

Haryana State Action Plan on Climate Change



Government of Haryana

Haryana State Action Plan on Climate Change

December 2011



Government of Haryana

Disclaimer

“The data and information used for preparing this report have been sourced from secondary sources including state government departments and officials, published sources of Government of India, and climate change assessment made by the consultants. While due care has been taken to ensure authenticity of the data and other information used, any inadvertent wrong data or information used is regretted. We are not liable to any legal or penal responsibilities arising from this and also from the use of this report by anyone.”

Foreword

Acknowledgement

Preface

Table of Contents

FOREWORD	I
ACKNOWLEDGEMENT	II
PREFACE	III
TABLE OF CONTENTS	IV
LIST OF FIGURES	VIII
LIST OF TABLES	X
ABBREVIATIONS	XII
 EXECUTIVE SUMMARY	 XVIII
 CHAPTER 1 - INTRODUCTION	 1
 BACKGROUND	 1
ORGANIZATION OF THE REPORT	1
HARYANA STATE PROFILE	2
PHYSIOGRAPHY	2
CLIMATE	3
NATURAL RESOURCES	3
Water Resources	3
Landuse	4
DEMOGRAPHY	13
ECONOMY	14
INFRASTRUCTURE	15
Physical infrastructure	16
Social infrastructure	20
SAPCC PREPARATION PROCESS	23
 CHAPTER 2 - CLIMATE – CURRENT BASELINE AND CLIMATE PROJECTIONS	 27
 DATA USED	 27
OBSERVED PRECIPITATION TRENDS	27
OBSERVED TEMPERATURE TRENDS	30
 CLIMATE CHANGE SCENARIOS	 32
 REGIONAL CLIMATE SCENARIOS FOR INDIA USING PRECIS	 34
 CLIMATE CHANGE DATA EXTRACTION	 35
Comparison of Observed and Simulated Temperature and Rainfall	36
ANALYSIS OF THE CLIMATE CHANGE DATA	37
PRECIS TEMPERATURE	37
PRECIS PRECIPITATION	40

TEMPERATURE HUMIDITY INDEX (THI)	43
HEAT STRESS - HUMAN HEALTH	44
Humidex	44
Wet Bulb Global Temperature (WBGT)	46
CHAPTER 3 - STATE GHG EMISSION	50
ASSESSMENT OF EXISTING GHG EMISSIONS GASES	50
ASSESSMENT OF EXISTING GHG EMISSIONS BY SECTOR	53
CHAPTER 4 - CLIMATE CHANGE IMPACTS AND VULNERABILITY	56
IMPACT OF CLIMATE CHANGE ON WATER RESOURCES OF HARYANA	56
IMPACTS OF CLIMATE CHANGE ON WATER RESOURCES	56
Agricultural water stress indicator	58
IMPACT OF CLIMATE CHANGE ON FORESTS OF HARYANA	59
CLIMATE IMPACT ASSESSMENT USING DYNAMIC VEGETATION MODELS	61
Impacts of climate change on currently forested grids	61
IMPACTS OF CLIMATE CHANGE ON POTENTIAL FUTURE AREAS UNDER FOREST IN HARYANA	63
LIKELY IMPACTS OF CLIMATE CHANGE ON AGRICULTURE	64
LIKELY IMPACTS OF CLIMATE CHANGE ON LIVESTOCK	65
Impact on production systems	65
Impact on animal growth and reproduction	65
Impact on physiological responses and functions	66
Affect on feed and fodder	66
Feed and Fodder Availability	66
Animal diseases and livestock health	66
Impact on poultry	67
LIKELY IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH	67
CHAPTER 5 - PRESENT POLICIES AND PROGRAMS AND LINKAGES WITH NAPCC	69
EIGHT MISSIONS OF NATIONAL ACTION PLAN ON CLIMATE CHANGE	69
LINKAGES WITH NAPCC	70
WATER MISSION - EXISTING STATE POLICIES AND PROGRAMS	70
Concerns related to water resources	70
GREEN INDIA MISSION FORESTS AND HORTICULTURE - EXISTING STATE POLICIES AND PROGRAMS	73
FORESTRY AND WILD LIFE PRESERVATION PROGRAMMES	74
Tree Improvement schemes (Plantation)	75
Soil and Moisture Conservation	75
Biodiversity Conservation	75
Wild Life management	75
ENERGY: EXISTING ACTS, POLICIES, MISSIONS, PROGRAMS AND PROJECTS	77
JAWAHARLAL NEHRU NATIONAL SOLAR MISSION (JNNSM)	78

Grid Based Solar Power Generation	78
Offgrid decentralised solar applications	81
HARYANA ENERGY EFFICIENCY PROGRAMME	82
REGULATORY MEASURES: STATE SOLAR MISSION AND ENERGY EFFICIENCY PROGRAMME	90
State Renewable Power Policy	93
ENERGY: ACTIONS AND DEMONSTRATION PROJECTS	94
UNDP Ongoing Projects	95
SUSTAINABLE HABITAT MISSION	96
Town and Planning	96
DEVELOPMENT OF SOLAR CITIES IN HARYANA	97
PUBLIC WORKS DISTRIBUTION (BUILDINGS AND ROADS)	98
Roads	98
Urban Transport	98
HEALTH - EXISTING STATE POLICIES AND PROGRAMS	99
The national Rural Health mission	99
National Vector Control Diseases Programme (NVBDCP)	100
Revised Tuberculosis Control Programme (RNTCP)	100
Integrated Disease Surveillance Programme (IDSP)	100
National Programme for Health care for the elderly (NPHCE)	101
National Program for Prevention and Control of Diabetes, Cancer, Cardiovascular diseases and Stroke (NPCDCS)	101
STRATEGIC KNOWLEDGE MISSION	101

SECTORAL CLIMATE CHANGE STRATEGY AND ACTION PLAN **103**

CHAPTER 6 - SECTORAL CLIMATE CHANGE STRATEGY AND ACTION PLAN **104**

FORESTRY	104
GREENING INDIA MISSION	104
Adaptation programme under the Greening India Mission	104
Mitigation projects under the Greening India Mission	104
Mitigation potential of the proposed projects under Greening India Mission	106
ADAPTATION TO CLIMATE CHANGE	107
Proposed Adaptation Projects by State Forest Department	107
MAINSTREAMING ADAPTATION IN FOREST PLANNING AND MANAGEMENT	108
SUSTAINABLE AGRICULTURE MISSION	109
HORTICULTURE	111
PESTS AND DISEASES	111
WEED MANAGEMENT	112
LIVESTOCK	112
FISHERIES:	113
Adaptation measures in fisheries	114
Mitigation measures in fisheries	114
TIME PERIOD AND BUDGET REQUIREMENT FOR AGRICULTURE AND LIVESTOCK SECTOR	114

ENERGY MISSION	115
Agriculture sector	119
Fund requirement	119
Urban Development	119
Fund requirement	120
Summary	125
STRATEGIES TO ADDRESS CONCERNS IN WATER SECTOR	125
Rural Development: Proposed activities under IWMP are as under:-	128
Farm based-	128
Off farm based -	128
HEALTH SECTOR CLIMATE CHANGE STRATEGY AND ACTION PLAN	129
STRATEGIC KNOWLEDGE MISSION	132
Awareness of Climate Change	132
Capacity Development	133
Brief monitoring and evaluation framework	133
CONSOLIDATED ABSTRACT OF BUDGET REQUIREMENT FOR HARYANA	135
SECTOR WISE CONSOLIDATED ABSTRACT OF BUDGET REQUIREMENT	150
<u>CROSS CUTTING ISSUES AND INTEGRATED APPROACH</u>	<u>151</u>
<u>CHAPTER 7 - CROSS CUTTING ISSUES AND INTEGRATED APPROACH</u>	<u>152</u>
SECTORAL POLICY AND BARRIER ANALYSIS FOR M & A PROJECT DESIGN, IMPLEMENTATION AND MONITORING	152
CRITICAL AREAS:	152
AREAS OF RESEARCH:	152
NEED FOR INTEGRATED APPROACH	153
DATA AND INFORMATION INFRASTRUCTURE, MODELLING	154
LINKING VULNERABILITY REDUCTION AND CARBON SINK ENHANCEMENT	155
Institutional arrangements for vulnerability reduction programmes - Forestry	156
CAPACITY BUILDING	156
INSTITUTIONAL ARRANGEMENTS	157
MONITORING AND EVALUATION	157
REVIEW AND CONTINUOUS IMPROVEMENT	157

List of Figures

FIGURE 1 : GEOGRAPHICAL CONTEXT OF THE STUDY AREA.....	2
FIGURE 2 : AGRO CLIMATIC ZONES OF HARYANA	4
FIGURE 3 : LANDUSE OF HARYANA (NRSA, 2007-08)	6
FIGURE 4 : FOREST COVER OF HARYANA.....	7
FIGURE 5 : TRENDS IN AREA UNDER DIFFERENT TYPES OF FOREST IN HARYANA.....	7
FIGURE 6 : ADMINISTRATIVE SETUP OF HARYANA.....	14
FIGURE 7 : DISTRICT POPULATION AND GROSS DOMESTIC PRODUCT OF HARYANA	15
FIGURE 8 : SPATIAL SPREAD AND TRENDS OF MALARIA, DENGUE AND JAPANESE ENCEPHALITIS IN HARYANA	21
FIGURE 9 : TRENDS OF TYPHOID, CHOLERA AND VIRAL HEPATITIS IN HARYANA BETWEEN 2006 AND 2011	22
FIGURE 10 : PROCESS OF SAPCC PREPARATION	24
FIGURE 11 : INTER ANNUAL VARIATION IN SEASONAL RAINFALL IN HARYANA.....	28
FIGURE 12 : OBSERVED SEASONAL RAINFALL TREND IN HARYANA	28
FIGURE 13 : OBSERVED RAINFALL STATISTICS –AVERAGE SEASONAL RAINY DAYS - HARYANA.....	29
FIGURE 14 : OBSERVED RAINFALL STATISTICS – INTER ANNUAL VARIATION IN RAINY DAYS - HARYANA.....	30
FIGURE 15 : OBSERVED MEAN MAXIMUM AND MINIMUM TEMPERATURE IN HARYANA.....	31
FIGURE 16 : OBSERVED SEASONAL TEMPERATURE IN HARYANA	32
FIGURE 17 : PRECIS DATA GRIDS OF HARYANA	35
FIGURE 18 : COMPARISON OF OBSERVED AND SIMULATED BASELINE TEMPERATURE AND RAINFALL - HARYANA	36
FIGURE 19 : PROJECTED CHANGE IN MEAN ANNUAL PRECIPITATION AND TEMPERATURE IN HARYANA	37
FIGURE 20 : CHARACTERISTICS OF SIMULATED SEASONAL AND ANNUAL TEMPERATURE - HARYANA.....	38
FIGURE 21 : PROJECTED CHANGE IN SEASONAL TEMPERATURE IN HARYANA.....	39
FIGURE 22 : CHARACTERISTICS OF SIMULATED SEASONAL AND ANNUAL RAINFALL AND TEMPERATURE	41
FIGURE 23 : PROJECTED CHANGE IN SEASONAL PRECIPITATION IN HARYANA.....	42
FIGURE 24 : PROJECTED THI FOR DIFFERENT MONTHS IN HARYANA	43
FIGURE 25 : PROJECTED HUMIDEX FOR DIFFERENT MONTHS IN HARYANA.....	45
FIGURE 26 : PROJECTED WBGT FOR DIFFERENT MONTHS IN HARYANA.....	47
FIGURE 27 : POWER GENERATION CAPACITY, GENERATION AND CONSUMPTION IN HARYANA.....	50
FIGURE 28 : PETROLEUM PRODUCT CONSUMPTION IN HARYANA (000TONNES).....	51
FIGURE 29 : NITROGEN FERTILIZER APPLICATION AND RICE PRODUCTION IN HARYANA	51
FIGURE 30 : DISTRICT LEVEL EMISSIONS OF VARIOUS GREENHOUSE GASES IN HARYANA DURING 2005-2006 .	52
FIGURE 31 : RELATIVE INCREASE IN GDP, POPULATION, ELECTRICITY CONSUMPTION AND GHG EMISSIONS IN HARYANA (INDEXED 1990 = 100).....	52
FIGURE 32 : DISTRICT LEVEL GREENHOUSE GAS EMISSIONS (EXCLUDING LULUCF) IN HARYANA DURING 2005- 06	53
FIGURE 33 : SECTORAL GREENHOUSE GAS EMISSIONS (EXCLUDING LULUCF) FROM HARYANA DURING THE 2005-06.....	54
FIGURE 34 : CHANGE IN WATER AVAILABILITY TOWARDS 2030S WITH RESPECT TO 1970S (IPCC SRES A1B SCENARIO) IN HARYANA	57
FIGURE 35 : CHANGE IN WATER AVAILABILITY TOWARDS 2080S WITH RESPECT TO 1970S (IPCC SRES A1B SCENARIO) IN HARYANA	58
FIGURE 36 : CHANGE IN AGRICULTURE WATER STRESS FOR BASELINE, MID CENTURY AND END CENTURY SCENARIOS (IPCC SRES A1B SCENARIO) IN HARYANA	59
FIGURE 37 : FOREST VEGETATION CHANGE PROJECTED BY 2035 AND 2085 UNDER A1B SCENARIO IN HARYANA	62
FIGURE 38 : PROJECTED IMPACTS OF CLIMATE CHANGE ON POTENTIAL FUTURE AREAS UNDER FOREST BY 2035 AND 2085 UNDER A1B SCENARIO IN HARYANA	63

FIGURE 39 : INSTALLED SOLAR WATER HEATING SYSTEMS IN THE PAST FOUR YEARS.....	80
FIGURE 40 : HARYANA ANNUAL OUTLAY FROM 2007-2012	117

List of Tables

TABLE 1: SHARE OF WATER FOR HARYANA IN VARIOUS RIVERS	4
TABLE 2: LAND USE LAND COVER STATISTICS OF HARYANA (MAPPING CYCLE WISE)- AREA IN LHA	5
TABLE 3: DISTRICT-WISE FOREST COVER IN 2007.....	8
TABLE 4: GROWING STOCK IN 2010 (LAKH M ³).....	8
TABLE 5: GROWING STOCK AND MAI IN HARYANA (LAKH M ³) IN 2011.....	9
TABLE 6: SOURCES OF COOKING FUEL IN HARYANA	10
TABLE 7: DISTRICT-WISE AREA UNDER WASTELANDS IN HARYANA	11
TABLE 8: MICRO-WATERSHED DETAILS OF HARYANA.....	17
TABLE 9: EXISTING AND UNDER IMPLEMENTATION POWER GENERATION PLANTS IN HARYANA	18
TABLE 10: OBSERVED RAINFALL STATISTICS AVERAGE OVER THE TIME PERIOD 1971-2005 (35 YEARS) FOR HARYANA	27
TABLE 11: OBSERVED TEMPERATURE STATISTICS AVERAGE OVER THE TIME PERIOD 1969-2005 (37 YEARS) FOR HARYANA	30
TABLE 12: SUMMARY OF IPCC SRES SCENARIOS	33
TABLE 13: CHARACTERISTICS OF SIMULATED SEASONAL AND ANNUAL TEMPERATURE	38
TABLE 14: RAINFALL STATISTICS FOR HARYANA.....	41
TABLE 15: TEMPERATURE HUMIDITY INDEX (THI) STRESS LEVEL SCALES	43
TABLE 16: RANGE OF HUMIDEX AND DEGREE OF COMFORT OR DISCOMFORT	45
TABLE 17: WET BULB GLOBAL TEMPERATURE (WBGT) SCALES	46
TABLE 18: WOOD HARVESTED BY PRODUCTION CIRCLE HARYANA.....	60
TABLE 19: NUMBER OF CURRENTLY FORESTED GRIDS PROJECTED TO BE IMPACTED BY CLIMATE CHANGE DURING 2030S AND 2080S IN HARYANA.....	61
TABLE 20: NATIONAL PARKS IN HARYANA	75
TABLE 21: NODAL AGENCY WITH EXISTING ACTS, POLICIES AND PROGRAMMES.....	77
TABLE 22: EXISTING POLICIES, PLANS, MISSIONS AND PROGRAMMES PROMOTING CLIMATE CHANGE ADAPTATION	78
TABLE 23: VILLAGE ELECTRIFICATION PROGRAMME - PROJECT AT GLANCE	81
TABLE 24: ENERGY SAVED SINCE INCEPTION OF THE STATE ENERGY CONSERVATION PROGRAMME IN 2007-08	82
TABLE 25: STATUS OF RENEWABLE ENERGY PROJECTS IN HARYANA (AS ON 30.11.11).....	93
TABLE 26: YEARWISE PROGRESS OF RE POWER GENERATION IN HARYANA (MW)	93
TABLE 27: PROJECTS AT NATIONAL LEVEL (ONGOING)	96
TABLE 28: STATE SPECIFIC ONGOING UNDP PROJECTS.....	96
TABLE 29: NUMBER OF PPP PROJECTS IN HARYANA.....	97
TABLE 30: MITIGATION PROJECTS PROPOSED UNDER THE GREENING INDIA MISSION	106
TABLE 31: ANNUAL INCREMENTAL AND CUMULATIVE MITIGATION POTENTIAL (TCO ₂ -E) OF PROPOSED ACTIVITIES UNDER DIFFERENT GREENING INDIA SUB-MISSIONS.....	106
TABLE 32: STRATEGIES, ACTIONS, TIME LINES AND BUDGETS - LIVESTOCK AND LIVESTOCK PRODUCTS	112
TABLE 33: STRATEGIES, ACTIONS, TIME LINES AND BUDGETS - FISHERIES	114
TABLE 34: TIME LINES AND BUDGETS –AGRICULTURE AND LIVESTOCK	114
TABLE 35: TIME LINES AND BUDGETS –FOR THE PROPOSED CENTRE ON CLIMATE CHANGE RESEARCH IN AGRICULTURE	115
TABLE 36: SUMMARY OF PROPOSED POWER PLANTS IN HARYANA.....	117
TABLE 37: STRATEGIES, ENERGY CONSERVED AND THE AGENCIES/DEPARTMENT CONCERNED TO CARRY OUT THE VARIOUS PROJECTS	117
TABLE 38: PROPOSED PROGRAMMES FOR VARIOUS DEPARTMENTS ALONG WITH THE PROPOSED INVESTMENT	120

