations included the following:

- Inter-linking of carbon forestry and the livelihoods of the local communities with available mechanisms such as REDD+.
- Identifying state-level experts for carbon trading—this would reduce the transaction cost.
- Formulating timber production policies for higher altitudes.
- Poly-house culture to assist farming in small land holdings.
- Assisting migration of species by developing corridors.
- Addressing land degradation.
- Developing fodder.
- Adopting a river-basin approach rather than a sectoral approach.
- Establishing standards of environmental and ecological flows in rivers as well as monitoring them.
- Collecting information on distribution and discharge of springs in various regions of Uttarakhand.
- Tuning hydro-power development policy/guidelines to be climate-smart.
- Keeping tourism/recreation and religious needs in mind when planning for water resource management.
- Improving database for groundwater resources.
- Developing the right energy mix for the power sector, looking at de-centralized energy possibilities.
- More focused interventions for domestic energy requirements (smokeless chulhas, water gharats, etc.).
- Focussing on phase-wise implementation of efficient transport systems.
- Lack of extensive data for modelling and predictions: Setting up more automatic weather stations to capture local variations in weather patterns.
- Sharing of data for research and modelling across institutions.
- Developing a common platform to share and access ongoing research on climate change across institutions in the state.
- Identifying weak links in execution at the stakeholder level.
- Developing understanding of climate change issues, impacts and responses at the various decision-making and implementing levels.
- Clarifying roles and responsibilities of different institutions for successful implementation of the SAPCC.

These presentations set the tone for the discussion sessions for the day.

The first discussion session centred on the need for co-ordinated share and access of the ongoing research on climate change across institutions in the state and mechanisms for a common clearinghouse of data and information on climate change and its impacts on Uttarakhand from across the multitude of research centres/institutions/universities that carry out discrete research projects on the topic from time to time. Various ideas were shared on this front. The general consensus was that collaborative mechanisms between such research centres/universities were normally difficult and will need (i) a corpus fund to sustain such dialogue and sharing and (ii) have a formal institutional mechanism to facilitate the process. The UCOST, the state level counterpart of the Department of Science and Technology, GoI, offered to play the role of aggregating research information and data on climate change, given their already existing extensive outreach across research centres/institutions/universities.

The second session focussed on the role of civil society. It was widely acknowledged that civil society organizations, especially NGOs, had a significant role to play in the implementation of the SAPCC. Such roles could include awareness building among communities and government functionaries, knowledge sharing and networking, community resilience building, fostering and documenting community perceptions and autonomous adaptation, capacity building, especially of communities and field level functionaries, etc., apart from supporting a range of programme initiatives to build adaptive resilience in communities. It was also acknowledged that civil society could play both complementary (to government efforts) and at the same time a watchdog role, both of which are important. Discussions on whether it was possible to create a coalition of civil society agencies to have a co-ordinated approach to the climate change–related initiatives in the state showed that such a coalition may be difficult to put together for multiple reasons; significant sensitization will be required across the board and a strong rationale for such a coalition will need to be built.

Summary of Proceedings of Second Regional Consultation Workshop on State Action Plan for Climate Change, Uttarakhand, Organized by Uttarakhand Forest Department and GBPIHED, Almora (13–14 April 2012)

Minutes of Day 1

Mr Jai Raj, APCCF

- Climate change is a matter of concern all over the world.
- Need to convert challenges of climate change into opportunities.
- Eight missions have been identified by the GoI under the national action plan on climate change.
- State action plan on climate change (SAPCC) for Uttarakhand is being prepared in consultation with various departments, agencies, scientific organizations, NGOs, stakeholders and farmers.
- In this connection, the second regional consultation workshop for the Kumaon region of the state is being organized at GBPIHED, Almora.

Dr L M S Palni

- Change is the law of nature; impacts of climate change have been realized more in the recent past.
- There is a need to get benefits from the scenarios arising due to the changing climate.

- Regional-level changes play a dominant role in climate change.
- The Himalaya are being given more attention in relation to climate change impacts.
- For state-level policy making, the opinions/perceptions of local peoples and stakeholders of various sectors are very important.

Dr R S Toliya

- At the national and state levels, various policies are being made to assess the impacts of climate change on various sectors and identify their coping mechanism.
- Stakeholders are being consulted for their opinion, which will help make policies for state-level planning.

Dr P K Agarawal

- Seasonal changes are more prominent and affecting the crop production in hilly regions.
- The farming system needs to be improved to combat against climate change impacts.
- Food security has increased using high-yielding varieties (HYV) of crop and livestock.

Mr Himanshu Durgapal (Nainital)

- Changes/shifts in weather patterns have adversely affected the crop production.

Mr Anoop Singh (Ramgarh Block)

Major issues affecting livelihood options are as follows:

- Forest fires.
- Deforestation.
- Losses due to wild animals.

Mr Mohan Singh (Betalghat Block)

Issues/indications of CC are as follows:

- Apple production has been replaced by mango farming in the region.
- Increasing area of pine forests.

Mr Dayal (Betalghat Block)

Major issues affecting livelihood options are as follows:

- Apple production has reduced.
- Crop yield has decreased.
- Loss of biodiversity due to forest fires.

Mr Bhuwan (Betalghat Block)

Major issues affecting livelihood options are as follows:

- Timing/duration of rainfall has changed, which is affecting the crop yield.
- Landslides due to natural factors and anthropogenic activities are causing losses in crop production and biodiversity.
- More chemicals/fertilizers are being used in horticultural crops and other crops.
- Availability of less water is affecting livelihood options and resulting in increasing attacks of insects and diseases on crops.
- Losses due to wild animals.

Mr Jeevan (Dhauladevi Block)

Major issues affecting livelihood options are as follows:

- Man-made activities (such as deforestation) are causing climate change.
- Increase in human population is resulting in over-utilization of natural resources.

Mr Bhanu Joshi (Bhikiyasen Block)

Issues/indications of CC are as follows:

- Crop pattern has changed due to changes in climate.
- Soil moisture loss due to more intense use of fertilizers rather than bio-compost.
- Drying up of springs and reduction in water flows in streams and rivers.
- Increase in water demand.
- Climate change is forcing migration.
- Decrease in crop yield.
- Irregular rainfall.
- Shift in flowering period of various horticulture crops.

Suggestions:

- Proper information regarding crop production and cultivation needs to be provided.
- Drip irrigation, water harvesting need to be adopted.
- Regional weather forecast needs to be provided to farmers.
- Salary cost needs to be replaced by implementation cost.
- Cluster approach needs to be adopted.

Ms Champa Joshi (Hawalbagh Block)

Major issues affecting livelihood options are as follows:

- Losses due to wild animals.

Ms Radha Sati (Dwarahat Block)

Major issues affecting livelihood options are as follows:

- Losses due to wild animals.
- Less fodder available for feeding animals.
- Decrease in livestock production.

Suggestions:

- Timely availability of seeds and other available techniques need to be assured.
- Technical/scientific information should be provided to farmers.

Mr R D Sati (Dwarahat Block)

Major issues affecting livelihood options are as follows:

- Mango production has decreased over the years.
- Quantity of the rainfall is almost the same; the duration and timings have changed.
- Decrease in livestock production.

Suggestions:

- Community participation with support and motivation from various departments of state government is required.

Ms Meena Devi (Dwarahat Block)

Major issues affecting livelihood options are as follows:

- Losses due to wild animals and availability of less water for daily use and irrigation.

Mr Ganesh (Gangolihat)

Major issues affecting livelihood options are as follows:

- Water crises.
- Less productivity.

Suggestions:

- Region-specific developmental policies should be made.

Mr Himmat Ram (Gangolihat)

Major issues affecting livelihood options are as follows:

- Fragmentation of land and increase in human population.
- Reduction in crop yield.
- Livestock production has decreased.

Suggestions:

- Timely supply of seeds and fertilizers.
- More use of bio-compost.
- Water harvesting needs to be adopted.
- Promotion of livestock production.

Mr Naveen (Gangolihat)

Major issues affecting livelihood options are as follows:

- Anthropogenic activities such as deforestation and cutting of trees are causing climate change.
- Fruit production has decreased.
- Loss in crop yield due to wild animals.

Mr V S Mehta (Gangolihat)

Major issues affecting livelihood options are as follows:

- Less irrigation facilities.
- Losses due to wild animals.
- Reduction in crop production.

Mr D S Pandey (Devaria, U S Nagar)

Major issues affecting livelihood options are as follows:

- Increase in diseases in crops due to industrial waste.
- Water pollution due to contaminated water from the industries in the region.
- Productivity of the soil has decreased.
- Reduction in crop yield.
- Changes in timing/duration of various crops due to industrialization of the region.

Mr R B S Bhakuni (Takula Block)

Major issues affecting livelihood options are as follows:

- Potato production has decreased due to availability of less water.
- Water level has gone down.
- Drying up of springs and reduction in discharge.
- Changes in land use patterns.

Mr M P Singh (Garur)

Major issues affecting livelihood options are as follows:

- Reduction in discharges in streams and water flows in springs.
- Deforestation and other anthropogenic activities.

Mr R P Joshi (Garur)

Major issues affecting livelihood options are as follows:

- Irregular pattern of rainfall.
- Crop loss due to monkeys and other wild animals.
- Deforestation for fuel and fodder.
- Non-availability of fodder for livestock.
- Reduction in milk and other livestock produce.