TABLE 39: SUMMARY OF CLIMATE CHANGE ACTION PLAN FOR WATER SECTOR.....	126
TABLE 40: SUMMARY OF CLIMATE CHANGE ACTION PLAN FOR IWMP BY RURAL DEVELOPMENT DEPARTMENT	129
TABLE 41: PROJECTS PROPOSED AND FUNDING REQUIREMENT FOR HEALTH SECTOR	129
TABLE 42: STATE FUNDING REQUIREMENT FOR ALL SECTORS FOR CLIMATE CHANGE VULNERABILITY REDUCTION MEASURES	135

Abbreviations

Abbreviations	Description
°E	Degree East
°N	Degree North
°C	Degree Centigrade
AD	Anno Domini
AMC	Annual Maintenance Contract
AT&C	Aggregate Technical and Commercial
AYUSH	Ayurvedic, Unani, and Homeopathy
B&R	Buildings and Roads
BCC	Behavior Change Communication
BCM	Billion Cubic Meters
BEE	Bureau of Energy Efficiency
BL	Baseline
BOVs	Battery Operated Vehicles
BPL	Below Poverty Line
BURM	Bal Urja Rakshak Mission
CADA	Command Area Development Authority
CAGR	Compound Annual Growth Rate
CC	Climate Change
CCA	Climate Change Adaptation
CCHF	Chimean Congo Haemorrhagic Fever
CCRF	Code of Conduct for Responsible Fisheries
CCS HAU	Chaudhary Charan Singh Haryana Agricultural University
CDM	Clean Development Mechanism
CERC	Central Electricity Regulatory Commission
CFA	Central Financial Assistance
CFL	Compact Fluorescent Lamp
CFM	Community Forest Management
CFR	Community Forest Rights
CH ₄	Methane
CHCs	Community Health Centres
CM	Chief Ministers
CNG	Compressed Natural Gas
CO ₂	Carbon Dioxide
CO _{2e}	Carbon dioxide equivalent
COMAP	Comprehensive Mitigation Analysis Process
CPSU	Central Public Sector Undertaking
CR	Conservation Reserves
CSU	Central Surveillance Unit
DBT	Department of Biotechnology
DCRTPP	Deenbandhu Chhotu Ram Thermal Power Plant Project

DDP	Desert Development Programme
DHBVNL	Dakshin Haryana Bijli Vitran Nigam Limited
DHs	District Hospitals
DLF	Delhi Land and Finance Housing and Constrution Private Ltd
DoLR	Department of Land Resources
DOTS	Directly Observed Treatment Short
DRP	Development and Reforms Programme
DSM	Demand Side Management
DSOs	Department of School Education
EC	End of Century
ECAT	Energy Conservation Action Team
ECBC	Energy Conservation Building Code
EE	Energy Efficiency
EIA	Environmental Impact Assessment
ESCO	Energy Service Company
ET	Evapo-transpiration
ETa	Actual Evapotranspiration
ETp	Potential Evapotranspiration
ETrel	Relative Evapotranspiration
FAO	Food And Agriculture Organization
FRUs	First Referral Units
FSI	Forest Survey Of India
GBI	Generation Based Incentives
GCM	Global Circulation Models
GDP	Gross Domestic Product
GENCO	Haryana Power Generation Corporation Limited
GHG	Green House Gas
GIM	Green India Mission
GIS	Geographical Information Syatem
gms	Grams
GoI	Government Of India
GPS	Global Positioning System
GSDP	Gross State Domestic Product
GT Road	Grand Trunk Road
Ha	Hectares
HadAM3	Hadley Centre Coupled Model, version 3
HadCM3	Hadley Centre Coupled Model, version 3
HAREDA	Haryana Department of Renewable Energy
HCFP	Haryana Community Forestry Project
HERC	Haryana Electricity Regulatory Commission
HFD	Haryana Forest Department
HFED	Haryana State Co-operative Supply and Marketing Federation Limited
HID	Haryana Irrigation Department
HIRMI	Haryana Irrigation Research & Management Institute
HIS	Hydrological Information System
HLS	Home Lighting Systems

HP	Himachal Pradesh
HPGCL	Haryana Power Generation Corporation Limited
HPSV	High Pressure Sodium Vapour
HRMS	Hill Resource Management Committee
HSEB	Haryana State Electricity Board
HSIDC	Haryana State Industrial Development Corporation
HSR	Haryana Scheduled of Rates
HUDA	Haryana Urban Development Authority
HVPNL	Haryana Vidyut Prasaran Nigam Limit
IBIS	Integrated Biosphere Simulator
ICAR	Indian Council of Agricultural Research
IDSP	Integrated Disease Surveillance Programme
IEC	Information, Education, and Communication
IGEA	Investment Grade Energy Audit
IGSTPP	Indira Gandhi Super Thermal Power Project
IIMA	Indian Institute of Management, Ahmedabad
IISc	Indian Institute of Science
IIT	Indian Institute of Technology
IITM	Indian Institute Of Tropical Meteorology
IL&FS	Infrastructure Leasing & Financial Services
IMD	Indian Metrological Department
INR	Indian Rupee
INRM	Integrated Natural Resource Management
IPCC	Intergovernmental Panel On Climate Change
IPHS	Indian Public Health Standards
IPP	Independent Power Producer
IREDA	Indian Renewable Energy Development Agency
ISI	Indian Statistical Institute
ISRO	Indian Space Research Organisation
ISO	International Organization for Standardization
IT	Information technology
ITBNs	Insecticide Treated Bed Nets
ITI's	Industrial Training Institutes
IWDP	Integrated Wasteland Development Programme
IWMP	Integrated Watershed Management Programme
IWRM	Integrated Water Resources Management
JE	Japanese encephalitis
JF	January, February
JFMCs	Joint Forest Management Committees
JICA	Japan International Cooperation Agency
JJAS	June, July, August, September
JNNSM	Jawaharlal Nehru National Solar Mission
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
km	Kilometer
km ²	Square Kilometer
KMP	Kundli Manesar Palwal Expressway

KV	Kilo Volts
KVA	Kilo Volt Amperes
KWH	Kilowatt Hour
LBCs	Lateral Boundary Conditions
LED	Light Emitting Diode
LHA	Lakh Hectares
LPD	Liter Per Day
LPSV	Low Pressure Sodium Vapour
LULC	Land Use Land Cover
LULUCF	Land Use, Land Change And Forestry
M&A	Mitigation and Adaptation
m/s	Metre per second
MAM	March, April, May
MAS25	Aerobic rice geno type
MAS26	Aerobic rice geno type
MC	Middle of Century
Mha	Million hectares
mm	Millimetre
MNRE	Ministry of New and Renewable Energy
MNREGA	Mahatma Gandhi National Rural Employment Gurantee Act
MoEF	Ministry Of Environment And Forests
MoU	Memorandum of Understanding
MT	Million metric tonne
MtCO ₂	Metric Tonne Carbon Dioxide
MU	Million Units
MW	Megawatt
MWS	Micro-Watersheds
N ₂ O	Nitrous Oxide
Nabard	National Bank for Agriculture and Rural Development
NAP	National Afforestation Programme
NAPCC	National Action Plan on Climate Change
NATCOM	India's National Communication
NCDs	Non Communicable Diseases
NCR	National Capital Region
NDRI	National Dairy Research Institute
NERIST	North Eastern Regional Institute of Science and Technology
NGO	Non-governmental organization
NHRM	National Rural Health Mission
NITCON	North India Technical Consultancy
NMEEE	National Mission for Enhanced Energy Efficiency
NP	National Parks
NPCDCS	National Program for Prevention and Control of Diabetes, Cancer, Cardiovascular diseases and Stroke
NPHCE	National Programme for Health care for the elderly
NPOP	National Policy on Older Persons
NRDWP	National Rural Drinking Water Programme

NRSA	National Remote Sensing Agency
NSDP	Net State Domestic Product
NSP	New sputum positive
NTFPs	Non Timber Forest Produce
NTPC	National Thermal Power Corporation
NVBDCP	National Vector Control Diseases Programme
NVVN	NTPC Vidyut Vyapar Nigam Ltd.
NWM	National Water Mission
NWP	National Water Policy
O&M	Operation And Maintenance
OHSAS	Occupational Health and Safety Advisory Services
OND	October, November, December
OPD	Out Patient Department
PDS	Power Distribution System
pH	Measure of the Acidity
PHCs	Primary Health Centres
PMGSY	Pradhan Mantri Gram Sadak Yojana
PMGY	PRADHAN MANTRI GRAMODAYA YOJANA
PPA	Power Purchase Agreements
PPE	Perturbed Physics Ensemble
PPP	Public Private Partnership
PPRs	Preliminary Project Reports
PRECIS	Providing Regional Climates For Impact Studies
PSPT	Panipat Thermal Power Station
PWD	Public Works Development
QTL	Quantitative Trait Loci
QUMP	Quantifying Uncertainty in Model Predictions
R&D	Research and Development
R&M	Renovation & Modernisation
RCH	Reproductive and Child Health
RCM	Regional Climate Models
RDW	Rural Works Department
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RGTPP	Rajiv Gandhi Thermal Power Project
RH	Relative humidity
RIDF	Rural Infrastructure Development Fund
RILs	Recombinant inbred lines
RNTCP	Revised Tuberculosis Control Programme
RP	Rinderpest
RPO	Renewable Purchase Obligation
SAPCC	State level strategy and Action plan
SC	Schedule Caste
SD	Sustainable Development
SDA	State Development Agency
SDHs	Sub-Divisional Hospitals
SECF	State Energy Conservation Fund

SEZs	Special Economic Zones
SFDA	State Forest Development Agency
SFRI	State Forest Research Institute
SKS	Swastya Kalyan Samitis
SLNA	State Level Nodal Agency
SLS	Street Lighting Systems
SME	Small and Medium Enterprises
SMS	Sakshar Mahila Samooh
SPV	Solar Photovolataic Programme
sq	Square
SRES	Special Report On Emission Scenarios
SRS	Sample Registration System
SRTM	Shuttle Radar Topography Mission
SSR	Simple Sequence Repeat markers
STC	State Level Technical Committee
SWAT	Soil and Water Assessment Tool
SWHS	Solar Water Heating System
SWPs	State Water Policies
TB	Pulmonary tuberculosis
TCP	Town and Country Planning
TERI	The Energy and Resources Institute
THI	Temperature Humidity Index
TRANSCO	Haryana Vidyut Prasaran Nigam Limited
UCs	Utilisation Certificates
UHBVNL	Uttar Haryana Bijli Vitran Nigam Limited
UNCRPD	UN Convention on the Rights of Persons with Disabilities
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UP	Uttar Pradesh
UPSDA	Uttar Pradesh State Designated Agency
USA	United States of America
USAID	United States Agency for International Development
VFC	Village level forest committees
VHSc	Village Health & Sanitation Committees
VLC	Village Level Committee
WBG	Wet Bulb Global Temperature
WCD	Women and Child Development
WHO	World Health Organization
WHRB	Waste Heat Recovery Boiler
WLS	Wild Life Sanctuaries
WMO	World Meteorological Organization
WRC	Wetland Rice Cultivation
WTEA	Walk through Energy Audit
WYC	Western Yamuna Canal

Executive Summary

India's National Action Plan on Climate Change (NAPCC) released in 2008 outlines its strategy to meet the challenge of climate change. After the NAPCC was announced all States have been asked to prepare a state level action plan to deal with challenges of climate change. The state level action plans are envisaged to be an extension of the NAPCC at various levels of governance aligned with the 8 National Missions.

Based on the discussions, inputs provided by the various state departments, the Draft State Action Plan for Climate Change for Haryana is prepared.

The State of Haryana is situated in the northern part of India and is bounded by Punjab and Himachal Pradesh to the north, and by Rajasthan to the west and south. The river Yamuna defines its eastern border with Uttarakhand and Uttar Pradesh. Haryana also surrounds Delhi on three sides, forming the northern, western and southern borders of Delhi. Haryana is a landlocked state in northern India with total geographical area of the state is 44,212 km², which is 1.4 % of the geographical area of the country.

State Profile

Haryana is administratively divided into 21 districts, 47 sub-divisions, 67 tehsils, 45 sub-tehsils and 116 blocks. Haryana has a total of 81 cities and towns and 6,759 villages. Haryana is the nation's seventeenth most populous state and the population of Haryana, is 25,353,081, according to the 2011 census. The population density is 573.4 people/km². Haryana has a skewed sex ratio at 861.

There are two agro climatic zones in the state. The north western part is suitable for Rice, Wheat, Vegetable and temperate fruits and the south western part is suitable for high quality agricultural produce, tropical fruits, exotic vegetables and herbal and medicinal plants.

Agriculture and related industries have been the backbone of the local economy. Haryana is an industrial state and has emerged as a base for the knowledge industry including IT and biotechnology. It is also a leading agricultural state of the country. Animal husbandry has been taken up as an integral component of diversified agriculture.

There are no perennial rivers in Haryana, Ghaggar is the only seasonal river, which flows through the northern fringes of the state. The availability of water vis-à-vis demand is less, which has created an imbalance and sometimes leads to conflict. In view of the scarce availability of surface irrigation water, development of canal network assumed vital importance for the State.

Major land use in Haryana is agriculture (85%), Forest (2.4 %), about 7.2 % fallow and 5% waste land. The state has about 33000 ha under protected area network, which consists of 2 national parks, 8 wildlife sanctuaries and 2 conservation reserves. Over 500 bird species have been recorded in the State, which is almost 40 percent of total bird species in the country.

Haryana is self-sufficient in food production and the second largest contributor to India's central pool of food grains. The main crops of Haryana are Wheat, Rice, Sugarcane, Cotton, Oilseeds, Gram, Barley, Pearl Millet, Green Gram etc. There are two main types of crops in Haryana: Rabi and Kharif.

Agriculture contributes 17% of the state's GDP and employs 65% of the total workforce. The net sown area is 85% of the total geographic area as compared to the national average of 46%, the gross cropped area is 65 lakh Ha with a cropping intensity of 180%.

Out of a total geographical area of 4.421 Mha of Haryana State 3.819 Mha is culturable, of which 2.93 Mha is covered under canal systems. The length of main canals in the state is 2264 km and length of Distributaries and Minors is 9955 km.

SAPCC Preparation Process

Department of Environment acted as the State Nodal Agency for the preparation of SAPCC. State Steering Committee (SSC) under the chairmanship of Chief Secretary was constituted. Other members in the SSC included Financial Commissioners, Principal Secretaries, of the various line departments, research institutions, NGOs and academia. Thereafter, the line departments dealing with the sectors sensitive to climate change constituted the seven sectoral Working Groups (WGs) with one person designated as the Nodal Officer (NO) of the sector.

The working group was represented by members from different relevant sectors/departments who contributed to the sectoral action plans prepared by the working group. These working groups were chaired by Chairman/ Secretary of the respective sector with a designated nodal officer. In addition to the experts from the concerned department/ministry, the working groups had participation of experts from the Science and Technology, academia, research, NGOs and Civil Societies including experts from Deenbandhu Chhotu Ram University. The working groups were sensitised with the climate change issues in Haryana. Orientation for approach and methodology to be followed in the preparation of SAPCC was conducted in early September 2011. One-day Inception Workshop was held on October 13th, 2011 at Chandigarh which was well represented by line department heads, officers, experts from academia, research, NGOs and civil society representatives. Deliberation and discussions made were used as the guiding principle in formulating the action plan for various sectors. Extensive consultations within the working group members and other concerned stake holders were carried out. Actions, budget and period of implementation of the proposed actions across the sectors based on the above deliberations were drafted in to action plans. Draft report was further circulated to the stakeholders for comments. The draft report was updated with the comments duly received.

Observed Climate Trends and Projected Climate Change

Current Climate: The long term analysis for trends in observed temperature over Haryana using IMD gridded temperature at daily time scales show that there is no significant trend in the mean maximum temperature and minimum temperature shows an increase of about 1.0°C to 1.2°C. Similarly trends in observed seasonal precipitation is negligible in many parts of Haryana, parts of Bhiwani, Faridabad, Fatehabad, Gurgaon, Jhajjar, Jind, Karnal, Kurukshetra, Mahendragarh, Rohtak, Sirsa, Sonapat show decreasing trend in the monsoon rainfall.

Climate projection: The projected climate change in 2050's and in 2080's over Haryana using IPCC SRES A1B scenario¹ (PRECIS² regional climate model output) have been studied. Mean maximum

¹ A1B IPCC SRES socio-economic scenario (characterized by a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies, with the development balanced across energy sources)

temperature is projected increase by 1.3°C and mean minimum temperature by 2.1°C towards mid century. The increase in mean maximum temperature is projected to be 4.2°C and mean minimum temperature 4.7°C towards end century respectively. Mean annual rainfall is projected to decrease marginally by about 63 mm (3%) by mid century and increase by about 347 mm (17%) by end century. Monsoon months, JJAS show marginal to 14% increase in mid and end century scenarios respectively.

State GHG Emission

Haryana emits nearly 2% of national greenhouse gases (GHG). Fossil fuel consumption, power generation and agricultural activities being major factors responsible behind this. Haryana represents about 3% of national fossil fuel consumption and 2% of national electricity consumption. Power generation in the state covers about 47% of the state CO₂ emissions and 2% of national power related CO₂ emissions. Agriculture sector contributes about 82% and 91% of CH₄ and N₂O emissions of the state. Majority of CH₄ emissions occur from enteric fermentation of livestock (62%) followed by rice cultivation (14%) and biomass burning (6%). While majority of N₂O emissions occur from application of synthetic nitrogenous fertilizer (62%) followed by indirect N₂O emissions (20%) and nitrogen from crop residue left (5%). Municipal solid waste and domestic waste water treatment contribute about 3% and 2% to CH₄ and N₂O emissions of the state respectively.

Climate Change Impact

IIT Delhi and IISc Bangalore had made assessment of the impact of projected climate change on water and forests.

Impact on Water resources: For the Yamuna and Indus basins lying within Haryana, analysis projects an increase in annual precipitation of about 9% (72 mm) by mid century, this results in 46% (33 mm) increase in runoff to the stream flow and 7% (5 mm) increase in baseflow, negligible decrease to the ground water recharge is projected. Evapotranspiration is projected to increase by 39% (28 mm). Increase in annual precipitation of about 23% (186 mm) by end century is projected, resulting in increase in runoff by 58% (108 mm) and about 6% (11 mm) returns to stream as baseflow. Evapotranspiration is projected to increase by 25% (46 mm). Negligible changes in ground water recharge is projected. These projections are derived from SWAT distributed hydrologic modelling.

Impact on Forest: The dynamic vegetation model outputs show that during the short-term period of 2030s, out of the 14 forested grids in Haryana, 4 (28.57%) will be impacted by climate change. The number of currently forested grids projected to be impacted by climate change remain the same towards 2080s. It is also assessed that any afforestation programme undertaken in future, in the districts of Karnal, Panipat, Jind, Bhiwari, Sonapat, Gurgaon, etc., could be vulnerable to future climate impacts.

Impact on Agriculture: Likely Impacts of Climate Change on Agriculture projects that with short periods of exposure of wheat crops to temperatures of 28 °C to 32°C result in significant decrease in yield by 20% or more. Unpredictable moisture deficits during crop growth are a major constraint to

² PRECIS (Providing Regional Climate for Impact Studies) is the Hadley Centre portable regional climate model, developed to run on a PC with a grid resolution of 0.44° x 0.44°. PRECIS simulation datasets is provided by the Indian Institute of Tropical Meteorology, Pune

productivity, Sclerotinia stem rot may become a serious threat to the successful cultivation of Indian mustard.

Impact on Livestock: The environmental conditions that induce heat stress on dairy animals may exacerbate and may lead to decline in milk productivity and may impair reproductive functions and efficiency of livestock species.

Impact on Health: Extreme air temperature leading to heat waves are a direct contributor to deaths from cardiovascular and air pollution to respiratory disease, particularly among elderly people, major infectious diseases transmitted by water may increase in future.

Present Policies & Programs and Linkages with NAPCC

The Government of Haryana Haryana had made a number of policies or is in the process of enacting. The state has initiated several programs towards addressing adaptation and mitigation options as linkages with the NAPCC.

The State has formulated its draft state water policy to address major issues relating to the water sector, joining a few state in India which have come out with such policies. Scheme for enhancing productivity of degraded lands in the catchment of Flood Prone River, Scheme for Reclamation of Alkali Soils (USAR) and National Agricultural Insurance Scheme are undertaken. Integrated Wasteland Development Programme governed by the common guidelines issued by the Ministry of Rural Development, Government of India for Watersheds has been implemented by Department of Rural Development.

In order to increase the forest and tree cover, the Haryana Forest Department (HFD) has undertaken a massive afforestation programme on Government lands, Institutional Lands, Panchayat lands, Common lands and wastelands. The Haryana Government has adopted a State Forest Policy-2006.

Under Jawaharlal Nehru National Solar Mission, the first phase for solar power generation for grid-based centralized application has been initiated. Haryana was the first State in the country to issue a comprehensive notification dated 29.07.2005 on Energy Conservation Measures. Energy Conservation activities under the Energy Conservation Programme were started in Haryana in 2007-08 with the launch of 5 years State Energy Conservation Action Plan by the Hon'ble Chief Minister, Haryana. The action plan envisaged energy saving potential of about 500 MW in the state through various energy conservation and efficiency measures.

A statewide urban infrastructure development programme called Rajiv Gandhi Urban Development Mission, Haryana was launched in 2010 to provide affordable housing for the urban poor, water supply, sewerage, integrated solid waste management and other civic amenities. The Government had already earmarked Rs.2, 500 crore for implementation of the programme over the next five years.

To reduce the traffic Congestion, noise pollution, air pollution the department metro proposed to extend the Delhi Metro to Sikanderpur but DLF wanted to expand it to provide connectivity to its Cyber City.

Through The National Rural Health Mission in state of Haryana is building up a pool of female health activist in each village. The state is in the process of mapping of all the Districts to identify the

Blocks/PHC/Sub Centers where likelihood of the malaria disease is moderate (API > 5) or severe (API > 10). The integrated Surveillance Project was launched in the state of Haryana in Nov. 2004 to establish decentralized State based system of surveillance for communicable and non-communicable diseases.

Strategies to address concerns of climate change

To synergize sustainable development and adaptation to climate change a list of programs and policies as perceived by the State have been identified by state sectoral departments.

Forestry: Under the State Action Plan, both adaptation and mitigation projects could be proposed for addressing climate change impacts on forest ecosystems as well as to mitigate the climate change through enhancing the carbon sinks. Forests in Haryana are vulnerable to climate change risks and any afforestation/reforestation programme to be implemented under the Greening India Mission (GIM) could also be vulnerable to climate change impacts. Thus there is a need to incorporate adaptation measures. There are no scientific studies to recommend specific adaptation measures suitable for different vulnerable forest types and regions. Potential projects under the adaptation programme could be adoption of short rotation species, sustainable harvesting of timber and non-timber products, promoting agro-forestry and Social Forestry (increasing biomass and creating carbon sink) with multiple species and incorporation of anticipatory planting of species.

A preliminary list of climate change vulnerability reduction interventions and project ideas, based on the Greening India Mission has been identified. There is a need for conducting preliminary studies to identify locations for implementing the vulnerability reduction measures. The exact area for implementing the vulnerability reduction interventions is not readily available but a preliminary estimate of the investment required is provided. Four projects are proposed under the vulnerability reduction interventions under sub-mission 1 and 4 of GIM with a combined proposed investment of about 6060 crore rupees.

Carbon sink enhancement potential of proposed activities is estimated using COMAP model and based on carbon sequestration rates used in the Greening India Mission. The annual incremental carbon sink enhancement potential is estimated to be about 49.34 million tonnes of CO₂ by 2020.

Agriculture: Department of Agriculture and Department of Animal Husbandry and fisheries have jointly proposed the vulnerability reduction measures. Some of the research area proposed include: Molecular breeding for heat stress tolerance during grain filling period in wheat, development of water efficient aerobic rice, improving abiotic (drought and salinity) stress tolerance in Indian mustard, Molecular Breeding of chickpea for drought prone environments and enhancing soil health. Extension work and advisory for fruits and vegetables in horticulture, strengthening of pest monitoring system are proposed. Under livestock, strengthening extension to provide advisory on Adaptation practices by capacity building of farmers, Dairy, feed and fodder development, preventive health measures, strengthening disease investigation system and risk management are proposed. Under fisheries, Improving fisheries management, reducing post harvest losses, increasing waste recycling, maximizing yield and quality and reducing spoilage are suggested.

These proposals under vulnerability reduction spread over 3-5 years with a proposed investment of 111.5 crore rRupees.

Energy: The Climate Change Action Plan for the Twelfth Five Year Plan that currently focuses on two missions: Solar Mission and Enhanced Energy Efficiency Mission from energy savings perspective. The proposals of HAREDA has a total cost implication is about 45326 crore rupees.

Water Resources: Haryana Irrigation Department has suggested comprehensive water database modeling and analysis of the data for climate change impacts on water resources with a proposed investment of 33.5 crore rupees and for development of real time water quality monitoring system another investment of ` 10 crore rupees has been proposed. In addition to this an investment of 3 crore rupees have been proposed for setting up of water regulatory authority in the state. In order to mitigate impacts of possible climate change on water resources, an investment of 3500 crore rupees has been proposed for rehabilitation of irrigation infrastructure and flood control measures for efficient management of water resources in the state. Capacity building, groundwater management, rainwater harvesting, water logging and salinity control, construction of dams in upper catchments, crop diversification, use of water saving technologies, R and D etc. have also been proposed for which cost estimate is yet to be done. These activities are for 3 to 4 years and ongoing duration. Total proposed investment is to the tune of Rs. 4497 crore.

Integrated Watershed Management Programme (IWMP): Haryana Rural Development department has plans to implement IWMP for 1521 micro-watersheds in 15 years with 311 to be taken in next 5 years at a cost implication of 222.42 crore rupees (Central share of 199.28 and State share of 23.14 crore rupees respectively).

Health: Some of the action plans and projects for a sustainable development and adaptation to Climate Change as perceived by the Department of Health and family Welfare at a cost of 108.5 crore rupees have been proposed.

Capacity building: It is felt that 1% of the total funding for the State need to be provided for Capacity building.

Total proposed cost implication for climate change vulnerability reduction and Carbon sink enhancement projects under different sectoral departments is estimated at Rs. 56,565 crore (566 billion rupees) including 1% capacity building cost and excluding IWMP.

Source of financing can have multiple approaches from creating corpus of fund for climate change, urging Banks, Government Departments to seek funding from national Climate change Missions and international mechanisms on climate change.

Strategies and Proposed Investment

Proposed activities and the investment required are given the table at the end of executive summary.

Institutional arrangements

Constitution of Climate Change Authority in State may be considered aiming, at coordination among various departments. The Authority will act as a facilitator to provide a framework for integration, planning, monitoring and assessment. While the overall programme implementation will be facilitated, supervised and monitored by the, designated department. Village Committees and Eco-development Committees will have a greater role in implementation of works at field level with involvement of NGOs and other village level thematic groups like Self Help Groups under linkage

with Gram Panchayats. Line departments have identified the activities to be carried out by them with assistance from their strategic partner departments like State Remote Sensing Department, Science and Technology, Krishi Vigyan Kendra.

Monitoring and Evaluation

Monitoring and evaluation (M&E) framework is to measure and assess performance of the identified key strategies. It is proposed to select Research Institutions and universities and train on methods and approaches on monitoring mitigation and adaptation projections. Line departments have their inbuilt monitoring mechanism which may take care of monitoring and evaluation once trained.

Proposed activities and the investment required

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
Forest Sector							
Sub Mission 1: Enhancing quality of forest cover and improving ecosystem services	Moderately dense forest cover, but showing degradation	80	Short (2020) to Long (2030)		20000	40000	
	Eco- restoration of degraded open forests	650			100000	65000	
	Restoration of grasslands	80			20000	40000	
Sub-mission 3: Enhancing tree cover in Urban and Peri-urban areas	Avenue, city forests, municipal parks, gardens, households, institutional lands, etc.	50			10000	50000	
Sub Mission 4: Agro-forestry and Social Forestry (increasing biomass & creating carbon sink)	Agroforestry	5000			1000000	50000	
	Community and Panchayat land are under tree cover	100			100000	10000	
	Corridor	100			10000	100000	
Total Forest		6060			1260000	355000	
Water Sector							
Comprehensive water database and assessment of climate change on water resources	Development of Hydrological Information System on Real time	18.5	3-4 years & ongoing	Haryana Irrigation Department			Modernization of existing water data collection & management system
	Modelling & analysis of the data for climate change impacts on water resources	15	4-5 years & ongoing	Haryana Irrigation Department			Procurement & development of appropriate modelling tools for all aspects of water resources management
	Development of modern real time water quality monitoring system	10	3-4 years & ongoing	Env't. Deptt., HSPCB & Haryana Irrigation Department			Better water quality monitoring & effective

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
							measures to combat pollution of water resources
Efficient management of water resources	Better management practices	0.5	1-2 years and ongoing	Haryana Irrigation Department			Comprehensive review of the existing management practices
	Establish State Water Tariff Authority	3	1 year and ongoing	Haryana Irrigation Department			Reassessment of water tariff, water allowance & allocation priorities
	Promote Participatory Irrigation Management		2-3 years & ongoing	Haryana Irrigation Department & CADA			Plan & execute an extensive PIM programme
	Rehabilitation, Remodelling of irrigation infrastructure	1000	2 years and ongoing	Haryana Irrigation Department			Conservation of water by checking leakages, seepages, etc.
	Flood Control Works and Rehabilitation of flood protection works.	2500	2 years and ongoing	Haryana Irrigation Department			Conservation of water by checking leakages, seepages.
Groundwater management	Groundwater legislation		1 year & ongoing	Agriculture Department			Better groundwater management
Rainwater harvesting & judicious recharging of groundwater	Expedition implementation of programme for conservation of water through recharge of ground water including rainwater harvesting and artificial recharge		Ongoing	HID, AD, HUDA, TCP, etc.			Arrest groundwater depletion & conservation of water

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	in areas/situations sensitive to climate change						
Waterlogging & salinity control	Set up a Task Force to suggest effective measures to combat Waterlogging & soil salinity		1 year	HID and AD			Implementation Plan for checking Waterlogging & Soil salinity
	Measures to control Waterlogging & soil salinity		2-3 years & ongoing	HID and AD			Action as per the implementation plan
Construction of dams in catchments of rivers	Take up the issue of construction of dams in the catchments of rivers		5-10 year & ongoing	HID			
Crop diversification	Set up a Task Force to suggest Crop Diversification Plan		1 year & onwards	AD and HID			
Promote water saving technologies	Sprinkler Irrigation System	300	2-5 years	Agriculture Department			Provide subsidy to farmers for installing sprinkler sets to cover 4 lac hectares area.
	Drip Irrigation System	400	2-5 years	Agriculture Department			Provide assistance to farmers to set up drip irrigation system to cover 40000 hectares area.
	Underground Pipeline System	250	2-5 years	Agriculture Department			Laying of underground pipeline system in 2.00 lac hectare area for efficiency in water conveyance and

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
							bringing more area under irrigation.
Legislation, Policies & Guidelines to handle climate change impact	Frame policies, law for climate change situation on water sector		2-3 years	HID, CADA, AD			
Research & development by partnering with academic institutions	Set up R&D cell in HID for research in water sector & climate change		1 year & onwards	HID			
Capacity building	Implementation Plan for Extensive Capacity Building & Training		1 year & ongoing	HID and HIRMI			
Total Water Sector		4497					
Energy Sector							
Solar Mission (and other renewable sources of energy)							
Generation of power from solar energy	To invite and pre-register the solar power project under Jawaharlal Nehru National Solar Mission	179	2012-2017	HAREDA			
	Signing of power purchase agreement for sale of power to the utilities.						
	Execution of the projects and synchronization with grid						
Biomass cogeneration Power Projects	Awareness among the industries specifically rice sellers to adopt this technology	180	2012-2017				
	Preparation of feasibility-cum-detailed project report and approval of Ministry of New & Renewable Energy for sanction of CFA						
	Execution of the project						
Biomass Power Plants	Awareness among the industries/developers to set up biomass power projects in the State.	860	2012-2017				

Programme/Mission	Action Plan	Prposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	Preparation of feasibility-cum-detailed project report and approval of State Govt.						
	Approval of Detailed Project Report						
	Signing of Power Purchase Agreement with the State Utilities						
	Execution of the project						
Off grid roof top and other applications	CFL based Home Lighting Systems	51.9	2012-2017				
	SPV Street Lighting Systems						
	SPV Power Plant of 10 KW each						
	Solar Pumps 5.00 KW						
	Solar power packs (1 KW to 100 KW)						
Other Programmes	Energy Efficiency Mission	25	2012-2017				
	Solar Water Heating Projects		Ongoing				
	Energy Service Company (ESCO) Projects		Ongoing				
	Mandatory Use of Compact Fluorescent Lamp (CFL) in Government Buildings/Government Aided Institutions/Boards/Corporations		Ongoing				
	Scheme on Energy Audit for Industries, commercial buildings, govt. buildings and institutions		Ongoing				
	Enhance EE municipal water pumping	50					
	Improvement of Demand Side EE appliances in residential and commercial sectors	100	Proposed				
	Scheme on energy conservation in agriculture sector						

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
To conserve Electrical Energy in the Agriculture sector.	All the farmers of Haryana who are taking new tubewells connection or opting higher capacity pump sets will be encouraged to install at least 4 star rated (BEE Star rating) pump sets and will be eligible for the state subsidy. Farmers having old non ISI motors and want to replace these with Latest 4 star rated motors will also be eligible under this scheme.		Ongoing	Agriculture Sector			
To encourage and educate the formers to adopt the energy efficient pump sets in their tubewells.							
To manage electrical energy demand in Agriculture sector.							
Scheme on energy conservation in agriculture sector	Replacement of ALL/remaining inefficient pump sets with 4/5 star rated (BEE star rating) and the installment of new pump sets in order to double the agricultural production	15000	Proposed				
To conserve Electrical Energy in the Agriculture sector.							
To encourage and educate the formers to adopt the energy efficient pump sets in their tubewells.							
To manage electrical energy demand in Agriculture sector.							
Demand Side Management Application	Reducing inductive losses on load side appliances to be done in phases	500	Proposed				
	Meter Installation for pump sets - to be done in phases	1000	Proposed				
	Rural 3-phase feeder separation - to be done in phases	20000	Proposed				
	Reducing aggregate technical and commercial losses (AT&C)	2500	Proposed				
	More mechanization to increase energy efficiency of agriculture, including off-road vehicles (e.g. tractors, machines etc) - to be	2000	Proposed				