Mr P S Mehra (Pati Block, Champawat)

Major issues affecting livelihood options are as follows:

- Availability of less water.
- Deforestation.

Summary of Day 2

The proceedings of Day 2 were along the lines of those of the Doon University Workshop and as such they are not repeated.

Summary of Proceedings of the Civil Society Consultations Workshop on State Action Plan for Climate Change, Uttarakhand (1 October 2012)

A number of civil society organizations organized a state consultation on the recently released revised draft of the Uttarakhand Action Plan on Climate Change (June 2012). More than 70 participants representing research institutes, academic institutions, experts, practitioners, farmers' and women's organizations, forest and indigenous populations, government departments, agriculture universities, water and forest research institutes and

civil society participated in the consultation. The organizers included Beyond Copenhagen, CECOEDECON, PAIRVI, BJVJ, SADED, UDI, G.B. Pant Agriculture and Technical University, H.M. Bahuguna Garhwal University, PSI, Inter Agency Group, CASA Mountain, Insaaf Uttarakhand, Citizen Global Forum, HAARC, HESCO and others.

Mr. Suresh Satpathy, from CASA Mountain, welcomed the guests. Mr. Soumya Dutta, laying the global context of climate change and its impact on India and on Uttarakhand, said that there has been no development in the international negotiations on climate change and the developed countries, which have been primarily responsible for bringing about this crisis, are holding the entire world to ransom by not taking prompt, appropriate and ambitious actions. He emphasized that the national and sub-national policies are becoming increasingly important in view of the stalemate at the global level. He added that while developed countries must take quick actions to reduce the impact of climate crisis on the developing and least-developed countries, countries such as India and other developing countries must also address the impacts on poor people, especially forest dwellers, fisherfolk, farmers and women, who bore the brunt of impacts. Ms. Vanita Suneja, from Oxfam India, said that they have been working with partners in monitoring national and state action plans, which have till now showed very little promise. She emphasized that it is extremely important that states such as Uttarakhand, which are extremely vulnerable, adopt appropriate policies to support people in adapting to climate change impacts. She added that women have been impacted in multiple ways and that Oxfam also stresses that policy response must recognize the multiple vulnerabilities of women to climate change and its impacts.

Mr Ajay Jha, from Pairvi, shared the development in state action plans and the group's experience in engaging with SAPCCs of various states. He said that till now 20 states have reportedly submitted their drafts to the MOEF, five of which (MP, Rajasthan, Sikkim, Tripura, Arunachal) have been approved by the National Steering Committee and five of which (Andhra, Assam, Orissa, West Bengal, Meghalaya) have been considered by the expert committee. He added that the processes in all the states have been entirely consultant driven, with very little participation of the people. He explained that Beyond Copenhagen has tried to democratize these state plans by organizing discussions on the draft plans and engaging with policy makers to open both the process and content for more discussion and bring an appropriate focus on adaptation and sectors such as agriculture, water, forests and energy. He explained that consultations have been organized in states such as Bihar, Rajasthan, Madhya Pradesh, Manipur, Uttarakhand where more groups are engaging with these policies. He stressed that SAPCCs have such a broad sweep that unless there is monitoring by people, these plans may alter, or rather, intensify, the GDP-obsessed growth pattern in all the states. He added that most of the states have till now approached action plans mainly as documents rather than well-devised polices and there are hardly any roadmaps for financing, dovetailing with existing resources and policies, incorporating the major concerns of the affected populations in the states. Mr. Virendra Painuly (Retired Professor, IIT Roorkee) said that the biggest problem with the plan is that it promotes the same structure, institutions and policies, which have brought us to the crisis. He said that there is very little focus on adaptation and the plan does not acknowledge the contribution made by various social and environmental movements that have taken place in the state and are considered landmark movements not only in the country but also globally. He added that in view of the different agro-climatic zones in the states, strategies should be proposed based on the requirements of these separate agro-climatic zones (hills and plains). He also added that more people should be consulted and their views incorporated in the plan. Mrs Sushila Balooni, chairperson of the state commission for women, said that the agriculture and livelihood are being severely affected and therefore women are at the centre of adverse impacts. She added that policies must be

women centric, with special provisions to support women in agriculture and their adaptation efforts. She said that she would speak to the chief minister to emphasize that the plan must acknowledge the crisis faced by women and must have a gender-specific approach in climate policy.

Mr Anand Sharma, Director of the Meteorology Department, said that with or without climate change, there are certain things that need to be taken into consideration. He explained that agricultural land is decreasing, irrigation is also being affected, livelihoods are under severe stress in the states and, in view of these problems, the state needs to take expeditious steps to ensure that a large majority of the population does not continue to suffer. The chief guest of the inaugural session and the chair, Mr. Anil Prakash Joshi (HESCO), said that the crisis could not be dealt with until and unless we change the blind pursuit of a growth in the GDP. He added that the GDP has failed to reflect the crisis that this pattern of growth has created. He also suggested that the gross ecological product (GEP) could be a better indicator, incorporating ecological concerns and achievements. He added that until and unless we create a convergence in economic and ecological growth patterns, the crisis cannot be dealt with.

In the second session, participants shared their concerns on the UAPCC. A number of organizations and individuals, including Prof. Sanjay Jain (NIH), Prof. Mohan Panwar (H.M. Bahuguna University), Suresh Bhai, Raghu Tiwary (Insaaf Uttarakhand), Bihari Ji (farmer), Dev Bahuguna (farmer), Rahul Jugran (Disaster Management and Mitigation Cell), Atul Sharma, Mr Sanjay Singh Chauhan (ECO Development Society), PSI, HAARC, Dr Dhyani (Insaaf Uttarakhand) and representatives from Gene Campaign participated. Concerns were raised with respect to following issues:

- Loss of floral and faunal biodiversity
- Soil and water conservation
- Drying up of traditional water bodies
- *In situ* and *ex situ* conservation of traditional seeds and coarse grains
- Livestock
- Adaptation
- Transport and communication
- Hydel power projects and their impact on biodiversity, communities and displacement
- Lack of irrigation facilities in the hills
- Organic farming
- State's potential in horticulture and lack of facilities for promotion
- Lack of support to organic and sustainable agriculture (despite Uttarakhand being declared an organic state).

The third session focused on recommendations for improving the UAPCC and was chaired by Mr Jai Raj, Additional Principal Conservator of Forests and Nodal Officer, SAPCC. Mr Ajay K Jha and Mr Soumya Dutta shared the main gaps and recommendations on behalf of the participants. Mr Jai Raj, the Nodal Officer, SAPCC explained the process adopted in formulating the plan, major objectives and proposed strategies. He said that efforts have been made to organize consultations to include a variety of stakeholders. He added that it is difficult to satisfy everyone and have all sorts of comments incorporated in the plan. He

added that the plan is a living document and is still open for comments. Therefore, he invited participants to provide their comments in a structured manner within a week to enable the department to consider and incorporate their recommendations. He also agreed to a number of suggestions provided by the floor and assured that these will be considered. The participants and organizers thanked him for his openness and willingness to consider the recommendations in a positive manner. The vote of thanks was delivered by Mr T S Bhandari, from UDI.

The major recommendations from the consultation are as follows:

1. Overall structure, approach and vision

1.1 The plan needs to be translated into Hindi, so that it can be accessed and understood by the majority of the population.

1.2 More consultations need to be organized to reflect the concerns of the majority of the population.

1.3 There is no vulnerability assessment and the district-wise vulnerability needs to be conducted and actions proposed accordingly. The current vulnerability assessment is based on the 4 × 4 assessment and Max Plank Institute's assessment; these two differ substantially in their approaches and suggestions—the plan needs to recognize the differences between these assessments.

1.4 Increased focus on adaptation needs to be brought in, especially in agriculture.

1.5 The plan needs to acknowledge the significant contributions made by social and environmental campaigns such as Chipko and others.

1.6 The proposed institutional mechanism is very weak and will be unable to take prompt action. The longer the chain of government institutions, the slower will be the response. The chain needs to be shortened.

1.7 There is no roadmap for financing strategies, dovetailing with existing resources, plans and policies. There are no resources allocated for monitoring, review and assessment, which will result in poor implementation and review.

2. Agriculture, water and livestock

2.1 The strategies and actions in agriculture continue with the same pattern of agriculture, which has been responsible for bringing agriculture to the current state and for poor growth in agriculture.

2.2 The focus on agriculture must be on adaptation. More efforts are needed in the form of strong soil and water conservation efforts, soil testing and analysis, risk and insurance coverage and strategies according to agro-climatic zones.

2.3 The state has a large number of women in agriculture and the policies must support increased access for women to land, farm inputs, credit and risk coverage, information and capacity building and post-harvest facilities.

2.4 The agriculture sector also perceives an increased use of biotechnology and GMOs as the solution to climate change impacts and increasing productivity and introducing pest resistance. The experience of GMOs in India does not support that conviction.

2.5 Excessive use of chemical pesticides and fertilizers has resulted in contamination of land and water. It has also resulted in many birds getting extinct. Policy encouraging the use of unbalanced inputs in NPK must be reversed.

2.6 There are a number of best practices in agricultural adaptation and agro-ecological mixed farming, such as 'barahnaja', which need to be acknowledged and shared and promoted.

2.7 The development of drought-, flood- and pest-resistant varieties must take into consideration the fact that there a number of varieties and seeds already available, which should be used and popularized. Increasing their production should be supported by the state.