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	done in phases						
	Solar pump sets	200	Proposed				
	Biomass based power generation (using rice straw)	160	Proposed				
	Reducing farmers' vulnerability to climate change stresses through introduction of specific crop insurance schemes and packages	250	Proposed				
	Drip irrigation systems for increasing water-energy efficiency of irrigation systems		Proposed/Water Resources				
Food Processing Industry	Providing necessary infrastructure (eg Cold storages, Godowns)	250	Proposed				
	Requirement of energy-efficient storage for agricultural products						
	Biomass and solar based cold storages (absorption chiller technology)	50	Proposed				
Designing power utilities for 'Zero effluent discharge'	DCRTPP Yamuna Nagar		Done	Haryana Power Generation Company Limited (HPGCL)			
Designing power utilities for 'Zero effluent discharge'	Required at all power plants	150	Proposed				
• Renovation, Modernization and Capacity Addition	• R&M at Panipat Thermal Power Station (PTPS)		Ongoing/Done				
• ISO Certification for HPGCL Power Plants	• ISO Certification for (DCRTPP, Yamunanagar & PTPS, Panipat)						
• Energy Efficient Buildings	• Energy Efficient Buildings (DCRTPP, Yamunanagar, PTPS, Panipat & corporate office at Panchkula)						
• Energy Savings by Reducing Consumption	• Energy Savings by Reducing Consumption (DCRTPP, Yamunanagar & PTPS,						

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	Panipat)						
• Energy Audit Tests	• Energy Audit Tests (DCRTPP, Yamunanagar & PTPS, Panipat)						
• Renovation, Modernization and Capacity Addition	• R&M at the remaining thermal power stations	100	Proposed				
• ISO Certification for HPGCL Power Plants	• ISO Certification for FTPS, RGTPS						
• Energy Efficient Buildings	• Energy Efficient Buildings (FTPS, RGTPS, IGSTPP)						
• Energy Savings by Reducing Consumption	• Energy Savings by Reducing Consumption (FTPS)						
• Energy Audit Tests	• Energy Audit Tests (FTPS, RGTPS)						
Technical modifications (for ex.: in air & fuel cycle; steam, feed water and condensate cycle; fuel & ash cycle; electrical & lighting system etc.) for energy efficient and cleaner technologies		10	Proposed				
Enhancing renewable power capacity and generation (including solar PV, wind, biomass, hydro)		100	Proposed				
Reducing Aggregate Technical & Commercial Losses (AT&C)	Stations should be automated to improve quality and reduce energy losses	200	Proposed	Haryana Vidyut Prasaran Nigam Limited (HVPNL) (UHBVNL and DHBVNL)			
Encourage use of Energy-Star Labeled Appliances and BEE Star Labeling		25	Ongoing				
Smart grid applications Research, Development & Demonstration		25	Proposed				
Energy conservation campaign	Bachat lamp Yojna		Ongoing				
Urban Planning	Integrate Climate Risk and Disaster Management Preparedness in urban plans	100	Proposed	Town and Country Planning and Urban Local Bodies			
	Promote sustainable cities	10	Proposed				

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	programme - in phases						
	Promoting green buildings	250	Proposed				
	Improving urban infrastructure through rain water harvesting and reuse of waste water	100	Proposed				
	Improve land-use planning	25	Proposed				
	Improve drainage, sewerage and sewage treatment in all ULBs	150	Proposed				
Urban Transport	Promote and plan Public Transport System and parking infrastructure in large ULBs	40	Proposed				
	Increasing efficiency of city buses, including phasing out old stock with new and efficient stocks	60	Proposed				
	Adequate infrastructure facilities for pedestrians, cyclists and non-motorists transport	10	Proposed				
	Metro rail in over 5 lakh population cities as well	100	Proposed				
	BRTS in more cities	50	Proposed				
	Hybrid and electric vehicle proportion projects	10	Proposed				
Waste Management	Capacity Building for Waste (Municipal solid waste, domestic sewage, waste water) to Energy. Also waste to compost to be used as fertilizer.	60	Proposed				
Bharat Nirman	Integrate Climate Risk and Disaster Management Preparedness in flagship programmes (Rural Housing, Rural Roads)	50	Proposed	Public Works Dept. (B&R)			
Urban Planning	Improvement and widening of	300	Proposed				

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	congested roads						
Research and Development	Identify, study and disseminate latest EE technologies required to increase agricultural production	15	Proposed	Dept. of Science and Technology			
	Identify, study and disseminate latest EE technologies in commercial and industrial sectors	10	Proposed				
	Research to study adverse impacts of climate change on various sectors and locations in Haryana state	20	Proposed				
Total Energy Sector		45325.9					
Health Sector							
Addressing enhanced diseases burden With reference to Climate Change	An assessment needs to be carried out to understand the extent of disease burden that may occur due to climate change and population projections,	4					Funding to continue from present source
	Identification of vulnerable areas for each disease, and						
	Identification of vulnerable communities along with identification of windows of opportunity of new diseases that might occur due to change in climate determinants,						
	An assessment of number of additional health centres and health personnel required.		5				
	IDSP to continue to monitor disease prevalence and outbreak		10				
	IDSP to include private, public as well as all village level health care centres for surveillance		10				Funding to continue from present source

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	Putting in place additional health care centres and medical personnel		10				Funding to continue from present source
Reduction targets for Vector Borne diseases	Reduction in Malaria incidence by at least 50%.						To be funded from current NVBDCP
	To bring API below 1 in all the Districts of the State.						
	Enhanced use of ITBNs (especially in High Risk Areas) by 50% among Below Poverty Line (BPL) Population.						
	Enhanced use of larvivorous fish in 75% villages of high-risk areas 50% villages of all areas.						
	50% reduction in use of Indoor Residual Spraying by spraying only high-risk areas.						
	Entomological study on prevalence and vector densities for Malaria, JE, Dengue, CCHF (Chimean-Congo Haemorrhagic Fever) in the state.	1.25					@ Rs.0.05 Cr per districts and Rs.0.2 Cr for State Hq. Includes also training cost, monitoring, field work and lab. Test etc.
Control of TB	Under RNTCP the aim is in terms of Universal Access is 100% case detection. At present in Haryana is 57% total TB Cases and 56% NSP cases in the year 2010		5				To be funded from the RNTCP
	Expansion of DOTS Plus services						
	Extend services in private hospitals with OPD patient intake		5				To be funded from the RNTCP

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	of 100-150 per hospital						
To control NCD	To control NCDs main emphasis will be given on IEC activities to reach out target communities, continuous monitoring and independent evaluation of the program and research, Promotion of public private partnerships, Mainstreaming AYUSH – revitalizing local health traditions		10				To be funded from NPCDCS and NRHM
Ecological study on air pollutants- from industry, transport and domestic cooking, pollen and molds (as triggers of Asthma and Resp. diseases) and how they are affected by CC	Pilot study is proposed for all districts Hospitals, *To screen and study patients suffering from Bronchial Asthma and other Resp. Diseases	2.1	5				@ 0.1 Cr rupees per district *Required Med. Specialist and Chest Specialist are available.
Enhanced provision of Primary, Secondary and Tertiary health care facilities and implementation of public health measures, including vector control, sanitation and clean drinking water supply	i) Primary level:- Awareness and sensitization to all sectors on Climate change ii) Secondary level:- Early diagnosis and treatment i.e. Testing kits and drugs. Iii) Tertiary level:- Testing kits and treatment with drugs	2.5					Primary level: Rs.0.05 cr per districts and Rs.1.8 Cr for State Hq Secondary and tertiary level each: Rs.1 Cr @ of Rs.0.05 Cr per districts and Rs.2 Cr for State Hq.
Providing high resolution weather and climate data to study the regional pattern of diseases.	Through IDSP (Integrated Disease Surveillance Project) which is a project by GOI on Disease Surveillance and is engaged in Outbreak/ Epidemic forecasting and investigation/management.						Fund will be needed for engaging Remote Sensing department for high resolution data transfer.

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
Development of a high resolution health impact model at the state level	Assistance of department. Of Science and Technology, Remote Sensing section will be taken for real time high resolution weather and climate data.	1					
GIS mapping of access routes to health facilities	Both State Remote Sensing Health departments, under NVBDCP will be utilized for GIS mapping.						
Development of a disaster Risk reduction plan	In association with the National Disaster Management Authority develop plans for risk reduction of diseases escalation and outbreaks due to climate change						
Climate change coordination committee	A committee needs to be formulated with members from all disease control programmes who will ensure integration of climate change concerns in planning and implementing diseases control measures for existing and new and emerging diseases						
Total Health Sector		10.85					
Agriculture, Livestock and Fisheries							
Agriculture	Reserach in:, Creation of assured irrigation in settled cultivation areas, Promotion of scientific planning and cropping pattern to improve the yield per hectare, Integrated efforts for enhanced productivity , Integrated crop management, Continuation of the traditional organic farming to meet market demands for organic products, Efforts for improving the rice production rate , Ecologically	100	3 to 5 years				

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	sustainable and economically viable diversification of agriculture, Major emphasis on growing off season vegetables and fruits	11.5					
Horticulture	Extension work and advisory for fruits and vegetables , pest and diseases and weed management						
Livestock	Enhancement of livestock production by introduction of CC adaptive measures, dairy development, Feed and fodder development, Preventive health measures, Strengthen disease investigation system and risk management						
Fisheries	Better feeds, selective breeding and genetic improvement; Improve efficacy of water usage; encourage non-consumptive water use in aquaculture, e.g. culture based fisheries; Encourage uptake of individual/cluster insurance; improve siting and design to minimize damage, loss and mass escapes; Encourage use of indigenous species to minimize impacts on biodiversity use non-reproducing stock in farming systems;						
Centre on Climate Change Research in Agriculture	Automatic Weather station with GPRS facility, Open Top Climate & Growth Chamber , Digital Meteorological data dissemination system, Hyper spectral radiometer, Computers						

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	(Desktop and laptop) with software and accessories; along with global and regional climate models-software and Recurring (staff)						
Total Agriculture/Horticulture/Livestock/Fisheries		111.5					
Total (Rs. Crore)		56005.25					
Strategic Knowledge (Capacity Building (@1%))		560.05					
Grand Total (Rs. Crore)		56565.00					

Sector wise Proposed activities and the investment required

Sector/Mission	Sector	Proposed* investment (in Rs crore)	Duration	Carbon sink enhancement potential
Forest (Greening India Mission)	Forest	6060.0	Short (2020) to Long (2030)	6.32 million tonnes of CO2 by 2020
Agriculture (Sustainable Agriculture Mission)	Agriculture	111.5	Short (5 years)	
	Live-stocks			
	Horticulture			
Energy (Enhanced Energy Efficiency Mission Jawaharlal Nehru National Solar Mission)	Energy	45325.9	Short (5 years) to Long (10 years)	
Water (National Water Mission)	Water Resources	4497.0	Short (5 years)	
Rural Development	IWMP	2224.20	13th and 14th plan	
Health Sector		108.5	Short (10 years)	
Total		56005.25		
Strategic Knowledge (Capacity Building (@1%))		560.05		
Grand Total		56565.00		
		Rs. 566.0 billion		

Chapter 1

Introduction

Chapter 1 - Introduction

Background

India's National Action Plan on Climate Change (NAPCC) released in 2008³ outlines its strategy to meet the challenge of Climate Change. NAPCC is guided by the principles of sustainable development (SD) and aligns the environmental and economic objectives. It outlines a national strategy that aims to enable the country adapt to climate change and enhances the ecological sustainability of India's development path. It stresses that maintaining a high growth rate is essential for increasing living standards of the vast majority of people of India and reducing their vulnerability of the impacts of climate change. There are eight "National Missions" which form the core of the National action plan. They focus on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.

As a second step, after the National Action Plan on Climate Change (NAPCC) was announced, all States have been asked to prepare a State level action plan to deal with the challenges of climate change. Broadly the State level action plans are envisioned to be an extension of the NAPCC at various levels of governance, aligned with the 8 National Missions. Building on such a need, a National Consultation Workshop was held on 19th August 2010 in New Delhi for discussing the common framework/approach for preparing State level action plans on climate change. During the workshop, it was suggested that States can take their lead from the Mission documents while formulating mitigation/adaptation strategies under the State level strategy and Action plan (SAPCC). It was recommended that all state governments finalize their SAPCC by 31st March 2011. Delhi and Orissa became the first two states in the country to complete and launch their State Action Plans. Although all State governments are implementing climate-friendly strategies (broadly aligned with the missions) as a part of their development programmes, some states have taken specific leads in the matter.

Organization of the Report

The Draft Final Report consists of seven chapters and an Executive Summary. The Chapter 1 is an introduction to the study and describes the study area with background information. Current observed climatology of Haryana and the predicted climate change analysis is covered in Chapter 2. The Chapter 3 describes state green house gas emission sector-wise and district-wise. Impacts and vulnerability due to climate change on various sectors based scientific studies carried out at the national level is presented in Chapter 4. The Chapter 5 covers details of ongoing projects addressing possible mitigation, local coping strategy and adaptation options in terms of present policies and programs of the state and linkages with NAPCC. Sectoral Climate Change Strategy and Action Plan for the state is discussed in the Chapter 6 followed by a broad view on cross cutting issues and integrated approach in the Chapter 7.

³ http://pmindia.nic.in/climate_change.htm

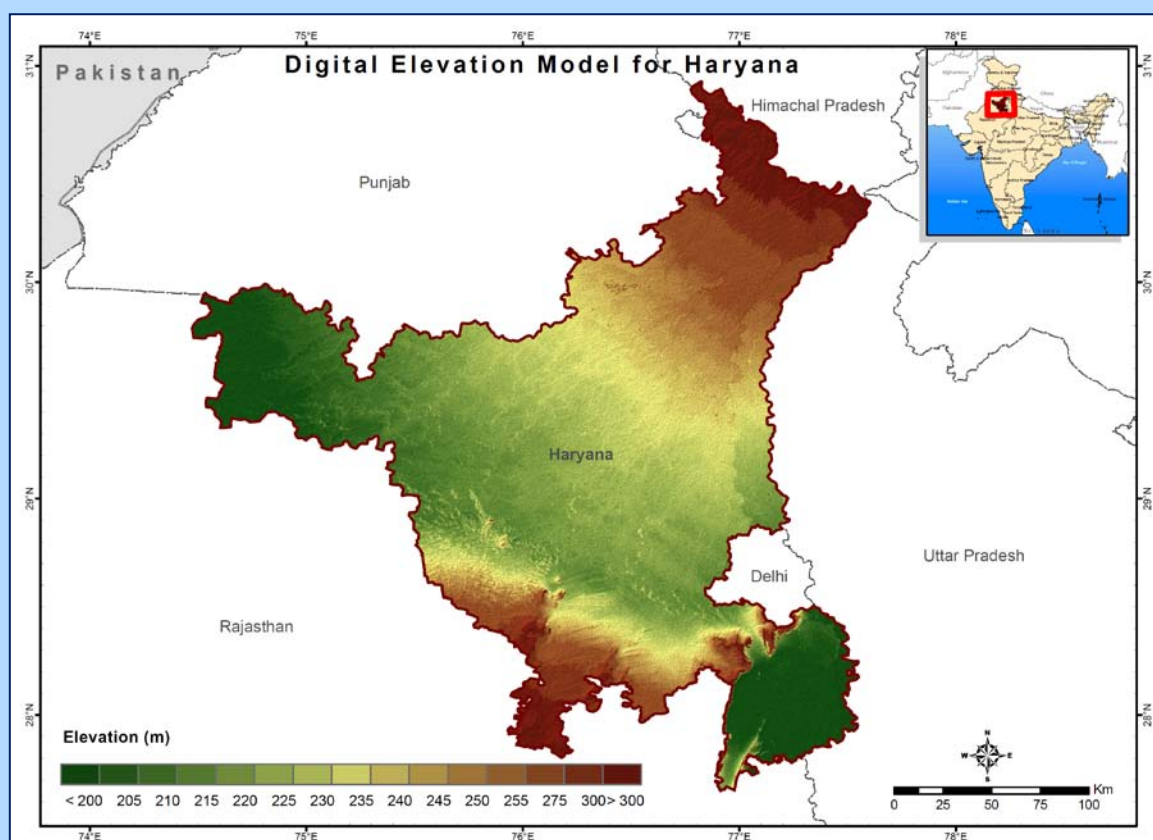
Haryana State profile

Physiography

The State of Haryana is situated in the northern part of India and is bounded by Punjab and Himachal Pradesh to the north, and by Rajasthan to the west and south. The river Yamuna defines its eastern border with Uttarakhand and Uttar Pradesh. Haryana also surrounds Delhi on three sides, forming the northern, western and southern borders of Delhi⁴.

Haryana is a landlocked state in northern India. It is located between 27°37' to 30°35' N latitude and between 74°28' and 77°36' E longitude. The altitude of Haryana varies between 200 m to 1200 m above sea level. The total geographical area of the state is 44,212 km², which is 1.4 % of the geographical area of the country (Figure 1).

Figure 1 : Geographical Context of the Study Area



Haryana has four main geographical features, namely the Shivalik Hills to the northeast, the Aravalli Range in the south, the Aravalli Range in the south, the Semi-desert sandy plain to the southwest and the Yamuna-Ghaggar plain forming the largest part of the state.

- Shivalik Hills: These hills are the source of the rivers like Saraswati, Ghaggar, Tangri and Markanda. Parts of Panchkula, Ambala and Yamunanagar districts.

⁴ <http://en.wikipedia.org/wiki/Haryana>

- Aravali hills: This is a dry irregular hilly area.
- Semi-desert sandy plain: This area includes the districts of Sirsa and parts of Hissar, Mahendergarh, Fatehabad, Bhiwani and shares border with Rajasthan.
- Ghaggar Yamuna Plain: Divided in 2 parts - the higher one is called 'Bangar' and the lower 'Khadar'. This alluvium plain is made up of sand, clay, silt and hard calcareous balls like gravel known locally as kankar.

The main seasonal river of Haryana is Ghaggar. The Ghaggar rises in the outer Himalayas, between the Yamuna and the Sutlej and enters Haryana near Pinjore, Panchkula district and passes through Ambala and Hissar. The Markanda river originates from the lower Sivalik Hills and enters Haryana near Ambala. Another important tributary is the Tangri and The river Yamuna flows along its eastern boundary.

Climate

The climate of Haryana is very hot in summer and cold in winters. The hottest months are May and June and the coldest being December and January. Rainfall is varied, with the Shivalik Hills region being the wettest and the Aravali Hills region being the driest. About 80% of the rainfall occurs in the monsoon season during the months of July and September. Rainfall is varied with Shivalik Hills region being the wettest and the Aravali Hills region being the driest.

Haryana is very hot in summer and cold in winters. The temperature falls to the lowest in January and reaches upto 50° C during the months of May and June. Winter months have average temperatures in the range 3°C to 9°C and the summer months temperatures are higher in the range of 48°C to 35°C.

Natural Resources

Water Resources

Haryana has limited rainfall ranging from 300 mm in the southwest to 1,100 mm in the northeast in the state. The state lies in the basins of the Indus and the Yamuna Rivers and receives water from Sutlej and Yamuna Rivers and its share from the surplus water of rivers Ravi and Beas, as per various inter-state agreements.

There are no perennial rivers in Haryana, Ghaggar is the only seasonal river, which flows through the northern fringes of the state. The Ghaggar rises in the outer Himalayas, between the Yamuna and the Sutlej and enters Haryana near Pinjore, Panchkula district. Passing through Ambala and Hissar, it reaches Bikaner in Rajasthan and runs a course of 467 km before disappearing into the deserts of Rajasthan. The Markanda river which is a seasonal stream like the Ghaggar, originates from the lower Sivalik Hills and enters Haryana near Ambala. During monsoons, this stream swells into a raging torrent notorious for its devastating power. The surplus water is carried on to the Sanisa lake where the Markanda joins the Sarasvati.

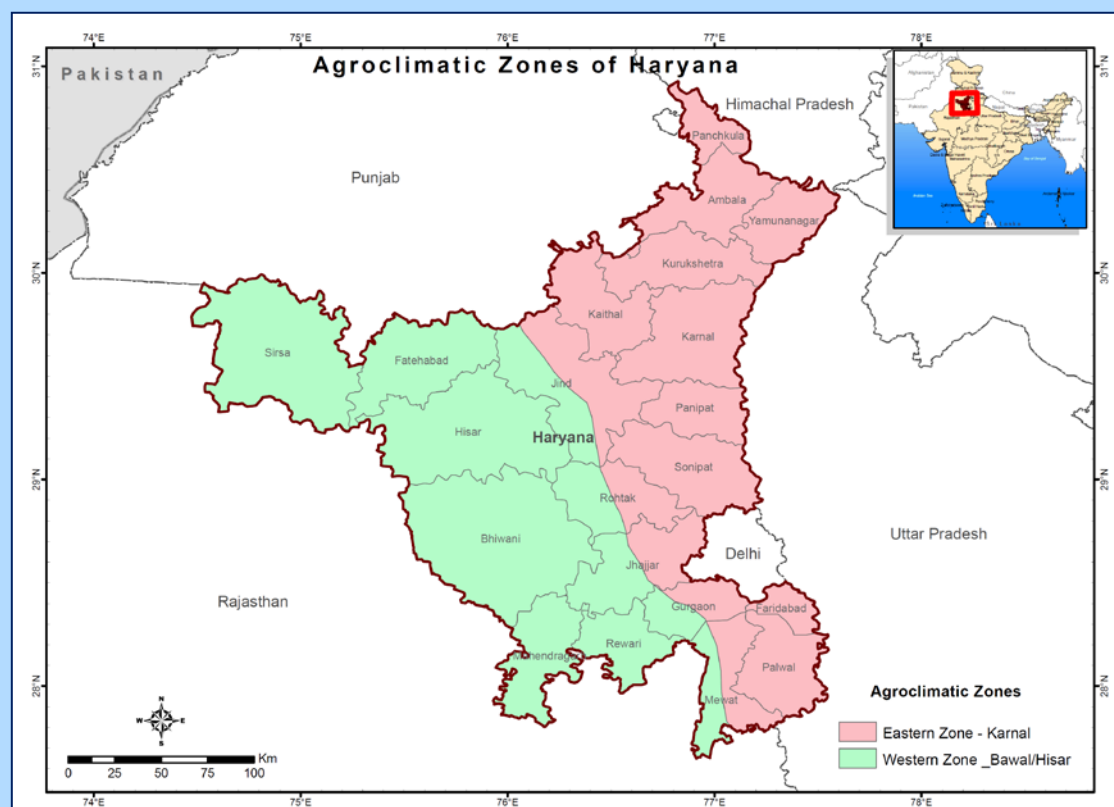
The availability of water vis-à-vis demand is less, which has created an imbalance and sometimes leads to conflict. In view of the scarce availability of surface irrigation water, development of canal network assumed vital importance for the State. The share of water for Haryana is shown in **Table 1**.

Table 1: Share of Water for Haryana in Various Rivers

River	Share BCM	Availability in River BCM	Agreement
Yamuna	5.730	11.983	MOU between partner states i.e. Haryana, UP, HP, Rajasthan and Delhi (1994)
Sutlej	5.427	17.281	Bhakra Nangal Agreement (1959)
Ravi- Beas	4.724	26.409	As per the Ravi Beas Tribunal Report
Total Share from all Rivers	15.881	56.173	

Landuse

There are two agro climatic zones in the state. The north western part is suitable for Rice, Wheat, Vegetable and temperate fruits and the south western part is suitable for high quality agricultural produce, tropical fruits, exotic vegetables and herbal and medicinal plants. Figure 2 shows the agro climatic zones of the state.

Figure 2 : Agro Climatic Zones of Haryana

Major land use in Haryana is agriculture (85%), Forest (2.4 %), about 7.2 % fallow and 5% waste land (Table 2). Figure 3 shows the land use pattern of Haryana.

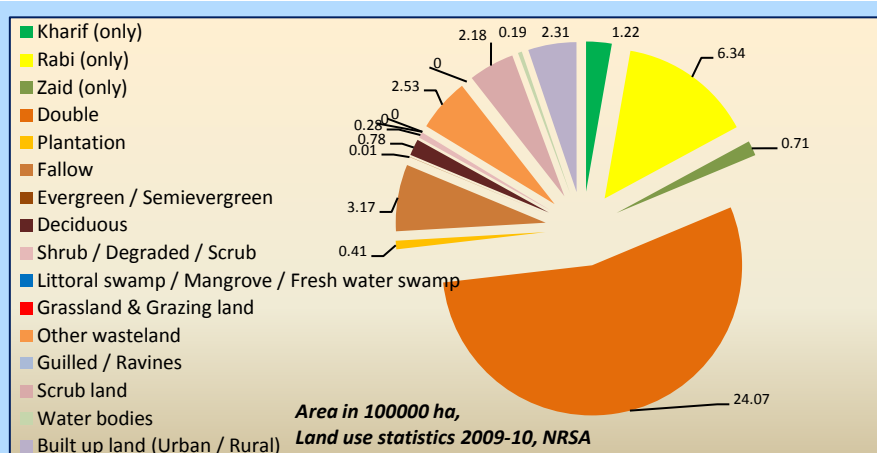
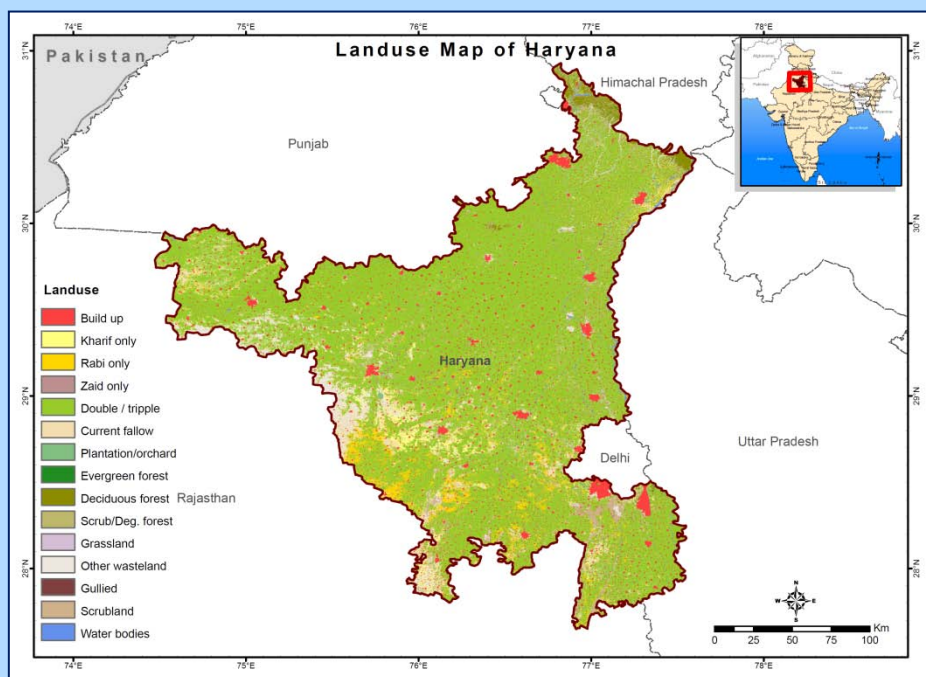
Table 2: Land use land cover Statistics of Haryana (Mapping cycle wise)- Area in Lha

LULC Statistics of Haryana (Mapping cycle wise)- Area in Lha							
LULC Class	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Kharif (only)	6.76	8.48	2.62	1.15	5.91	1.22	2.6
Rabi (only)	9.23	4.22	4.43	1.86	0.96	6.34	0.02
Zaid (only)	2.49	0	0	0.1	0.15	0.71	0
Double	14.94	20.28	26.95	31.32	27.17	24.07	32.81
Plantation	0.53	0.41	0.41	0.41	0.41	0.41	0.41
Fallow	2.8	2.22	1.34	0.92	1.34	3.17	0.01
Evergreen / Semievergreen	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Deciduous	0.81	0.78	0.78	0.78	0.78	0.78	0.78
Shrub / Degraded / Scrub	0.15	0.28	0.28	0.28	0.29	0.28	0.28
Littoral swamp / Mangrove / Fresh water swamp	0	0	0	0	0	0	0
Grassland and Grazing land	0.06	0	0	0	0	0	0
Other wasteland	2.68	2.55	2.55	2.55	2.54	2.53	2.53
Guilled / Ravines	0	0	0	0	0	0	0
Scrub land	1.97	2.19	2.19	0	2.18	2.18	2.18
Water bodies	0.53	0.49	0.35	0.35	0.19	0.19	0.27
Built up land (Urban / Rural)	1.25	2.3	2.3	2.3	2.3	2.31	2.31

BHOOSAMPADA - An Information Portal of ISRO,

http://applications.nrsc.gov.in/lulc/maps/LULC_India/viewer.asp

Figure 3 : Landuse of Haryana (NRSA, 2007-08)



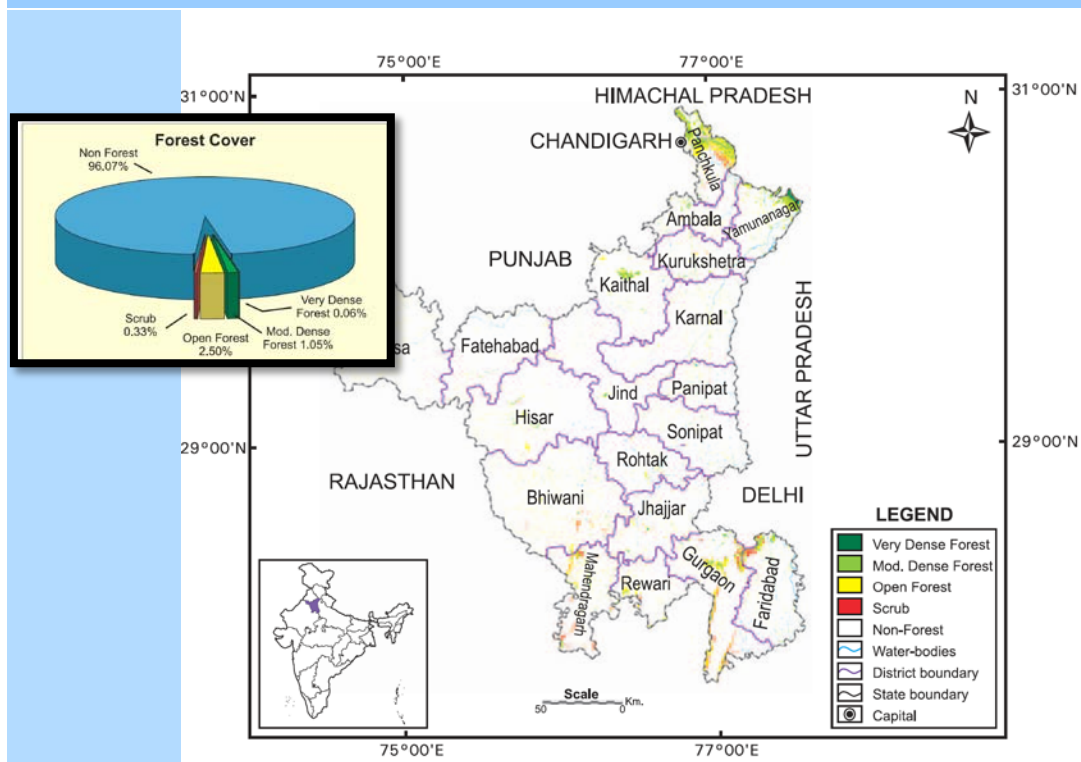
Forest

The state of Haryana has a recorded forest area of 1,559 km² which constitutes 3.53% of its geographic area. As per legal status Reserve Forest constitutes 15.97%, Protected Forests 74.28% and Unclassed Forests 9.75% (FSI, 2009⁵). Most of the roadside plantations in the State have been notified as Protected Forests. The State has 5 different forest types as per Champion and Seth's classification system (1968), belonging to two type groups viz. Tropical Dry Deciduous and Subtropical Pine Forests. Forestry activities in the state are dispersed over rugged Shivalik Hills in north, Aravalli hills in south, sand dunes in west, wastelands, saline-alkaline lands and waterlogged sites in the central part of the state.

⁵ FSI (2009) State of Forest Report 2009, Ministry of Environment and Forests, Government of India

The distribution of forests along with crown densities in Haryana is given in Figure 4. Out of the total area under forests, open forests account for about 2.50% followed by moderately dense forests and very dense forests accounting for about 1.05% and 0.06%, respectively.

Figure 4 : Forest cover of Haryana



It can be observed that the state has sparse vegetation cover scattered across districts like Panchkula, Jamunanagar, Faridabad, Gurgaon, Kaithal, etc. Most of the other districts are either under agriculture or under open forests. Figure 5 shows the trends in area under different types of forests in Haryana. It can be inferred that there has been a significant decline in the area under dense forests and an increase in the area under open forests. The area under scrub forests has also increased.

Figure 5 : Trends in area under different types of forest in Haryana

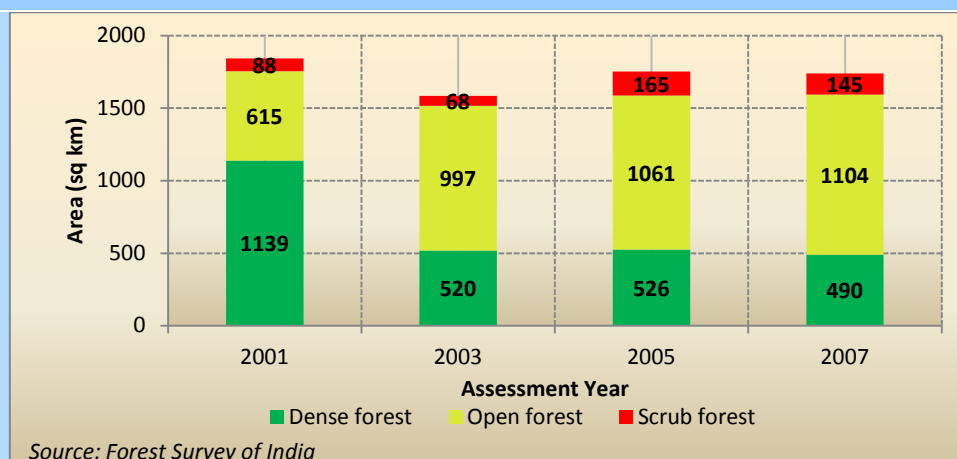


Table 3 shows the district-wise distribution of forest cover in Haryana during 2007. Districts such as Bhiwani, Gurgaon and Panchkula have large areas under open forests.