2.8 The lab-to-farm approach should be applied to agricultural research and it must also include feedback from below.

2.9 Agriculture extension and demonstration of appropriate technology and research outcomes on developing climate-hardy varieties must be strengthened and investment must be increased.

2.10 A number of rivulets and water sources have dried up (approximately 1,000 in the state and more than 80 in Rudraprayag alone) and water is getting contaminated due to excessive use of chemical fertilizers and pesticides. The agricultural policy must correct the imbalance in the use of NPK with policy support.

2.11 The focus on foreign breeds in livestock breeding must be reversed, as exotic varieties are less adaptable to climate change impacts. The local varieties of cows, goats and buffaloes adapt to climate change more easily. Breeding programmes must promote local varieties.

2.12 There is a need to introduce weather index-based insurance for crops and mortality index-based livestock insurance.

2.13 In the proposed estimates of the budget for implementation, agriculture receives only 0.8% of the budget that needs to be increased.

3. Energy, transport and roads

3.1 The energy mission only focuses on electricity, while the use of electricity only forms 16% of the energy use. The mission on energy must place an adequate focus on viable, cost-effective and green sources of energy.

3.2 The mission on energy must include equity consideration and must ensure increased access to energy to resource-poor, rural areas and difficult terrain.

3.3 Biomass forms the sole source of energy for the majority of the population (up to 70%); therefore, appropriate efforts should be made to develop biomass, its judicious use and increased access to people.

3.4 Many of the energy requirements, viz. drying of crops, heating, etc., can be facilitated using solar thermal means.

3.5 The mission proposes an increased use of LPG, CNG, etc.; however, the state does not have easy access to sources of CNG and LPG. Bringing LPG and CNG sources from far-off places will contribute to more emission and make access to energy more vulnerable.

3.6 Increased emphasis must be placed on strengthening and greening the public transport system rather than making attempts to prioritize conversion of private vehicles to using green fuels.

3.7 Both the roads and transport sectors focus only on motorized transport. There is no consideration for promoting non-motorized means of transport.

4. Forests and biodiversity

4.1 The forest mission must focus on increasing both the cover and quality of the forests, reverse monoculture and increased participation of Van Panchayats and forest dwelling and forest-dependent populations in forest management.

4.2 It must also increase the access of forest-dependent populations to NTFPs in accordance with the Forest Rights Act.

4.3 The Forest Rights Act and the JFM proposed by GIM work at cross-purposes as far as the rights of forest-dwelling populations are concerned. They must be harmonized, keeping the objectives of the Forest Rights Act and the significant contributions of forest-dwelling populations and indigenous populations in consideration.

4.4 The plan is strongly focused on REDD+ and Green India Mission and seeks to earn carbon credits. However, the national and global experience in REDD projects amply manifest a lack of significant benefits to communities, a loss of control of forest-dependent communities and destruction of natural forests and their displacement by monocultures. The state must review its plan regarding the involvement of REDD+, GIM and other efforts aimed at commercializing forests.

5. Disaster management

5.1 The role of people in disaster management needs to be acknowledged. The experience suggests that people and communities play a major role in natural disasters. The plan must have a role for communities and people in disaster management.

5.2 A district-level disaster response team must be developed for harm reduction.

*****

Annexure 2—Brief Notes on Findings of the WWF-India and ICIMOD-IFAD Studies

WWF-India study—*Facing the facts: Ganga Basin's vulnerability to climate change*

The districts of Almora and Garhwal in Uttarakhand appear to be the least vulnerable despite their high exposure to climate variability and vulnerability. These districts hold some of the most diverse ecosystems of the Indian Himalaya, which are quite sensitive to climate variability. The districts of Rudraprayag and Champawat emerge as moderately vulnerable due to their high sensitivity and their low adaptive capacity. Uttarkashi District and Udham Singh Nagar District have a very high vulnerability index values. This is primarily due to the high exposure index. In the case of Udham Singh Nagar district, the dependence on irrigation (surface water and groundwater) is very high and this has resulted in high sensitivity values. On the other hand, the lack of infrastructure development and high biomass dependency, along with high exposure, have resulted in low adaptive capacity values for Uttarkashi district, making it highly vulnerable.

ICIMOD-IFAD Study

Introduction

Uttarakhand, formerly Uttaranchal, is a scenic but poor mountainous state in north-western India, formed on 9 November 2000 after separation from UP. Almost half of Uttarakhand's population lives below the poverty line; the majority in hill areas, where they depend on agriculture for their livelihoods. As agriculture is highly weather dependent, communities in the state are strongly affected by climate-related variability and change. The vulnerability of Uttarakhand's rural population to climate and socio-economic change stems from a number of factors, especially their dependence on ecosystem services, high levels of persistent poverty, marginalization and social inequality. In the 3 years from 2008 to 2010, Uttarakhand received less-than-normal rainfall, which affected harvests and adversely affected the livelihoods of the majority of the state's population.

Study area

Focus group discussions and interviews were carried out in June–July 2010 in four villages situated at different altitudes and of varying accessibility in each of two districts—Almora and Tehri Garhwal. The people in these districts still follow a predominantly traditional lifestyle mainly dependent on agriculture, animal husbandry and seasonal processing of forest products and they are guardians of a vast body of local knowledge. Besides climate variability and change, they are exposed to rapid socio-economic changes that have an impact on their livelihoods, including increasing rates of male out-migration and the associated feminization of agriculture.

Analysis of data from the India National Sample Survey 2003 showed that poverty in Uttarakhand was much higher than the average of the Indian Himalayan region. Close to half of both rural and urban households in Uttarakhand were below the poverty line of $1 per day as compared with 17% in the remainder of the rural Indian Himalayan region; half of the household heads were uneducated and 34% of the household members were illiterate. Close to 85% of the population was involved in agriculture.

The residents of the two districts classified themselves into four categories of economic status using their own criteria: Category 1, extremely poor; Category 2, poor; Category 3, marginally poor; and Category 4, other. The numbers interviewed in each wealth category are shown in Table 3. The sources of income identified by the different wealth groups are summarized in Table 4. Of the poorest families, 86% of households in Almora and 94% in Tehri Garhwal were dependent on a combination of agriculture and labour as their main source of income, but the corresponding values in the wealthiest households were only 40% and 31%. The better-off households thus appear to be comparatively less vulnerable as they depend on more diversified sources of income such as businesses, salaries and remittances.

Information on perceptions of change was obtained from detailed interviews and larger focus group discussions. Regardless of the socio-economic status of the households, water was seen as the most important resource required in agriculture. Given that arable land, especially irrigated land, is a scarce resource in mountains, it is not surprising that in a society characterized by caste and class differentiation, the proportion of poor households with access to irrigated land was extremely low. Farmers without irrigated land depend solely on annual rains. In the past, some communities had adapted their agricultural activities to make use of the small amounts of rainfall falling in the non-monsoon months, but according to the communities, this phenomenon has now ceased almost completely. The winter precipitation is crucial for re-charging groundwater. Some springs had dried up completely, affecting the availability of water for people, livestock and irrigation. The overall rainfall was thought to have declined, but at the same time, there were more periods of high-intensity rainfall, which can lead to floods, landslides and soil erosion. This high-intensity rainfall is also associated with high surface runoff and limited infiltration of water to underground aquifers. The major observations are summarized in Table 5 and discussed in the following.

The winter precipitation has become extremely erratic and unpredictable. Some communities reported that there were no winter rains and that it now rained in March–April, when the winter crop is ready for harvest, causing the cereals to rot. Villages at high altitudes used to have moderate to heavy snowfall in December–March, with up to 1 m (several feet) of snow that would lie for a long time. Currently, it only snows for 1–2 months and with low intensity. It has not snowed in Almora for 3–4 years. Medium-altitude villages that were accustomed to moderate to low snowfall now receive very little, if any. Snowmelt used to be an important source of water for agriculture as it extends the availability of water from precipitation for long after the precipitation event.

The dry season has become longer, in line with the lack of precipitation. In 2006-07 and 2008-09, there was almost no winter rain and farmers in Uttarakhand experienced drought-like conditions. This could explain the strong perception of the communities that dry spells that usually lasted less than 2 months had now extended to more than 7 (Tehri) or 8 (Almora) months. Farmers also attributed an increase in the incidence of forest fires to the prolonged dry spells; fires are degrading the forests near villages and preventing natural regeneration by damaging the germination and growth of seedlings.

There was a significant perception that the temperature had increased with warmer summers and milder winters. People in all the communities studied felt that the warm season had been prolonged by several months and observed an overall increase in the intensity and frequency of hot days.

Impacts of change on livelihoods and community well-being

The communities ranked prolonged dry spells and increasing temperatures as having the most significant negative impact on their livelihoods. Increased attacks by insects and pests, forest

fires and landslides were identified as the major weather-induced hazards. Widespread crop damage caused by wild animals (wild boars, monkeys, porcupines and other herbivores) was also attributed to forest degradation, partly associated with changes in the climate. Positive impacts associated with changes in weather patterns included a decline in the duration and intensity of frost, reduced damage by hailstorms and, in some communities, an overall decrease in the frequency and intensity of storms.

Agriculture is dependent on a proper combination of weather and associated factors and is thus highly vulnerable to climate change—any slight change can have a severe impact on the yield of staple and cash crops. Close to 85% of the population of Uttarakhand is directly or indirectly dependent on agriculture for subsistence and income; a reduction in harvests greatly impacts the food security and the ultimate source of income of these households.