Table 3: District-wise forest cover in 2007

District	Geographical area	Very dense forest	Mod. dense forest	Open Forest	Total	% of G.A.	Change*	Scrub
Ambala	1,574	0	17	27	44	2.80	-2	1
Bhiwani	4,778	0	14	133	147	3.08	12	18
Faridabad	2,151	0	29	64	93	4.32	-3	20
Fatehabad	2,538	0	2	16	18	0.71	1	0
Gurgaon	2,766	0	52	177	229	8.28	-2	50
Hissar	3,983	0	13	29	42	1.05	6	1
Jhajjar	2,702	0	3	29	32	1.18	-3	2
Jind	1,834	0	5	15	20	1.09	0	0
Kaithal	2,520	0	36	36	72	2.86	-1	0
Karnal	2,317	0	6	31	37	1.60	-5	0
Kurukshetra	1,530	0	10	19	29	1.90	-5	1
Mahendragarh	1,859	0	16	54	70	3.77	1	23
Panchkula	1,268	6	151	243	400	31.55	-2	24
Panipat	898	0	4	14	18	2.00	-2	1
Rewari	1,745	0	8	43	51	2.92	0	4
Rohtak	1,582	0	3	20	23	1.45	3	0
Sirsa	4,277	0	3	53	56	1.31	2	0
Sonapat	2,122	0	4	16	20	0.94	-2	0
Yamunanagar	1,768	21	87	85	193	10.92	-8	0
Total	44,212	27	463	1,104	1,594	3.61	-10	145

Source: Forest Survey of India 2009

Timber- Growing Tree Stock

The growing stock as reported in SFR-2009 was reported to be 48.9 lakh cubic meters on recorded forest and 155.8 lakh cubic meters on TOF (Table 4). The total growing stock (GS) was 204.7 lakh cubic meter.

Table 4: Growing Stock in 2010 (lakh m³)

Forest	Growing Stock (GS) in 2007	MAI (=2*GS/30)	Growing stock (GS) in 2011
Recorded Forest	48.9	3.26	58.68
TOF	155.8	10.39	186.96
Total	204.7	13.65	245.64

Considering the average rotation age of 30 years, the mean annual increment (MAI) of Forests in Haryana comes to be 13.65 lakh cubic meter/year. The mean annual increment of total recorded forest in Haryana comes to be 3.26 lakh cubic meter/year. The MAI of tree outside forests (TOF) in Haryana comes to be 10.39 lakh cubic meter/year. The period pertains to 2006-07. The growing stock of Haryana in 2010 will be 245.64 lakh cubic meter. Total GS on Recorded Forest is 58.68 lakh cubic meter and total GS on TOF is 186.96 lakh cubic meter. The average tree outside the forest is 13/ha.

Haryana Forest Department undertakes enumeration of Trees above 30 cm girth and the data is reported in the Annual Administrative Report. The total number of trees of various species on recorded government forests is 135.2 lakh with growing stock of 54.06 lakh cubic meters which excludes trees below 30 cm girth.

Trees Outside Forests

Trees outside forests have been providing timber, fuelwood, fruit, fodder and other useful products to the rural population in Haryana, which have been deficient in natural forest resources. Though most of the revenue districts (21) in Haryana have some pockets of government forest resource, tree outside forests have been contributing in a big way in meeting the domestic timber and fuelwood needs of the people. Growing trees on farm and community land have been a common practice of the rural people since the formation of Haryana state in 1966. They have been grown in home gardens, farm boundaries, roads and canal side in the country for providing fruits, shade for keeping the cattle, as a source of fuelwood, timber and income during scarcity. Trees also provide protection to bunds of the sacred ponds. The pace of tree planting outside forest area gained momentum after launching of tree planting programmes especially under externally aided social forestry project in late 1980s. The objectives of most of these externally aided projects were to plant trees in vacant lands, private as well as public for meeting the domestic needs of the local people, soil and moisture conservation, wildlife preservation and recreation. A lot of trees have been planted in different districts outside the natural forests after the implementation of the social forestry projects. As a result of massive afforestation programme initiated by the Forest Department under different externally aided projects, central and state schemes the tree outside forest (TOF) grew to 186.96 lakh cubic meter in 2010 (Table 5).

Table 5: Growing stock and MAI in Haryana (lakh m³) in 2011

Species	Forest	MAI	CNFA	MAI	Total GS	Total MAI	Rotation Age (yr)	Species wise %
Chir	1.02	0.03	0.00	0.00	1.02	0.03	60	0.4
Sal	1.70	0.03	0.00	0.00	1.70	0.03	120	0.7
Khair	4.34	0.22	0.00	0.00	4.34	0.22	40	1.8
Eucalyptus	16.62	4.16	67.91	16.98	84.54	21.13	8	34.4
Poplar	0.00	0.00	8.18	2.73	8.18	2.73	6	3.3
Kikar	8.63	1.08	3.28	0.41	11.91	1.49	16	4.8
Shisham	2.46	0.12	14.40	0.72	16.86	0.84	40	6.9
Misc	23.89	1.19	93.19	4.66	117.08	5.85	40	47.7
Total	58.68	6.83	186.96	25.50	245.64	32.33	30	100.0

As per the working plan and the demand for species in the market mostly Eucalyptus, Poplar, Shisham, Kikar and few miscellaneous species are harvested from forest strips and farm lands. Out of the total annual increment of 32.33 lakh cum, only 22.1 lakh cum is available as per the CEC estimate (Anonymous, 2006; 2007a, b, c, d; 2008a) report. The harvest from Government Forest land which is mainly from the production Forests (Forest Strips) was 1.51 lakh cum in 2010-11. The remaining were harvested from the Farm lands by private individuals due to ready market for Eucalyptus, Poplar Kikar, shisham and other local miscellaneous species.

Fuelwood, Fodder and Non-Timber Forest Products

Fuelwood: The household cooking energy requirement of the local communities is met from many sources. The Census of India 2001 has given detailed information regarding sources of energy in households Haryana as given in Table 6. It has been found that the 1.1 million households (31.3 %) of the total 3.53 million household use fuelwood as the source of cooking fuel. These fuelwood is collected from the local forest and farm land plantation. The fuelwood is collected by locals for sale and for self consumption.

Table 6: Sources of cooking fuel in Haryana

	Total	%	Rural	%	Urban	%
Fuelwood	1105229	31.3	937270	38.2	167959	15.6
Crop residue	617927	17.5	583860	23.8	34067	3.2
Cow dung cake	579930	16.4	506121	20.6	73809	6.9
Coal, lignite, charcoal	3161	0.1	1548	0.1	1613	0.2
Kerosene	124558	3.5	28500	1.2	96058	8.9
LPG	1067110	30.2	376209	15.3	690901	64.3
Electricity	3372	0.1	2876	0.1	496	0
Biogas	18631	0.5	12858	0.5	5773	0.5
Any other	2436	0.1	1655	0.1	781	0.1
No cooking	7288	0.2	3566	0.1	3722	0.3
Total	3529642	100	2454463	100	1075179	100

Source: Census of India

The survey by NSSO (50th round) reveals that 80% of the rural population depends totally on fuelwood while 28% of the urban population uses wood and wood scraps for fuel. Out of the annual fuelwood consumed; 27.61 kg (32.8%) was home grown, while only 10.67 kg (12.5%) was from cash purchase, leaving 46.27 kg (54.7%) as from free collection. If we take the average annual fuelwood consumption of 1.0 tonnes per household then the fuelwood derived from the forest and trees in Haryana is approximately 1.1 million tonnes per year.

Fodder: To estimate the fodder production and its value, it has been assumed that the average leaf fodder production in India is 4.9 tons of dry matter per hectare and grass production is 3 tons per hectare (Tewari, 1994⁶). Haripriya (2001⁷) has assumed that only 2% of the leafy biomass is utilised as fodder. The estimation of fodder production from forest is estimated by estimating the total biomass produced by the woodland and forest. Though the HFD does not permit grazing in forest area, the incidence of illicit grazing is reported from all districts. It is assumed that since the Government forest and community forest lands are situated along roads, canals etc, and these are prone to illicit grazing. Thus keeping in view the large cattle population of 9.44 million in the state, about 20 % of the forest land is subject to grazing and the fodder consumed is not accounted for. The amount of land required to grow fodder grazed in the forests is computed as the ratio of total fodder grazed in forest and the average yield of fodder on agriculture land. The productivity of forest

⁶ Tewari, D.N. (1994), Tropical Forest Produce, Dehradun: International Book Distributors, India

⁷ Haripriya, G. S. (2001), Accounting for the forest resources in the national accounts in India, Environmental and Resource Economics, Vol. 19(1), pp. 73-95

for fodder was estimated by Haripriya at 4.9 tonnes/ha. The total fodder produced in Haryana from Forest resource for these livestock is estimated to be: 152300 ha *0.2*4.9 t/ha = 0.15 million tonnes.

Non Timber Forest Product (NTFP): Trees on CNFA are traditionally grown for timber and as cash crops (Eucalyptus and Poplar, Shisham, Prosopis Cineraria and fruit plants). The block forests however produce NTFP such as bhabhar grass, fruits, bamboo, cane and rattans etc. The NTFP is collected by various JFM committees. The residents however are allowed to collect NTFP for their needs and this is not recorded. This makes the task of computing the value of NTFP in the state difficult. In order to take into account the unrecorded production of these MFP, the NSO consider the value of NTFP to be 10 times the value of recorded production. The value of NTFP recorded by HFD is tabulated. During 2009-10 NTFP worth Rs.1.44 million was recorded by HFD. There is no record of medicinal plant collection. The unrecorded MFP is taken to be 10 times at Rs 14.4 million.

Area under Wastelands in Haryana

Wastelands in India include degraded grasslands, forests and several other land types, and are classified into 28 categories by the National Remote Sensing Agency (NRSA). The total area under wastelands in Haryana is estimated to be about 3,266 sq. km. accounting for about 7% of the total geographic area. These land categories could be potentially considered for different sub-missions of the Greening India Mission. Table 7 presents the district-wise area under wastelands in Haryana.

Table 7: District-wise area under wastelands in Haryana

Districts	Wasteland Area (sq km)
Ambala	58.41
Bhiwani	287.42
Faridabad	318.35
Fatehabad	94.66
Gurgaon	414.5
Hissar	222.01
Jhajjar	130.9
Jind	119.82
Karnal	80.19
Kaithal	60.4
Kurukshetra	23.67
Mahendragarh	281.36
Panchkula	411.65
Panipat	76.95
Rewari	132.83
Rohtak	109.2
Sirsa	115.88
Sonepat	163.63
Yamunanagar	164.61
Total	3266.45

Source: Wasteland Atlas 2005

Biodiversity

The state has about 33000 ha under protected area network, which consists of 2 national parks, 8 wildlife sanctuaries and 2 conservation reserves. Over 500 bird species have been recorded in the State, which is almost 40 percent of total bird species in the country.

Thorny, dry, deciduous forest and thorny shrubs can be found all over the state. During the monsoon, a carpet of grass covers the hills. Mulberry, eucalyptus, pine, kikar, shisham and babul are some of the trees found here. The species of fauna found in the state of Haryana include black buck, nilgai, panther, fox, mongoose, jackal and wild dog.

Although Haryana is deficient in natural forests but it has vast climatic diversity, which makes it suitable for variety of wildlife particularly local and migratory bird species. Out of nearly 1250 bird species recorded in Indian subcontinent approximately 500 species of birds are found in Haryana. Various types of ducks and geese such as Graylag Goose, Bar-headed Goose, Brahminy Duck, Northern Pintail, Common Shelduck, Mallard, Gadwall, Eurasian Wigeon, Blue winged Teal, Shoveller, Common Pochard, Ferruginous Duck and Tufted Duck can be seen at the Ghaggar and tanks during winter.

There are three mini zoos in Haryana at Pipli (Kurukshetra), Rohtak and Bhiwani. There is also one Deer Park in Hisar district located on Dhansu road. All the above zoos and deer park have wild animals and birds to educate the public particularly school children and farmers about habits and habitat of wildlife

Haryana forest department in collaboration with Bombay Natural History Society has established a Vulture Conservation Breeding Centre at Pinjore.

Agriculture and Horticulture

Haryana is primarily an agricultural state. Haryana is self-sufficient in food production and the second largest contributor to India's central pool of food grains. The main crops of Haryana are Wheat, Rice, Sugarcane, Cotton, Oilseeds, Gram, Barley, Pearl Millet, Green Gram etc. There are two main types of crops in Haryana: Rabi and Kharif. The major Kharif crops of Haryana are rice, jowar, bajra, maize, cotton, Green Gram and sugarcane. The major Rabi crops are wheat, gram, rapeseed and mustard. About 86% of the area of the State is arable, and of that 96% is cultivated and about 84% of the area is irrigated, through tubewells and an extensive system of canals.

Agriculture contributes 17% of the state's GDP and employs 65% of the total workforce. The net sown area is 85% of the total geographic area as compared to the national average of 46%, the gross cropped area is 65 lakh Ha with a cropping intensity of 180%. Small and marginal farmers account for 60% of the total land holding. The average landholding in the state is 2.13 Ha. Irrigation covers 84% of the net sown area and the remaining 16% is rainfed.

Horticulture crops cover 4.9% of the gross cropped area, corresponding to 2.47 lakh Ha and with an annual production of horticulture crops in the state is 31.1 lakh tonnes. The total area under fruits (mango, guava and citrus) was 24,071 ha with a total production of 2.47 lakhs MT during 2004- 05. The total area under vegetable (potatoes, cauliflower, cucurbits, carrots, tomatoes, radish and onions) was 2.08 lakhs ha with a total production of 27.67 lakhs. Flower (marigold, rose, tuberose and gladiolus) cultivation is about 4,810 Ha during 2004-05. Similarly, mushroom cultivation picked up during 1989-90 and by the end of 2004-05, production was to the extent of 6,163 MT and the state is now the highest producer of mushroom in the country. Cultivation of aromatic plants is also increasing due to higher returns and by the end of 2004-05 extended to 3,666 Ha.

Animal Husbandry and Dairying

Animal husbandry has been taken up as an integral component of diversified agriculture. Haryana has a livestock population of 98.97 lakh. Its 'Hariana' breed of cows and 'Murrah' breed of buffaloes are known throughout the world. Buffaloes constitute 45 % of the total livestock population and they contribute 80.5 % of the total milk production. About one lakh 'Murrah' buffaloes are exported every year to other States and abroad. The State is regularly supplying eggs, layer-chicks and broilers to the neighbouring States of Delhi, Rajasthan and Uttar Pradesh and has its markets in the far away States of Assam and Bihar.

The Animal Husbandry activities in the State of Haryana occupy a pivotal role in the rural economy because of its contribution towards income generation, draft power, rural upliftment and its potential which brings about growth in terms of livestock products like milk, eggs, meat and wool and also opening new avenues for employment. In fact, Animal Husbandry has transformed itself into an industry in Haryana. The State with 1.3% geographical area ranks second in the country in terms of 678 gms. per capita per day milk availability. In spite of limited resources, the State has been striving hard to maintain the tempo of development and enhance the production of milk, eggs and wool constantly. The prevalence of contagious and non-contagious diseases is a major factor for economic losses due to morbidity and mortality amongst livestock and poultry. To ameliorate the low productivity of our indigenous stock, this problem and to maximize per animal productivity, the State has a network of 942 Government Veterinary Hospitals, 1809 Civil Veterinary Dispensaries totaling to 2751 institutions, on an average, one institution for every 3 villages.

The livestock population trend and reasons thereof shows that:-

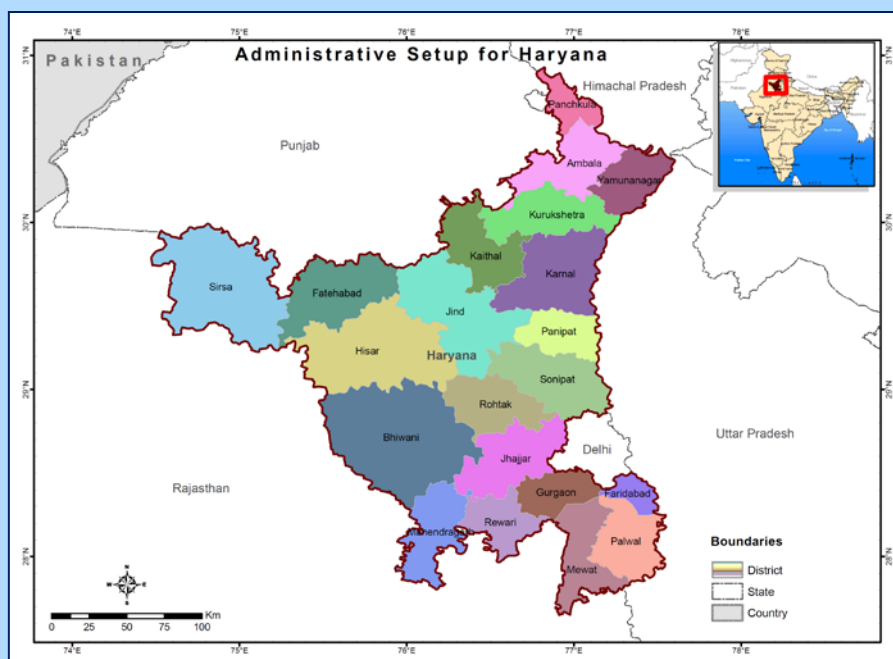
- i. The buffaloes population has been increased significantly and on the other hand cattle population has been decreased drastically.
- ii. The livestock draft power has been mainly replaced by mechanization of Agricultural operations.
- iii. Pasture grazing system has been replaced by stall feeding.
- iv. The Flocks of Sheep /Goats have been decreased due to non availability of pasture lands.
- v. The Domestic Desi Pigs have been replaced by improved farms of exotic breeds of landrace, Yorkshire and the piggery population has been decreased accordingly.
- vi. Scanty and Desi poultry has been replaced by improved poultry and has taken the shape of industry resulting in many fold increase in poultry population.
- vii. The Feed and Fodder is deficit in Macro, micro-trace-elements which are essential for livestock production.
- viii. The feed additives have become the necessity of the day.
- ix. Major outbreak of contagious/non contagious diseases have been checked by effective preventive vaccination and treatment.
- x. Through Bio-technological introduction viz. through Artificial insemination, Embryo Transfer Technology for fast multiplication of quality livestock production and tissue culture vaccine production are being taken up.