Anything affects a harvest

A lack of sufficient water immediately decreases the agricultural harvest. Similarly, the timing of rainfall is important—a delay in the monsoon forces farmers to delay the sowing of rice, especially on rain-fed fields and the yield declines considerably. Conversely, incidences of intense rainfall erode the nutritious topsoil, causing landslides that destroy farmland, block roads and thus interrupt access to markets and lead to loss of life and property. Changes in precipitation can also affect the incidence of pests. Farmers reported a significant increase in kurmula (white grub) over the past 5–7 years, which damaged major cash crops such as potatoes, other tubers, kidney beans, pulses and vegetables and reduced cash income. A lack of snow was thought to be the cause because heavy snowfall kills the eggs; warmer temperatures might also be conducive to the growth of this pest. As harvests fail, communities are becoming dependent on external markets. Previously, households could rely on two types of cereals to fulfil their basic needs for at least 11 months of the year, but now some respondents said that they only had enough food to last for 2–3 months of the year. However, this should not only be attributed to climate change. Among other reasons, high rates of male out-migration and the associated reduction in the workforce had led to widespread phenomenon of land growing fallow.

A new phenomenon observed in Uttarakhand is the double flowering of apple and Malta orange trees, leading to two harvests in a year. This adversely affected the fruit quality; fruits were smaller and less tasty (and not fit for sale). ‘Over the past few years the climate has changed drastically. There is very little snowfall and the weather has become quite warm and it seems that this is affecting the flowering pattern of apple and Malta trees here’, reasoned a villager. Horticulturalists are concerned that the double fruiting could result in crop losses and impair the overall health of the orchard as it prevents the trees from recuperating between crops and makes them weaker.

Women work more

Nearly two-thirds of the respondents (61%) thought that an increase in male migration rates was leading to increased feminization of agriculture, which was increasing women’s workloads. Around 80% believed that they have to travel longer distances to fetch fodder—the burden of fetching fuel and fodder falls solely on women. Similarly, drinking water has to be carried from the nearest springs (some of which are drying up), or someone has to wait in a queue for 2–3 h (or more) at the tap, another responsibility adding to the workload. Measures to counter the impacts of climate change—for example, repeat sowing in the event of crop failures; spreading traditional and chemical fertilizers and pesticides; and walking longer distances to fetch water and fodder—are all activities implemented by women and adding to their regular workload. The limited number of oxen available for ploughing in the

villages (and the inability to afford to rent these animals) is compelling women to use shovels to plough their fields. However, land is increasingly left uncultivated as a result of both high levels of out-migration and decreasing productivity. Changes in animal husbandry practices (moving from bigger to smaller ruminants) have reduced the time required to tend them from the previous 3–4 h to 1.5 h a day, relieving some of the workload for women.

Conversely, as household food production is becoming insufficient, more food needs to be purchased from the market and men, as the main cash income earners, are driven to seek wage labour wherever possible, adding to their workloads.

Health and nutrition suffer

The occurrence of disease and illness is perceived to have increased. Common ailments include colds, fever, jaundice, typhoid and kidney stones. Elders believe that the warmer temperature is conducive to germs. Unused to purchasing market food, communities do not trust bought grain and suspect that chemicals used in the production process could also be causing illness. The use of traditional knowledge of medicinal herbs to treat sickness is fading and the plants are also being lost as a result of forest degradation and over-exploitation. The drying up of springs adds pressure to the remaining springs and this could be leading to water pollution, explaining the increase in water-borne diseases. Women suffer the most when households lack adequate quantities of food—they consume food after serving the men and children and might have to sleep hungry. Accidents are also becoming more common as women travel farther to fetch fuel wood and fodder and have to climb steep slopes and slippery ridges.

Community-based responses to change

Mountain agriculture has traditionally been highly dynamic, with farmers continuously having to adjust to extreme environmental and climatic conditions over time. However, farmers have been unable to adjust their agricultural processes to the fast pace of change in weather patterns experienced in recent years. They are mainly adopting short-term measures to cope with climate stresses; adaptive measures are difficult to introduce in agriculture without extensive financial and physical resources.

Responses to erratic rainfall and reduced water availability

In response to erratic rainfall patterns, farmers were adjusting their agricultural calendar on a yearly basis by delaying or advancing the sowing of rice and other crops that depend on the monsoon precipitation. Winter crops such as potatoes and wheat were also planted earlier or later in some places, depending on the arrival of the winter rain. Farmers reported that in 2009-10 they had planted their winter crops up to 30 days late in expectation of rain. As a result, the harvesting of these crops also had to be delayed to allow maturing. When there was an early season crop failure because of inadequate rainfall, households that could afford a second batch of seeds either re-sowed the crop or replaced it. Rice was replaced with soybean, mustard, pulses, or madira (fodder grass); maize with soybean or vegetables; and mandua (millet) with pulses, soybean or potato.

In the past, communities in Almora had had a traditional irrigation system with water-sharing rules and regulations using *guhls* (water channels), but this mechanism had fallen out of use. Following the lack of rainfall and prolonged dry spells, this traditional rotational irrigation system has now been revived. The system fulfils everyone's needs and eliminates conflict over shared water. However, farmers situated at the end of the *ghuls*, mainly from the lowest economic strata, reported that they had to postpone sowing of rice by between 15 and 30 days while waiting for their turn for water and this adversely affected their harvest. Another

response to decreased water availability was protection of catchment areas by planting oak trees around spring catchments near villages.

Aajeevika (an IFAD-funded project) distributed improved seeds of numerous vegetables such as eggplant, tomato and capsicum, which are tolerant to water stress and germinate well, giving a high yield despite dry conditions and a lack of water. Unfortunately, other seeds provided for millets, pulses and beans gave only mediocre results. The same project also provided *Aloe vera* plants, which thrive in arid and semi-arid conditions.

Living with rising temperatures

As a result of rising temperatures, potatoes were found to mature faster and could be harvested in 3–3.5 months instead of the traditional 5–6 months. This additional time offers new opportunities to farmers and was successfully used to grow cauliflower and peas as cash crops for a higher income. Other new crops introduced included ginger and turmeric, both because they withstand water and temperature stress better and because they are popular cash crops that fetch a good price in the market. In addition, prolonged growing seasons now allow more than one crop cycle per year and rising temperatures were found to be suitable for new crops, such as groundnuts and fruits, such as mango and banana, which were described as being larger and better tasting and even fit for sale.

Combating the increased incidence of pests and disease

Traditionally, ash, cow urine and salt have been used as pesticides, but their effectiveness appears to be decreasing, as illustrated by the drastic increase in pests. Fires are lit post-harvest to kill insects and pests but can also kill earthworms and other micro-organisms beneficial to the soil. 'Earlier, traditional methods of pest control like spraying of salt or ash were effective in controlling the pests, but now, because of the increase in pest infestation, these methods have become ineffective', said Ram Singh, from Gud Gadoli village, in Almora. Chemical pesticides have been more effective in reducing crop pests and damage, but according to the farmers, their effectiveness is also reduced after 2–3 years of use. Uttarakhand Parvatiya Aajeevika Sanvardhan Company (UPASaC), created to implement Aajeevika, is providing ingeniously designed traps that have been used successfully to attract and kill kurmula (white grub).

Dealing with environmental and socio-economic change

Corn husks and leaves are being used as alternative fuels to reduce the hard work of collecting fuel wood as this resource becomes increasingly scarce. Farmers reported that medicinal plants were also rarer, possibly as a result of a combination of over-exploitation and forest degradation and thus people have become more dependent on more costly Western medicine.

Changes in livestock composition had also been made in order to cope with fodder and water scarcity and the reduced workforce resulting from the high levels of out-migration. Households were reducing the number of large ruminants and focusing on rearing goats, which require less labour, fodder and stall-feeding. Goats also have more than one offspring per litter and offer increased gains for farmers. When agricultural yields were insufficient for household needs, small/marginal farmers traditionally supplemented their incomes through wage labour on other farms or by rearing other people's livestock. With decreasing agricultural productivity, the number of people in search of wage labour is increasing, while the demand for wage labour has fallen and farmers have to look for work in nearby markets or towns. Decreasing agricultural productivity is also an important push factor for seasonal and rural/urban migration. At the same time, the tourist season appears to have lengthened with the lengthening of the summer in the Uttarakhand mountain areas, providing more

income-generating opportunities. Young people in particular are shifting to non-farm activities—running roadside eateries near tourist circuits, taxi driving and running other small businesses—disillusioned by agriculture and attaching little value to it. This phenomenon appears to be mainly due to changes in norms and values, but climate change is an aggravating factor.

Differences in vulnerability and adaptive capacity

Socio-economic and socio-political factors also play a role, in addition to the geo-physical environment, in determining the vulnerability and adaptive capacity of communities. The poorest households' excessive dependence on agriculture pre-determines their vulnerability. Literacy and an educational background are also crucial in seeking other professions or income opportunities in the endeavour to adapt to changing conditions. Among the four income categories, only 35% of the respondents in the extremely poor category were literate, compared with 51% in the wealthiest category. Wage labour was seen as the only livelihood option apart from agriculture for the non-literate. The relationship between poverty and literacy is a vicious cycle: Poor households do not have access to higher education or vocational training (or even basic education in some cases) since they cannot pay the costs, whereas the wealthy can afford to send their children to nearby towns or cities for higher education. In addition, the poorest households had the fewest migrants and thus the least access to financial remittances as well as to new skills, knowledge and other strategies for improving well-being.

The low incomes of the poor also resulted in low savings. In Tehri Garhwal, the average monthly income of people in Category 1, the poorest, was ₹969 (approximately $20) compared with ₹13,000 (around $265) for those in Category 4, the wealthiest. With this income, it is difficult to even meet daily requirements and savings are practically non-existent. The lack of financial capital also makes it difficult for the poorest to diversify their livelihoods, for example by setting up a small business. Poor farmers do not have enough collateral for a bank loan and farmers are anyway hesitant to apply for loans because of the volatility of their income. The main asset base was landholdings and these were small and unviable for both Category 1 and Category 2 respondents. Households in Category 1 had average landholdings of 0.13 ha, of which only 0.005 ha was irrigated. In terms of their adaptive capacity, the poorest were unable to risk diversifying crops, for example by growing cash crops instead of staples, for fear that they would lose their food security and they also could not afford some of the coping strategies. For example, a second batch of seeds was too expensive for repeat sowing.

Socially discriminated groups such as women and Dalits (the lowest caste group, previously considered untouchable) are more vulnerable to the impacts of climate change. Patriarchy is still widespread and women are economically poorer and also have limited access to resources. Within households, in terms of nutrition, women are the last to eat and the first to be affected by a food deficiency; they have greater responsibility for activities such as fetching fodder, fuel and drinking water and are also more prone to accidents when involved in these activities. Coping strategies require labour that is usually provided by women—repeat sowing, spreading pesticides and fertilizers and ploughing with shovels. The Dalit groups have smaller landholdings and are dependent on wage labour in other people's fields. Thus they suffer the most as agricultural productivity, the main source of income, declines.

The lack of access of the rural poor to markets and institutions is a major constraint in tackling the impacts of climate change. Health centres and veterinary hospitals were on average 15 km away, agriculture and allied departments more than 35 km away. As a resident of Bageshwar said, 'It takes one full day to go to the government offices and get home, so we

approach them very rarely'. Many villages are not connected by motorable roads and others do not have regular transport facilities, further limiting accessibility. Thus access to social safety nets, another key determinant of adaptive capacity, is also limited, particularly for more remote communities and marginalized groups.

Institutional opportunities and constraints

Institutions can be crucial in determining and influencing the adaptive capacity of any group, particularly by structuring impacts and vulnerability, mediating between individual and collective responses to climate impacts and thereby shaping outcomes of adaptation and delivering external resources to communities in order to facilitate adaptation. Some of the more important formal and informal institutions active in the study area are listed below together with the associated opportunities and constraints.

Traditional institutions (formal and informal)

Traditional water harvesting systems—In Almora, indigenous water harvesting systems were set up to counter the frequent water shortages and make use of the high surface runoff in the hills. Some of these traditional structures are still in use today, but many are on the verge of decline. Revitalizing these structures and combining their use with the traditional institutional mechanisms for water sharing could be an important way of adapting to increasing water stress of the type faced by the communities in the years preceding this study.

Van panchayats—Van panchayats are autonomous democratic local institutions characteristic of Uttarakhand. They are an institutionalized form of resource management through state community partnerships that regulate the utilization and protection of forests and forest products. Each van panchayat functions according to specific rules and regulations, which are based upon the traditional knowledge of the communities. Strengthening the existing 12,000 or so van panchayats in Uttarakhand and increasing their awareness of climate change related risks could be an effective strategy for guaranteeing the sustainable use of forest products and forest regeneration, as well as for sustainable water management.

Formal institutions

Gram panchayats—The gram panchayat, headed by a gram pradhan, is the lowest rung of the three-tiered local self-governance system. The gram panchayat oversees a cluster of 3–4 villages. It channels government funds for small-scale development and is responsible for the public distribution system (PDS) as well as for issuing the 'below poverty line' (BPL) cards, which determine subsidized rations and work allowances under the Mahatma Gandhi National Rural Employment Guarantee Act (NREGA). Unfortunately, the lack of transparency in the use of these funds and corruption in the issuance of BPL cards has damaged the credibility of these institutions and limits their effectiveness in assisting the coping and adaptive strategies of the most disadvantaged.

Fair price shops—The government ensures the supply of essential commodities under the PDS through networks of fair price shops that ensure affordable prices. With the shortfall in household food production and the need to purchase food, fair price shops have an important role to play in food security protection, but they need to enhance the quantity and quality and ensure a regular supply of food products.

Agriculture and other departments—The state departments for agriculture, fisheries, animal husbandry and horticulture were set up to provide agricultural extension services. Unfortunately, the officials in these departments lack awareness of climate change and believe that 'there is no need to worry unnecessarily', which was reflected in the complete lack of funds for climate change awareness or adaptation programmes and limits their role in

assisting rural farmers with tackling the impacts of climate change. These departments are perceived by the communities to be poorly managed and to distribute untimely and inadequate outreach services. Making these departments aware of the challenges that rural communities are already facing, partly as a result of climate change, strengthening their human and financial resources and ensuring transparency will be very important.

Revenue Department—Some compensation for crop damage due to drought was provided by the state through the Revenue Department, but communities claimed that the compensation provided was insufficient and distributed inequitably. Introduction of crop insurance is one way of strengthening the social safety net for rural communities and could be another important step in enhancing the resilience of the rural poor.

Conclusions

Poor farmers do not only face rapidly changing socio-economic conditions, they have also been coping to the best of their ability and resources with water and temperature stresses resulting from climate variability and change. These stresses are expected to continue and increase and the constant coping will have consequences, eventually depleting the asset base of the rural communities if new measures are not taken. Young people are already disillusioned and most try to leave if they can. The trend of seeing agriculture as an unviable livelihood option and leaving has implications for households and food security. Assisting farmers with adding value and productivity to agriculture will be of the utmost importance, for example, through the development of value chains for high-value products. But other livelihood options and associated human capital development will also have to be promoted by involving actors from the state government, local institutions, NGOs and primarily the stakeholders. Persistent poverty and social inequality need to be addressed, in particular supporting women and members of the lower castes.

Gender and Uttarakhand SAPCC—Inputs from Alternative Futures, in partnership with CBGA and CHEA

Inputs from the Workshop of November 2012

Background and Context[52]

The National Context

The National Action Plan on Climate Change (NAPCC) clearly states that '*the impacts of climate change could prove particularly severe for women. With climate change, there would be increasing scarcity of water, reduction in yields of forest biomass and increased risks to human health with children, women and the elderly in a household becoming the most vulnerable. With the possibility of decline in availability of foodgrains, the threat of malnutrition may also increase. All these would add to deprivations that women already encounter and so in each of the adaptation programme, special attention should be paid to the aspects of gender'.*

[52] The format follows the structure of the UAPCC June 2012 and these paragraphs/bullets can be inserted within the sections.

UAPCC Revision Process: First Ever Meet on Gender and SAPCC

The country's first ever inter-departmental Roundtable on mainstreaming gender in a State-level Action Plan on Climate Change (SAPCC) was hosted by the Uttarakhand Forest Department, the nodal departments for the Uttarakhand SAPCC (UAPCC), in collaboration with the Centre for Public Policy, Doon University; and supported by Alternative Futures, a Delhi-based development and policy research organization and Central Himalayan Environment Association (CHEA), a Nainital-based grassroots development organization. The invitation from Mr Jai Raj, Additional Principal Chief Conservator of Forests (APCCF), the nodal officer for the UAPCC, signalled the importance of integrating gender concerns in the UAPCC for all relevant departments.

The day-long Roundtable, inaugurated by Prof. V K Jain, Vice-chancellor, Doon University and chaired by Dr R S Tolia, former Chief Secretary and Chair, School of Public Policy at Doon University, was held at the university campus on 27 November 2012.

Section 3 - Overarching State Framework

(c)

Section 4 – Sectoral Implementation Approaches

[Note: This section requires a strong gender analysis in each of the elements.]

Section 5 – Agriculture

Section 5.5 – Issues, Challenges and Priorities
Section 5.5.1

Section 5.5.2

Under *Economic Security of Farmers*

- Institutional and policy reform as part of the State responsibility towards gender equality by promoting ownership of land by women farmers through *joint pattas* or as single owners.

6 – Forests and Biodiversity

Section 6.3 – Issues, Challenges and Priorities

- The upward shift of the tree line and plants will have severe repercussions on poor people's livelihoods, especially increasing the burden of women who are responsible for fetching fodder and firewood, access edible parts of plants to augment their food security and gather non-timber forest products for a livelihood.

Section 6.4 – Relevant Existing Initiatives

The Van Panchayats and the Gram Panchayats are two pillars of power that are often in conflict with each other. There is a need to address how the two institutions can work together and yet maintain

their core competence, perhaps by including management of forests as part of the village plan to be co-signed by heads of both the institutions.

There is also a need to converge schemes like MGNREGA, watershed development and forest management under Van Panchayat to address the multiple needs of ensuring adequate water-table for forests to rejuvenate and employment of people to do this task.

(Narrative on the presentations)

Addressing climate change is a great challenge for developing States like Uttarakhand where a large section of the population depends upon climate-sensitive sectors like agriculture and forestry for its livelihoods. Women are hit hardest by climate change because they are more vulnerable and have fewer means to be able to adapt to the adverse effects of climate change. Government's policies and programmes have to be gender-responsive and significant financial resources will be required to adapt to the adverse effects and reduce the impacts of climate change. The government has to play a major role to make its programmes and schemes gender-just and to finance the adaptation policy so that benefits flow to vulnerable women.