Demography

The state is divided into four divisions for administrative purpose - Ambala Division, Rohtak Division, Gurgaon Division and Hisar Division. There are 21 districts (Figure 6), 47 sub-divisions, 67 tehsils, 45

sub-tehsils and 116 blocks. Haryana has a total of 81 cities and towns and 6,759 villages. Haryana is the nation's seventeenth most populous state and the population of Haryana, is 25,353,081, according to the 2011 census. The population density is 573.4 people/km². Haryana has a skewed sex ratio at 861.

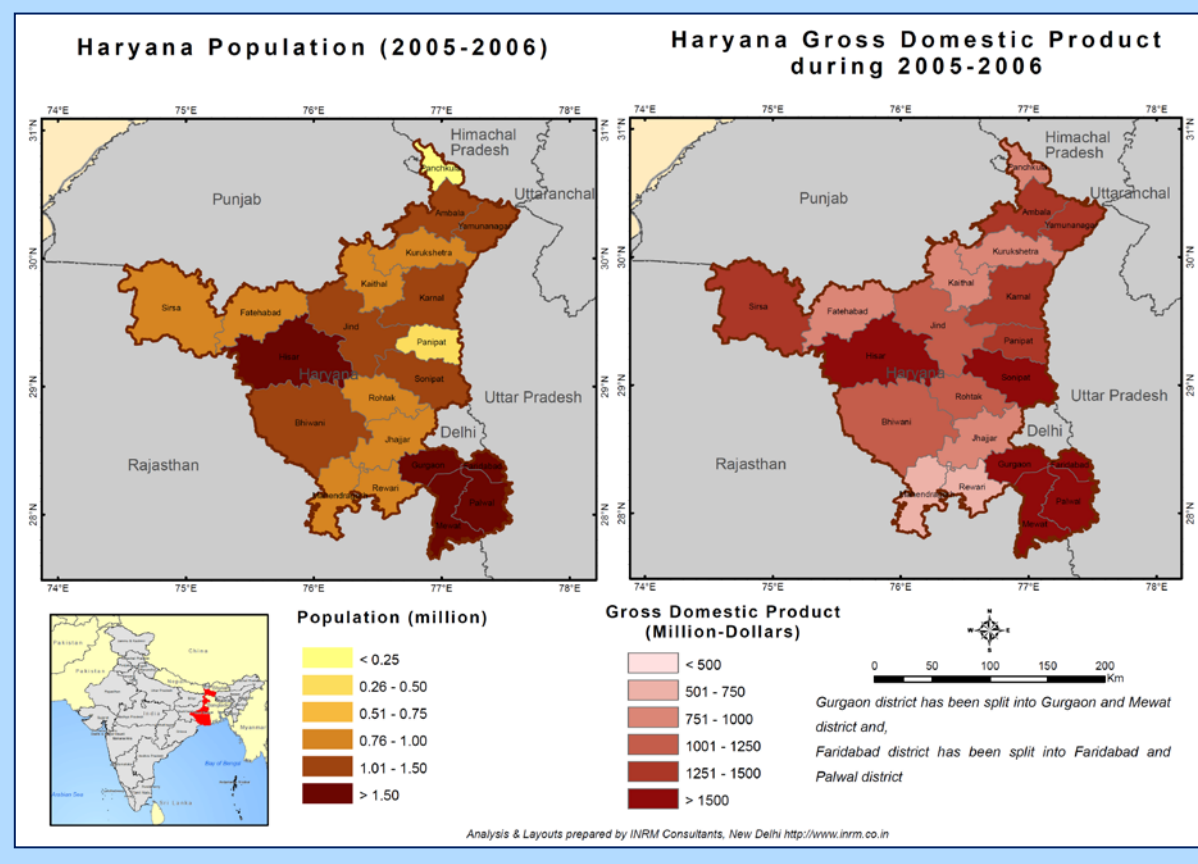
Figure 6 : Administrative setup of Haryana



Economy

Agriculture and related industries have been the backbone of the local economy. Haryana is an industrial state and has emerged as a base for the knowledge industry including IT and biotechnology. It is also a leading agricultural state of the country. Many large Indian and multi-national companies have set-up offices in the state because of good infrastructure and proximity to Delhi.

The Gross State Domestic Product (GSDP) of Haryana at constant (1999-2000) prices has been estimated at Rs. 111420.13 crore in 2008-09 as against Rs. 103244.09 crore in 2007-08 recording a growth of 7.9% during 2008-09. Agriculture Sector still continues to occupy a significant position in State economy, although, the share of this sector in the Gross State Domestic Product is continuously declining. The composition of Gross State Domestic Product at constant (1999-2000) prices reveals that the share of Primary Sector which includes Agriculture, Livestock, Forestry, Fishing and Mining Sectors has declined from 32.0% during 1999-2000 to 19.8 % during 2008-09 which together constitutes one fifth of the total NSDP of the state of Haryana. Of the total rural workers, 19.53% and 19.30% are cultivators and agricultural labourers, respectively, while 4.72 percent are engaged in household industries. According to the Modified Expert Group of Planning Commission, 8.7 % of the total population lived below poverty line in 1999-2000. District level gross domestic product (GDP) distribution of the state is shown in Figure 7.

Figure 7 : District Population and Gross domestic Product of Haryana

In terms of manufacturing, various companies are situated in the region. In addition there are more than 80,000 small-scale industrial units in the state which cumulatively bring in a substantial income for the state and its people. Hundreds of large scale and well known companies have their units in Haryana. Yamunanagar district is the largest industrial town wholly within in Haryana. It has Asia's largest paper mill and Asia's largest Sugar Mill. Yamunanagar has Asia's largest timber industry, an HPGCL thermal power plant, a hydro power plant and India's largest Railway workshop. Faridabad is another big industrial part of Haryana. It is home to hundreds of large scale companies. Panipat is a city of textiles and carpets. It is the biggest centre for cheap blankets and carpets in India. Ambala is the largest manufacturer of Scientific Apparatuses and one of the biggest exporters of educational instruments in the country.

Service industry is also flourishing in recent years in places like Gurgaon and many well known companies are setting up back offices or contact centers in Gurgaon.

Infrastructure

Physical infrastructure like road and transport, irrigation, power, telecommunication etc contributes to economic growth through generation of income and employment and social infrastructure consisting of education, health, housing and financial infrastructure like banking and insurance contributes to the process of growth through generation of human capabilities and capacity building.

Physical infrastructure

Transport

Haryana has a total road length of 23,684 kilometers. There are 29 national highways with total length of 1,461 km and many state highways with total length of 2,494 km. The most remote parts of the state are linked with metalled roads. Grand Trunk Road, commonly abbreviated to GT Road, is one of South Asia's oldest and longest major roads. It passes through the districts of Sonapat, Panipat, Karnal, Kurukshetra and Ambala in north Haryana where it enters Delhi and subsequently the industrial town of Faridabad on its way. Haryana and Delhi government has also constructed Delhi-Gurgaon Expressway which has the largest toll plaza in Asia and 3rd largest in the world. Haryana is well connected on the railway network also.

Its modern bus fleet of 3,864 buses covers a distance of 1.15 million Kilometers per day. The state government proposes to construct Express highways and freeways for speedier vehicular traffic. The 135.6-km long Kundli-Manesar-Palwal Expressway (KMP) will provide a high-speed link to northern Haryana with its southern districts such as Sonapat, Jhajjar, Gurgaon and Faridabad. There is a proposal for a Badarpur Flyover and the widening of the Mathura Road passing through Faridabad from 6 lanes to 8 lanes. There is also a proposal to connect Chandigarh to Haryana without entering Punjab through a 4-lane highway via Yamunanagar and Panchkula.

Irrigation

Haryana has an extensive irrigation network consisting of 59 main canals having length of 1498.69 km, 1326 numbers. Distributaries and minors having a length of 12328.10 km and 200 pump houses commissioned in the Lift Schemes.

Out of a total geographical area of 4.42 Mha of Haryana State 3.82 Mha is culturable, of which 2.97 Mha is covered by surface irrigation with 14370 km length of the canal network under the following canal systems: -

- Bhakra canal system covering a CCA of 1.28 Mha in the north-western and western parts of Haryana.
- Western Yamuna canals system covering a CCA of 1.00 Mha in the north-eastern and central parts of Haryana.
- Gurgaon canal and Agra canal systems covering a CCA of 0.12 Mha in south-eastern parts of Haryana.
- Lift canals covering a CCA of 0.57 Mha in south-western parts of Haryana bordering Rajasthan.

Floods: Accumulation of water, at times extensive, on land surfaces in Haryana is caused by two phenomena: flooding from rivers and/or rainfall which may occur separately or simultaneously. When the latter occurs, large areas of the State become inundated. Flood water comes from two major and numerous minor rivers entering the State from the north and northeast and to a lesser extent, from the southeast. It may cause floods in the flood plain of the rivers, during and following flood stages, and may spread over wide central, low-lying lands and accumulate in many depressions where it may remain for prolonged periods. The state has a good network of drains and pumping arrangements.

Ground water: Because availability of surface water in the state is not sufficient to cater to the demand of water for irrigation and other uses, there is unabated exploitation of groundwater. The unplanned and unchecked growth of groundwater uses has resulted in depleting groundwater and the state is quite concerned of the issue. The climate change scenario is likely to further increase the unabated usage of groundwater.

Total water requirement of the state is 39.5 billion cubic meter, availability is 23.1 billion cubic meter, making the deficit as 16.3 billion cubic meter. 54% of the area in Haryana have brackish ground water. Depletion of ground water is 17 cm . Out of 116 blocks, 55 blocks are over exploited blocks.

Rural Development Department, Haryana is responsible for the watershed development. Table 8 gives the details of the micro-watersheds in Haryana and status of development.

Table 8: Micro-watershed details of Haryana

S. No.	Item	Details	
		No.	Area in ha
1	Total micro-watersheds (MWS) in the State	5361	3391228
2	Total untreatable MWS (Reserved Forest, Barren Rocky, assured irrigation, etc.)	1974	1387956
3	Total treatable MWS in the State (1-2)	3387	2003272
4 a	Total MWS covered under pre-IWMP schemes of DoLR	1580	700968
b	Total MWS covered under schemes of other Ministries	286	236201
c	Total MWS covered under IWMP 2009-10 of DoLR	---	---
d	Total MWS covered under IWMP 2010-11 of DoLR	----	---
e	Total of 4 a to d	1866	937169
5	Balance micro-watersheds not covered till date (3-4e)	1521	1066103

Power

Haryana State has always given high priority to the expansion of electricity infrastructure, as it is one of most important inputs for the development of the State. Haryana was the first State in the country to achieve 100% rural electrification in 1970. The State Government constituted an independent Haryana Electricity Regulatory Commission (HERC), under the Haryana Electricity Reforms Act, 1997 to aid and advise the State Government on the development of power sector and take appropriate steps to balance the interest of consumers, power entities and generation companies. The erstwhile Haryana State Electricity Board was later unbundled into two corporate bodies namely Haryana Power Generation Company Limited (HPGCL) for the Generation of Power and Haryana Vidyut Prasaran Nigam Limited (HVPNL) for the Transmission and Distribution of power within the state of Haryana. Subsequently, the activity of distribution and retail supply of power was entrusted w.e.f. 1st July 1999, to Uttar Haryana Bijli Vitran Nigam Limited (UHBVNL) for north circles and Dakshin Haryana Bijli Vitran Nigam Limited (DHBVNL) for south circles of Haryana⁸.

According to Economic Survey of Haryana 2010-11, the total installed capacity available to the State at present is 5761.83 MW. It include 3230.50 MW from State's own stations, 875 MW from jointly owned projects and the balance as share in central projects and independent Private Power Projects.

⁸ Haryana Electricity regulatory Board (<http://herc.gov.in/mainpages/over.html>. Retrieved on January 24th, 2012)

State-owned capacity comprised 69.2 per cent of coal-based power plants and 28.6 per cent of hydro-power plants⁹. All of the private-sector controlled capacity was based on renewable energy sources. Domestic consumers account for about 77 per cent of power consumption; agriculture and industry are the two other prominent consumer segments. Table 9 shows the existing, under implementation power generation plants in Haryana.

Table 9: Existing and under Implementation power generation plants in Haryana

No.	Name of Power Station	Capacity (MW)
Existing		
1	Rajiv Gandhi Thermal Power Project (RGTPP), Hissar, Hissar	1200
2	Panipat Thermal Power Station	1367.8
3	Deen Bandhu Chhotu Ram Thermal Power Project (DCRTPP), Yamunanagar	600
4	WYC Hydel Project, Yamunanagar	62.4
Under implementation		
1	Indira Gandhi Super Thermal Power Project (IGSTPP), Jhajjar	750
2	Mahatma Gandhi Thermal Power Project in Jhajjar Case-II	1320
Future		
1	Gas based Project, Faridabad	1500
2	Additional super critical Thermal Unit at Yamuna Nagar	660
3	Nuclear Power Plant in Distt. Fatehabad	2800
4	Grid Interactive Solar Power Project, Yamuna Nagar	6.5

Source: Haryana Power Generation Corporation Ltd. (http://hpgcl.gov.in/personal_18.hp)

Telecommunication

Haryana has a state-wide network of telecommunication facilities. Haryana Government has its own state-wide area network by which all government offices of 21 districts and 127 blocks across the state are connected with each other. Government as well as most of the leading private sector players in telecom sector have operations in the state. Important areas around Delhi are also an integral part of the local Delhi Mobile Telecommunication System. This network system would easily cover major towns like Faridabad, Gurgaon, Bahadurgarh and Kundli.

Urban infrastructure

Gurgaon, Faridabad, Karnal, Ambala, Panipat and Kurukshetra are the key districts of the state. Around 40 per cent of the National Capital Region (NCR) of Delhi falls in Haryana. The NCR Board, under the Ministry of Urban Development, Government of India, decides on common development of cities falling in the NCR, thereby, facilitating seamless trade and commerce. Under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), four projects costing US\$153 million have been sanctioned for Faridabad.

The most commonly spoken languages are Hindi and Punjabi in the State. In most schools, the medium of education is English. It is among the states with good physical infrastructure such as power, roads and railways.

Haryana Roadways, with its fleet of nearly 3,411 buses, is among the biggest state road transport undertakings in the country. The Delhi Metro, a rapid transit system serves Delhi, Gurgaon and

⁹ Economic Survey of Haryana 2007-08. Retrieved December 2011: (esaharyana.gov.in/.../Economic%20Survey%20of%20Haryana/2008)

Noida. The Rapid Metro Rail Gurgaon is scheduled to be completed by 2013 and will be connecting Sikanderpur to Belvedere Towers. Other key public private partnership Roads projects are Panipat-Jalandhar, Rohtak-Panipat, Delhi-Haryana border to Rohtak, Badarpur elevated highway, Panipat elevated highway ect.

Prominent stadiums in the state include Tejlisports Complex (Yamunanagar), NaharSingh stadium (Faridabad), Tau Devi Lal stadium (Panchkula) and Nehru Stadium (Gurgaon). Kingdom of Dreams is India's first live entertainment and leisure destination located in Gurgaon. The Epicentre in Gurgaon has been developed as an arts and culture centre.

There are 2,329 post offices in the rural areas and 317 in urban areas. Some of the other focus areas of development are water supply, storm-water drainage and solid-waste management.

Water supply

The average per capita supply of water in major cities varies from 70 to 155 litres per day. Average per capita supply of water for 78 towns is about 117 litres per day. Under the JNNRUM, cities are planned to achieve per capita water supply of 135 litres per day between 2015 and 2021. Percentage area covered with sewers varies from 5% to 95% across 78 towns. Daily requirement of water is projected to be 2394 MLD with a projected population of 19309475 persons in 2050. In 2080, the requirement is projected to increase to 4310 MLD for a projected population of 34757055 persons. Some of the future plans include:

- ensuring adequate water supply @ 135 Litres Per Capita Per day to all the inhabitants in urban areas as per CPHEEO standards with required quality.
- ensuring sewerage system in complete areas of the towns.
- vaving the facility of sewage treatment plants for treatment of sewage in all the towns. The disposal of effluents would be done after proper treatment through Sewage Treatment Plants
- usage of sewage water after treatment for irrigation purposes/non domestic use.
- availability of effective system of leakage detection and efficient water management.
- mechanism for generating awareness & civic sense amongst the public for conservative use of the drinking water and avoid wastage.
- ensuring sustainable water supply an sewerage system through realistic structure.
- to implement on-line system for redressal of public grievances.
- to adopt Tertiary Treatment of Sewage in selected towns where there is demand for non potable –use of water in the industries and Irrigation of parks, lawns and other open spaces.