As climate change is not gender-neutral, hence adaptation policies and the budget should address gender-based disadvantages.

Policies and programmes affect men and women differently

Government policies, programmes and schemes affect men and women differently though this may be unintentional. This is because of the existing gender gap where women have fewer entitlements and face greater socio-economic barriers. Thus, programmes and schemes may be **'gender-blind'** where these do not at all take into account the gender differences and are often implicitly male biased. For example, introducing flexibility in the timings of agricultural extension work can ensure that extension services can start later in the day to reach out to women in late evenings when the women have time after attending to the farm and home. A national private financial institution working on micro-credit with women SHGs has ensured that local bank officials keep flexible timings so that they are available during the hours that work for women.

'Gender-neutral' programmes often reinforce gender inequalities. For example, the failure of the *Kisan* Credit Cards is largely due to the fact that they take into cognisance only land as an asset and majority of land-owners are male farmers. Women's productive 'assets' like livestock, her labour or peer women farmers' group are not recognized as valid collaterals for the KCCs. **'Gender-sensitive'** programmes transform gender relations to promote gender equality. The Van Panchayats or the ATMA programme are good examples of including women in decision-making structures but implementation of these in a gender-sensitive manner requires attention to details such as mandating inclusion of women members to complete the quorum of a meeting; promoting and training women farmers groups to participate fully in ATMA institutions; and recognising women farmers' groups as peer-certified entities to receive benefits from agriculture-related programmes even where these women farmers are tillers on farms that belong to outsiders. Gender-budgeting is also a gender-sensitive initiative of the GoI and the Uttarakhand government.

'Gender-transformative' initiatives promote structural and sustainable changes in gender relations. The 50% reservation for women in Uttarakhand PRIs is a good example but this needs to be supported by simultaneous work on empowering both women leaders and men to share power on

more a more equal footing. And **'gender-just'** programmes and schemes are those where men and women gain equally from the interventions.

The matrix below gives some examples of how to make some of the adaptation interventions more gender-transformative or gender-just:

Adaptive interventions	Gender analysis	What government/applied climate research can do
Organic farming	♦ More food security for both women and men ♦ More labour and time invested by women ♦ Less information/knowledge/inputs accessed by women ♦ Less participation in decision making bodies	♦ Promote vermi-composting as a women's enterprise so women have a choice to make or buy ♦ Provide organic manure through women's groups ♦ Provide weather-related information (over mobile phones) to women farmers/groups ♦ Provide rain gauges with women
Rain-water harvesting	♦ Benefits women more	♦ Promote because it also gives water for kitchen gardens + animals and household consumption
Mixed cropping/agro-forestry	♦ Food security for both women and men ♦ Women gain by food variety/nutrition ♦ Women invest more labour, time	♦ Promote joint pattas ♦ Provide seeds/manure for kitchen gardens ♦ Promote simple labour saving technologies
Adaptive Interventions	♦ Gender Analysis	♦ What government/applied climate research can do
Agriculture tools – SHG-run a village resource centre	♦ Benefits both in food production. ♦ Empowers women [untimely rains so use of pump sets]	♦ Women groups to be given tools by Panchayats/blocks
Promoting millets	♦ Benefits food security for both women and men ♦ Promotes women's traditional knowledge	♦ Panchayat to give seeds/inputs/training to women ♦ Women as trainers as part of extension programme
Seed banks/ grain banks/ fodder banks	♦ Resilience for both women & men ♦ Empowers women	♦ Mandatory in every panchayat through women's groups

Study of adaptation budget and adaptation-related gender-budgeting in Uttarakhand

Adaptation is loosely defined here as all those measures that increase the resilience of the people and the state to the inevitable impacts of climate change. These measures might be special schemes for

climate change or they may be other developmental schemes and programmes of the state that would increase the capabilities of the system and people (poverty alleviation, employment, education, nutrition etc.) to deal with the impacts. Thus, vide this loose definition, almost all the development expenditure of the government is termed as its adaptation expenditure. This would be in the nature of climate-resilient benefits from developmental programmes and thus their contribution to increasing adaptive capacities.

This in-depth analysis of the schemes that make up the adaptation strategies of the state government identified both state-level and central-level schemes under the following adaptation-oriented categories: (i) Poverty Alleviation, livelihood and food security, (ii) Land development, drought-proofing, irrigation and flood control, (iii) Agriculture and allied activities, (iv) Forestry, biodiversity and wildlife conservation, (v) Water resources and (vi) Disaster management.

Table 1 shows that out of the six areas identified, except for disaster management, all the other sectors have shown significant budgetary improvement over the last 2 years. The total adaptation expenditure in the state has been steadily increasing over the years from 1.52 % of GSDP in 2009-10 to 2.54% of GSDP in 2011-12 BE.

Figure 1 shows the sectoral distribution of this adaptation budget. Components such as poverty alleviation, livelihood and food security, land development and agriculture and allied services together constitute nearly 71.57% of the total adaptation expenditure. Climate-sensitive sectors such as forestry and wild life, water resources and disaster management have been given low priority and risk financing has been given the least priority in 2011-12. Forestry, biodiversity, wildlife conservation, disaster management and risk financing together constitute about 30% of overall adaptation budget in Uttarakhand. Out of 11.69% of total budgeted expenditure for adaptation in 2011-12, disaster management constitutes only 0.02% of GSDP, a very insignificant budget to meet climate change–related disaster predictions in Uttarakhand. This asymmetrical allocation will pose difficulties in making the State's developmental planning climate resilient.

Gender Budgeting

Given that the effects of climate change are not gender neutral and its impacts would be disproportionately borne by women, there is a need to engender both our adaptation strategies for climate change and our adaptation budgets. Budgets should address gender-based disadvantages to make the State climate-resilient.

The National Mission for the Empowerment of Women 2010 defines gender budgeting (GB) as 'a process that entails incorporating a gender perspective at all levels and stages of the budgetary process—planning/policy/ programme formulation, assessment of needs of target groups, allocation of resources, implementation, impact assessment and prioritization of resources'. India is one of the first countries to institutionalize gender budgeting within the Ministry of Finance, while following the budgetary accounting framework and analysing the possibilities of changes in the budgetary classification. India integrates gender budgeting in its mainstream budgets.

The 12th Five Year Plan notes that 'the scope of the GB Statement must be expanded to cover all Union Ministries and Departments by making it mandatory for all to report under the same'. The Budget Circular for Union Government for 2013/14 observes that for Statement No. 20 on gender budgeting in Expenditure Budget Vol.1, 'all Ministries and Departments are required to carefully

scrutinize their Detailed Demands for Grants and identify such programmes/schemes as fulfil the above objectives, along with their budgeted provisions for inclusion in the above Statement. Information in the format of the statement (Statement No. 20, Expenditure Budget Vol. 1) may be sent in two parts, Part "A" reflecting 100% provisions and Part "B" reflecting the specified percentage provisions for pro-women allocations respectively'. In the Union Budget, the GBS covers 33 Demands for Grants under 27 ministries/departments.

Gender budgeting in the Union Govt. is not only confined to conventionally perceived 'women-related' sectors but is also extended to other areas like science and technology, biotechnology, industrial policy and promotion.

Gender-budgeting in Uttarakhand

Gender budgeting exercise was introduced in Uttarakhand in 2007-08 in 18 Departments which reported budgets of ₹330.38 crore. The amounts being reported in the GBS have gone up substantially since then and in 2012-13, 29 departments reported an allocation of ₹2227.67 crore. The reporting structure in GBS in Uttarakhand follows the same format as that given at the Union level and is reported in two parts: Part '1' reflects 100% provisions for women and Part '2' reflects the specified percentage provisions of pro-women allocations (provisions >30%). The line departments propose allocations under GBS and the Department of Finance compiles the final statement.

The Uttarakhand GBS (2011) in its introduction notes that the exercise should go beyond the traditional departments of health, education and women empowerment and be extended to other mainstream departments as well. Yet the GBS for 2012-13 has only conventional departments reporting under it.

On the basis of the assumptions followed for computing the Adaptation expenditure, a similar exercise was carried out in this study to compute the adaptation expenditure flowing through the budgets to the women in the State. Table 2 shows the allocations computed under the various departments in the GBS.

Way Forward in climate-responsive GBS in Uttarakhand

- Changing GB from being an ex-post exercise to influencing the process of budget formulation and including the assumptions underlying the reporting in the GBS; attachment of explanatory memorandum that explains its inclusion in the budget document.
- Including all pro-women schemes reported in the Annual Plan of the State in the GBS (e.g. Human Resource Development Department activities, training for women under sericulture, assistance to stabilization and training for women under Cooperation, etc.)
- Generating gender-disaggregated data on beneficiaries of government programmes/schemes.
- Ensuring that budgetary allocations correspond to the proportion of women working in each sector.
- Undertaking benefit-incidence analysis in programmes/schemes reaching out to women.
- Orienting budgetary allocations towards women-specific concern areas like reduction of drudgery, especially in the wake of climate change.
- Introducing gender-responsive interventions, with requisite allocations, in the *indivisible* sectors such as water, sanitation, road transport, energy and tourism so that the benefits flow to women.

- Improving the gender-responsiveness of programmes and schemes in the *divisible* sectors—like how the basic design of a scheme can be made more gender responsive and how the operational guidelines and financial norms of a scheme can be made more gender responsive.
- Enabling convergence across departments in planning and budgeting from a gender lens.
- Ensuring that all departments report under the GBS through proper guidelines.

Table 1: Adaptation expenditure in Uttarakhand

Key adaptation sectors	2009-10 (As % of TBE)	2010-11 (As % of TBE)	2011-12 (As % of TBE)
Poverty alleviation, livelihood and food security	2.59	3.99	3.84
Land development, drought proofing, irrigation and flood control	2.36	3.14	3.42
Agriculture and allied activities	0.66	0.75	1.35
Forestry, bio-diversity, wildlife conservation	0.48	0.51	0.63
Water resources	0.94	0.80	2.38
Disaster management	0.03	0.10	0.02
Risk financing	0.03	0.05	0.05
As % of TBE	7.09	9.35	11.69
As % of GSDP (current prices)	1.52	1.82	2.54

Figure- 1 Share of various sectors in adaptation expenditure

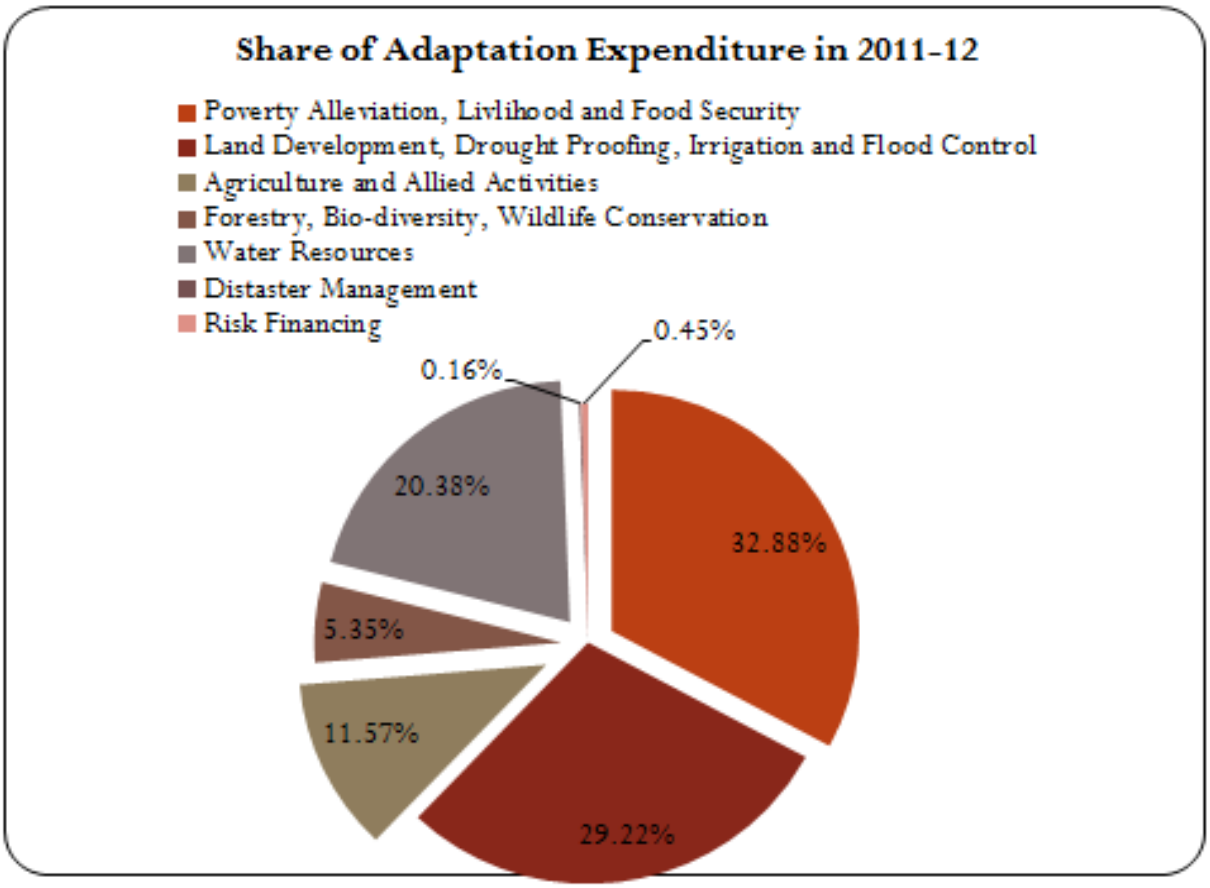


Table 2. Gender budgeting in key adaptation sector in 2012-13 for Uttarakhand (₹ in crores)							
	Part 1			Part 2			Total Part 1 + Part 2 Expenditure
	Plan	Non Plan	Total	Plan	Non Plan	Total	
Agriculture	0.0	0.0	0.0	10.6	0.0	10.6	10.6
Watershed management	0.0	0.0	0.0	12.9	0.0	12.9	12.9
Rural development	0.0	0.0	0.0	42.4	0.0	42.4	42.4
Food	0.7	0.0	0.7	0.0	175.0	175.0	175.7
Forestry	0.6	0.0	0.6	0.7	0.0	0.7	1.2
Dairy development	1.8	0.0	1.8	0.4	0.0	0.4	2.3
Animal husbandry	0.0	0.0	0.0		0.0		0.4
Horticulture	0.0	0.0	0.0	2.5	0.0	2.5	2.5
Sericulture	0.0	0.0	0.0	0.6	0.0	0.6	0.6

Table 3. Integrating gender into the budget process/budget cycle

State of budget process	Potential opportunities
Budget preparation	1. Gender-specific budget **initiatives** set forth in the budget policy. 2. Gender policies incorporated into overall budget **guidelines and instructions** from the central budget office. 3. Gender-specific **priorities** set for budget allocations within departments for specific agencies.
Budget approval	1. Creation of specific gender guidelines for expenditure and revenue **legislation** in the overall framework for legislative decision-making. 2. Integration of gender-specific **language** in legislation establishing new programs and agencies. 3. Use of gender-responsive budgeting **guidelines** in allocating discretionary **resources.** 4. Incorporation of gender **outcomes into fiscal notes** accompanying new spending and revenue legislation.
Budget execution	1. Creation of **guidelines for spending** where there is discretion given to departments by legislative bodies. 2. Development of gender **guidelines for outsourcing, procurement and grant disbursement.** 3. Implementation of gender goals in **staffing.**
Audit and evaluation	1. Incorporation of a gender dimension into **financial audits** that focus on expenditures and compliance. 2. Incorporation of a gender dimension into **performance audits** that focus on outputs and outcomes. 3. **Audit for compliance** with gender goals and guidelines.

Source: National Mission for Empowerment of Women, at
http://www.nmew.gov.in/index1.php?lang=1&level=0&linkid=28&lid=94&ltypeid=2&domid=4

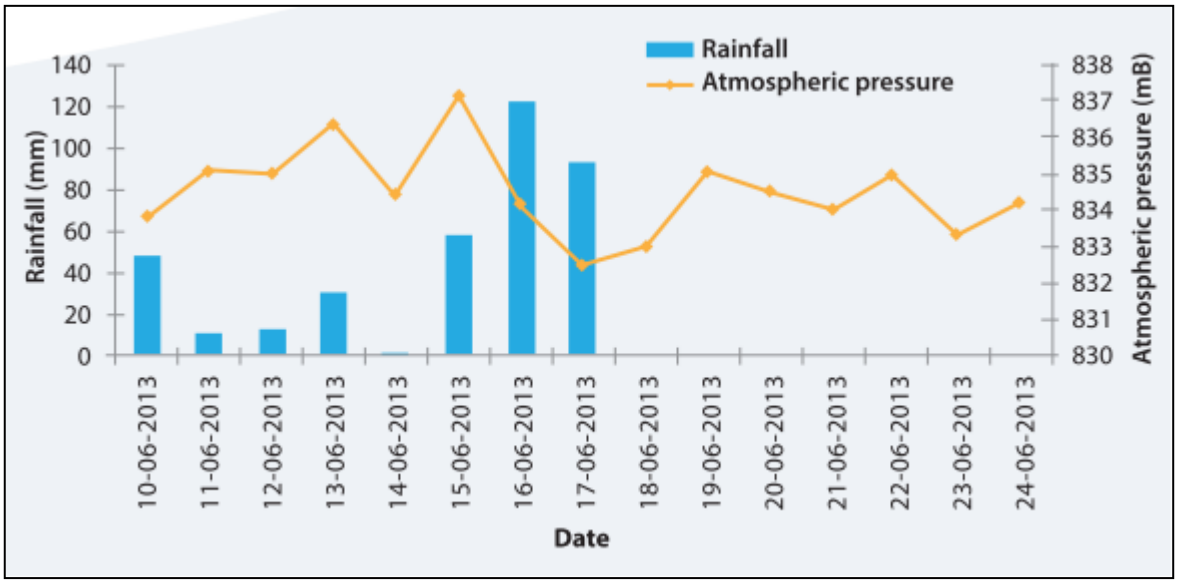
*****

Annexure 3 — Brief Notes on Uttarakhand Flood Disaster 2013[53]

During the month of June, 2013, cloud bursts and heavy (64.5 - 124.4 mm) to very heavy (124.5 – 244.4 mm) rainfall hit several parts of the higher reaches within Uttarakhand. This unprecedented rainfall resulted in a sudden increase in water levels giving rise to flash floods in the Mandakini, Alakananda, Bhagirathi and other river basins and also caused extensive river bed and toe erosion and landslides at various locations. The worst impact happened in the Mandakini river valley around the Kedarnath shrine region (Rudraprayag district) and its downstream areas. Rock falls resulted in the partial blockade and impoundment on the river channel to the left of Kedarnath. Adding to this, continuous rains and melting of the Chorabari glacier (that feeds the Gandhi Sarovar Lake or Chorbari Lake) caused waters in the Chorabari Lake to rise. The lake's weak moraine barrier gave way and a huge volume of water along with large glacial boulders came down the channel to the east, devastating Kedarnath town, Rambara, Gaurikund and other places in its wake.

The heavy rainfall across the upper reaches of the Himalayan terrain spread through Yamunotri, Gangotri, Badrinath, Hemkund Sahib and other mountains along the Kailash Mansarovar route. The districts of Bageshwar, Chamoli, Pithoragarh, Rudraprayag and Uttarkashi were among those most affected by this disaster. The flooded rivers reaching downstream carrying heavy amount of debris and sediment caused further devastation in the lower districts, though to a lesser extent, when compared to the higher Himalayan districts of Uttarakhand.

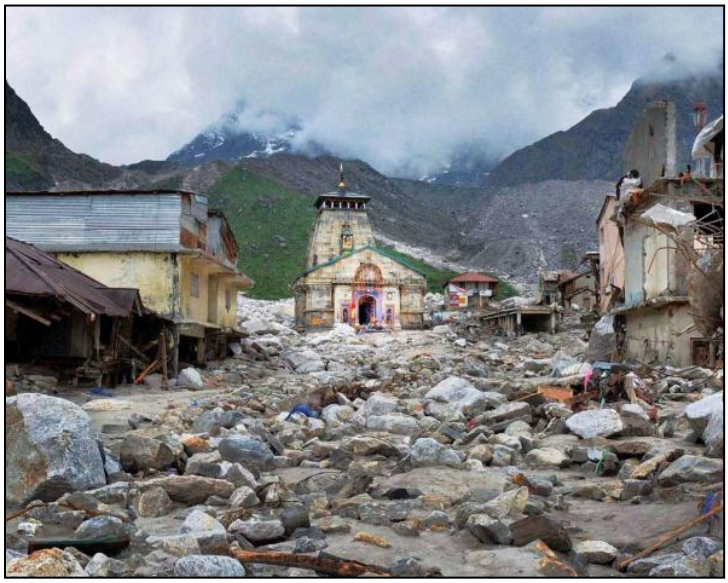
Figure: Rainfall and atmospheric pressure recorded at Kopardhar Observatory
(Near Ghuttu (WIHG) that is approximately 38 km (aerial distance) from Kedarnath)



[53] Sourced from "India Uttarakhand Disaster June 2013: Joint Rapid Damage and Needs Assessment"

This event coincided with the peak tourist and pilgrimage season within the state, thus significantly increasing the number of causalities, missing and affected populace, thereby compounding the impact of the disaster. The continuous rain disrupted normal life resulting in a total of 580 human lives being lost, over 5400 persons missing and left over 70,000 tourists and 100,000 local inhabitants stranded in the upper reaches of the mountain terrain.

In addition, the disaster has not only led to damages of physical infrastructure in the state, but has also resulted in damage and loss to natural infrastructure including forests and the associated Non Timber Forest Product (NTFP). Such losses, in the short term, has affected the resilience of people to manage their daily needs of cooking, heating and lighting and in the medium to long term will impact the livelihood of those that depend on those resources, particularly on the pilgrim circuit.



The Joint Rapid Damage Needs and Assessment (JRDNA)

The JRDNA report was a joint collaborative effort of the Government of Uttarakhand (GoUK), the World Bank (WB) and the Asian Development Bank (ADB) in response to a request from GoUK and the Government of India (GoI). The mission team, in partnership with GoUK, comprised of experts from different sectors in order to be able to produce a multi-sectoral assessment of the damages and needs. A sector-by-sector analysis of the damage was undertaken, utilizing specific templates for information recording and gathering in order to ensure consistency of information, non-duplication and comparability of the data. The total cost of reconstruction and repair due to losses in the Forests and Biodiversity Sector has been estimated to be about ₹ 54.2 crores.

While the main focus of the assessment was to estimate the damages to physical assets and the corresponding needs, this rapid assessment has been broadly based on the Damage and Loss Assessment (DaLA) methodology developed by the United Nations Economic Commission for Latin America and the Caribbean (UNECLAC) and further updated and expanded by the World Bank's GFDRR. It provides a preliminary estimate of the total cost of damages and identifies the needs for reconstruction. It is envisaged that detailed sectoral analyses would inform project design and implementation for the reconstruction activities to be undertaken.

Reconstruction Measures

Following are the reconstruction measures that are being taken. The main support is being provided through the following agencies: NDRF, CSS, WB, ADB and ACA/SPA:

Uttarakhand Disaster Recovery Project (World Bank Assisted)
Based on the findings from the JRDNA, The Uttarakhand Disaster Recovery Project (UDRP) through the Government of Uttarakhand was launched. The objective of UDRP is to restore housing, rural connectivity and build resilience of communities in Uttarakhand and increase the technical capacity of the state entities to respond promptly and effectively to an eligible crisis or emergency.

There are six components to the project, the first component being resilient infrastructure reconstruction. The objective of this component is to focus on the immediate needs of reconstruction of damaged houses and public buildings. The aim is to reduce the vulnerability of the affected population and restore access to the basic services of governance. The second component is the rural road connectivity. The objective of this component is to restore the connectivity lost due to the disaster through the reconstruction of damaged roads and bridges including: village roads, Other District Roads (ODRs), bridle roads and bridle bridges. The third component is the technical assistance and capacity building for disaster risk management. The objective of this component is to enhance the capabilities of government entities and others in risk mitigation and response. The fourth component is the financing disaster response expenses. This component will support the financing of eligible expenses already incurred by the state during the immediate post-disaster response period. The fifth component is the implementation support. This component will support the incremental operating costs of the project, including the operation of the Project Management Unit (PMU) and the respective Project Implementation Units (PIUs). Finally, the sixth component is the contingency emergency response. The total Project Cost is estimated to be worth US $250.00 million. The Core Committee, the High Powered Committee, the PMU and the PIU have already been set up and tenders have been floated for reconstruction projects (roads, buildings etc.)

Uttarakhand Emergency Assistance Project (ADB Assisted)
The Uttarakhand Emergency Assistance Project has been launched, through the State Disaster Management Authority (SDMA), to assist the Government of Uttarakhand (GoUK) to meet reconstruction needs due to disaster in Uttarakhand in June 2013 that severely affected several parts of Uttarakhand. The project is estimated to cost US $205.00 million. The impact of the project is improved economic and social condition in Uttarakhand after 2013 disaster. The outcome of the project is to restore basic public and social infrastructure, improve disaster preparedness, project management and institutional effectiveness. The design and construction standards for the physical infrastructure will be raised to an appropriate level and the focus will be to build back the same or better. The revised high flood levels of the rivers, natural streams and drainage channels will also be considered, while designing facilities, Geotechnical studies will be undertaken and slope stabilization measures considered for slide zones, wherever applicable

National and International Coordination[54]

DMMC has effective working linkages with National Institute of Disaster Management (NIDM), New Delhi. DMMC is also closely linked with several other ATIs, Research Institutes, Universities, organizations, NGOs, experts of Uttarakhand and other states and shares data/information with them. Disaster Mitigation and Management Centre (DMMC) has also completed ADB sponsored Technical Assistance on 'Strengthening of Disaster Management Strategies' for Uttarakhand and Disaster Risk Management Programme of the Government of India and United Nations Development Program (UNDP). UNDP in Uttarakhand is also supporting the state in building institutional mechanism for streamlining interventions in disaster risk reduction and climate change adaptation.

GIS Database

Database on the various critical infrastructures is an important resource for quick decision making so as to better manage the disaster situation. DMMC has prepared a detailed database of all critical resources for the entire state of Uttarakhand under the Geographic Information System (GIS) environment. DMMC is utilising the satellite data for preparing input theme maps into the GIS environment.

Layers for drainage, habitation, roads, irrigation, health infrastructure, police and revenue police infrastructure, wireless communication facilities and FCI Godowns are presently available with DMMC for the entire state. Besides the disaster management works this database is also being utilised by different departments for their planning and resource mobilisation related needs.

Documentation

DMMC prepares detailed reports of the various disasters and these are being utilised for experience sharing, seeking information regarding the particular event as also database creation. The DMMC has also got a video film by TIFAC on earthquakes (Surviving Nature's Fury) dubbed into Hindi. DMMC has prepared the following video films on disasters as also for mass awareness: Surkshi Jeevan Ki Or Pratyaksh Hi Praman Budhakedar Landslide Tragedy of 2002 Khetgaon Landslide Tragedy of 2002

Communication

Effective communication is a must for effective management of the disaster situation and therefore DMMC is emphasizing upon strengthening normal communication network as also erecting alternative backup communication infrastructure DMMC has police wireless connectivity at State Emergency Operation Centre, videoconferencing facility with all the 13 districts and 22 state headquarters and MHA. Satellite phones have been set up in ten districts as also in the DMMC and SEOC for providing alternative communication. DMMC is currently using SMS gateway service for emergency alerts. A HAM radio club has been formed in DMMC for providing alternative communication as also for promoting this hobby.

*****

[54] Disaster Mitigation and Management Center, GoUK