Industrial infrastructure

Haryana provides ample choice to an industrialist. Industrial land is being continuously developed and allotted to potential entrepreneurs. Haryana State Industrial Development Corporation (HSIDC), a State Government enterprise develops and provides industrial plots/sheds at reasonable and competitive rates. So far it has developed 35 industrial estates in which 5417 fully developed plots and 585 sheds have been provided. It's 'Udyog Vihar Complex' at Gurgaon has earned a name for itself for providing high quality infrastructural facilities. Haryana Urban Development Authority (HUDA) is another such agency which has developed and sold industrial plots besides developing commercial and residential sites. Facilities in the Developed Industrial Estates like Roads, Water

Supply, Sewerage and Disposal, Effluent Treatment facilities, Power, Banks are also provided. Haryana has a rich reservoir of trained and skilled manpower.

Social infrastructure

Education sector

The state of Haryana has made tremendous progress in the field of higher education. Accessibility to schooling is available within the radius of 1.10 km, 1.38 km, 1.66 km and 2.79 km at the primary, middle, high and senior secondary levels respectively in the State. The Haryana government provides free education to women up to the Bachelor's Degree level. The state also has the biggest agricultural universities in Asia. It is engaged in education, research and development related to agriculture.

Health infrastructure

As of 2009, Haryana had 46 hospitals, 91 community health centres, 427 primary health centres, 2,465 sub-centres, 20 district tuberculosis centres and 56 dispensaries. The Total Fertility Rate of the State is 2.5. The Infant Mortality Rate is 54 and Maternal Mortality Ratio is 186 (SRS 2004 - 06¹⁰) which are lower than the National average. Decadal Growth is 28.43 % (Census 2001).

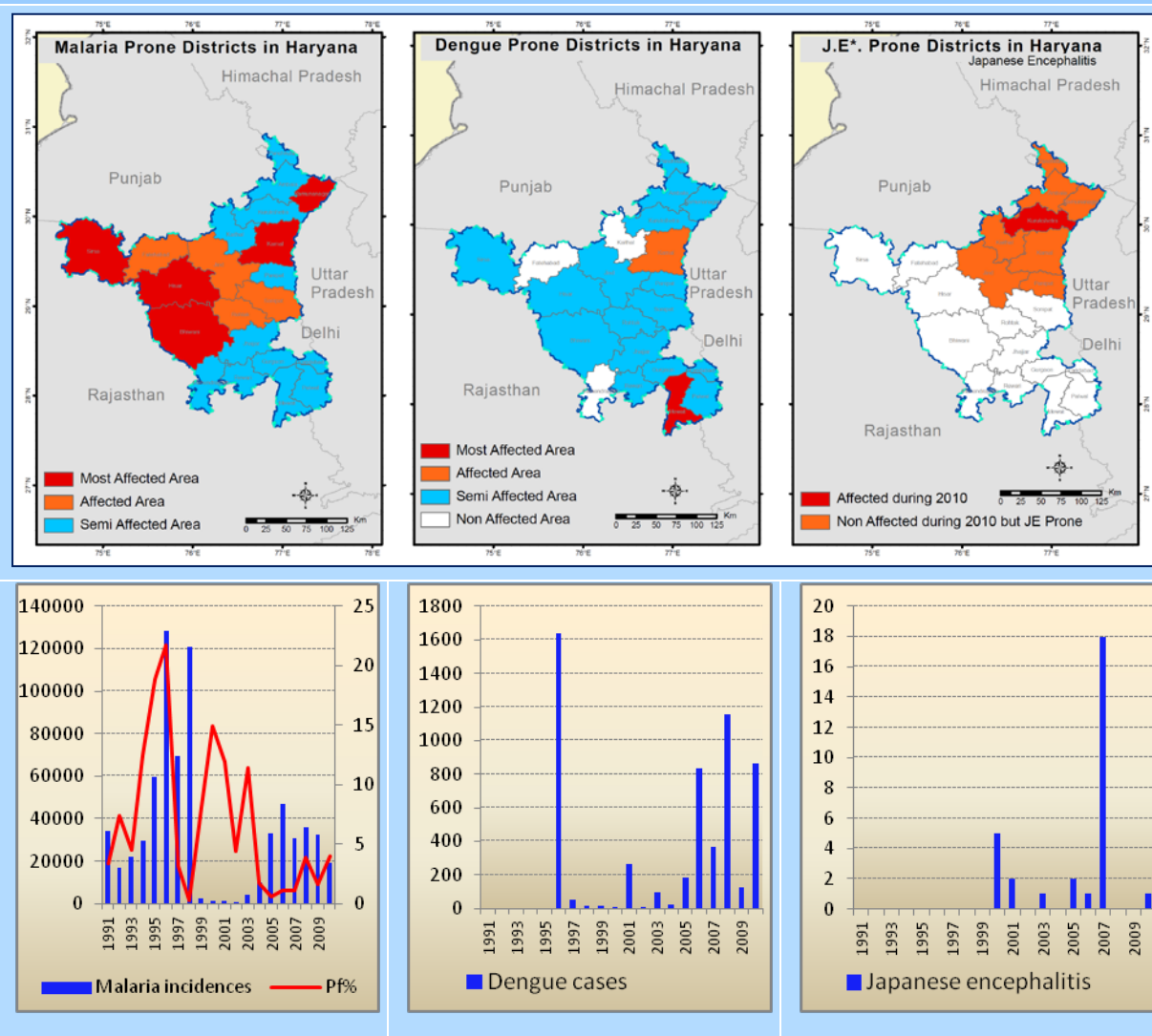
Current Disease Prevalence in Haryana

The increase, decrease or disappearance of incidences of some diseases are driven by the climate determinants such as Extreme temperatures, slow increase in temperature, changing pattern of rainfall, floods and droughts. For example, the transmission window of the vectors such as malaria, dengue, Chikungunya and Japanese Encephalitis are controlled by temperature, and humidity. Similarly, chorea and diarrhoea are on the increase when water gets polluted by floods. Increase in malnutrition is anticipated with increase in droughts as crop productivity reduces. Also pollutants in the air tend to increase with increase in tropospheric ozone thereby increasing the respiratory diseases. The current prevalence of some of the diseases in Haryana are described below.

Vector borne diseases: Records show that the cases of malaria have come down drastically in the decade 2001-2010 as compared to 1991-2000. Dengue, and Japanese Encephalitis have shown an emergence from 1996 and 2000 onwards in the state. The trends and spatial spread of the diseases are shown in Figure 8. As regards the vectors of malaria, in Haryana only Malaria Vivax and Falciparum are prevalent. The data shows that Malaria cases are more prevalent in the months from March to October, with peak number of cases in the month of August. Chikungunya and JE cases are not so common in occurrence in the state, one or two outbreaks are reported in the months of Sep-Oct. Dengue cases are more prevalent in the months of Sep to Nov, with peak number of cases in the month of October.

¹⁰ Registrar General of India, Special Bulletin on Maternal Mortality in India 2004-06 SRS, April 2009

Figure 8 : Spatial spread and trends of Malaria, Dengue and Japanese Encephalitis in Haryana

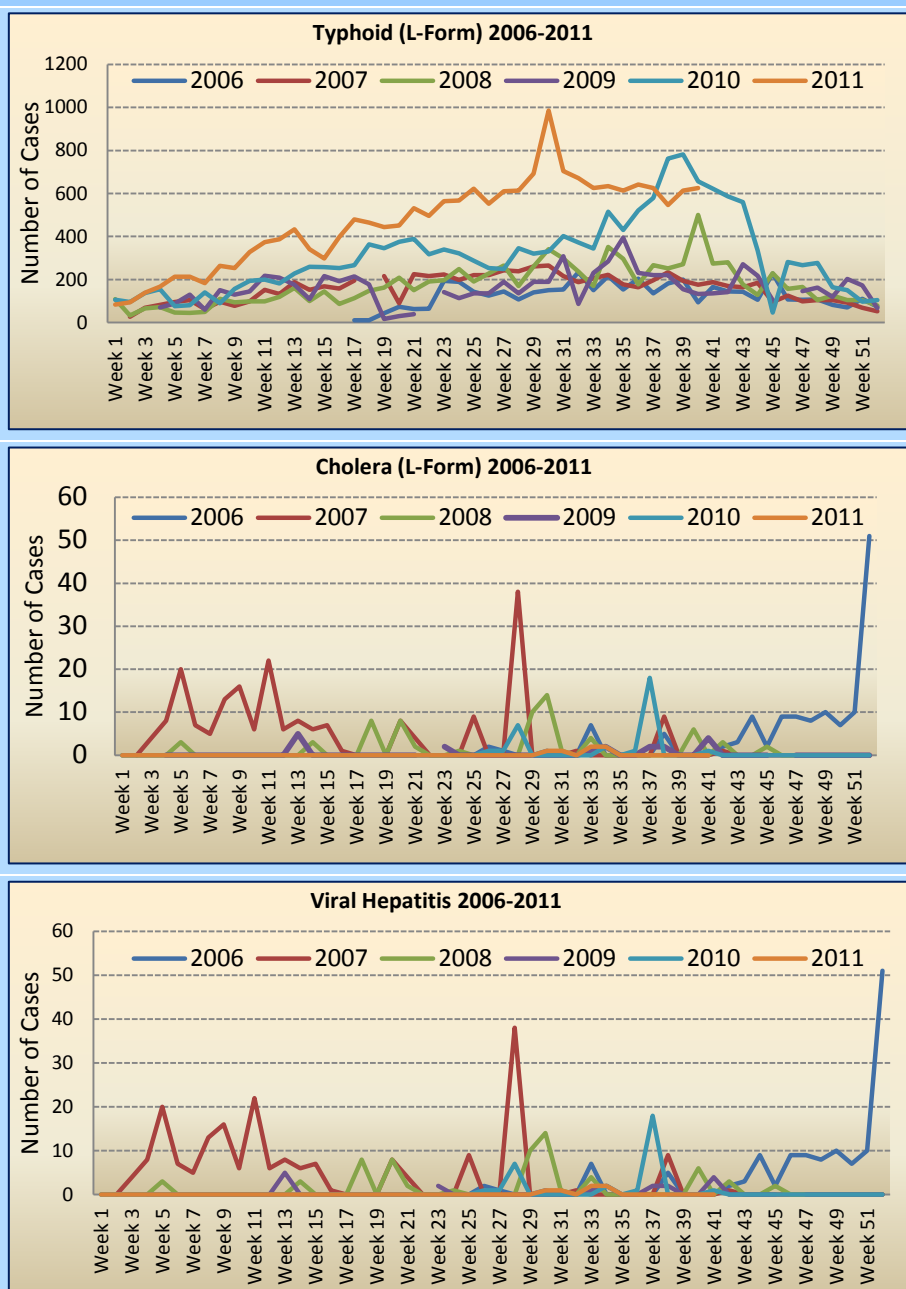


Source: Annual Report of the NVBDCP, Haryana State, 2010.

Water Borne diseases: Mainly water borne diseases like Viral Hepatitis, Typhoid and Cholera are prevalent in the state. Trends of Typhoid cases show that cases are present all over the year but more prevalent during the months from March to October. An overall decline is seen in Cholera cases over the last five years in the state, the cases are seen more in the months from March to July. Viral Hepatitis cases are observed throughout year with sporadic cases, but more number of cases is observed during the months from June to September. The peak number of typhoid cases In 2006 were seen during 45th week, In 2007 during 29th week, in 2008 during 31th week, in 2009 during 35th week, In 2010 during 38th week and in 2011 maximum number of cases were seen in week 30th. The peak numbers of Cholera cases in 2006 were seen during 37th week, In 2007 during 28th week, in 2008 during 30th week, in 2009 during 13th week, In 2010 during 37th week and in 2011 maximum number of cases were seen in week 34th. The peak numbers of Cholera cases in 2006 were seen during 37th week, In 2007 during 28th week, in 2008 during 30th week, in 2009 during 13th week, In 2010 during 37th week and in 2011 maximum number of cases were seen in week 34th. The peak

numbers of Viral Hepatitis cases in 2006 were seen during 26th week, in 2007 during 25th week, in 2008 during 28th week, in 2009 during 30th week, in 2010 during 20th week and in 2011 maximum number of cases were seen in week 21st. Figure 9 shows trends of typhoid, cholera and viral hepatitis between 2006 and 2011 in Haryana.

Figure 9 : Trends of Typhoid, Cholera and viral Hepatitis in Haryana between 2006 and 2011



Source: IDSP, Haryana

Tuberculosis: New sputum positive (NSP) case detection rate of TB patients follows a seasonal variation i.e. during April to September there is rising trend in case detection with peaks from April to June where as a decline is seen in the months of January to March and October to December. As of the 1st quarter 2009 report of the RNTCP, overall 162 TB suspects/lakh population are examined is satisfactory. In spite of good referral of TB suspects total case detection rate of 145/lakh

population and new smear positive case detection rate of 53/lakh population (56%) are low. Sputum conversion rate of 91% is satisfactory but cure rate of 84% in new smear positive patients is marginally low.

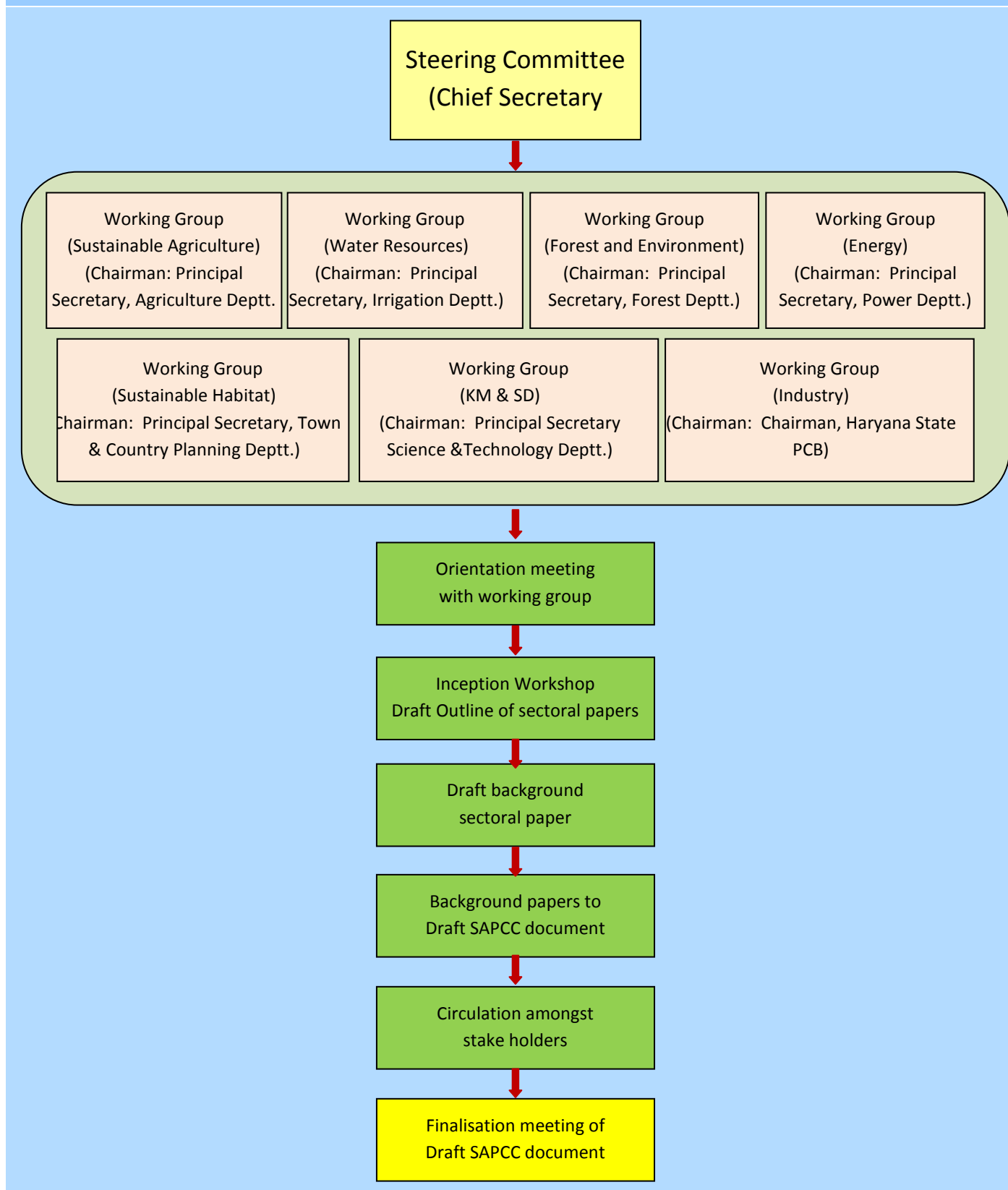
Respiratory Diseases¹¹: In 2010, about 55680 patients were admitted for treatment of respiratory diseases in Haryana. 12% of the total reported deaths in Haryana in 2010 were attributed to respiratory diseases such as asthma, bronchitis and pneumonia (other than TB).

SAPCC Preparation Process

Department of Environment acted as the State Nodal Agency for the preparation of SAPCC. State Steering Committee (SSC) under the chairmanship of Chief Secretary was constituted. Other members in the SSC included Principal Secretaries, Secretaries, Commissioners of the various line departments, research institutions, NGOs and academia. Thereafter, the line departments dealing with the sectors sensitive to climate change constituted the sectoral Working Groups (WGs) with one person designated as the Nodal Officer (NO) of the sector. Figure 10 shows the step involved in the preparation of Haryana SAPCC.

¹¹ Source: State HMIS data analysis- Haryana, April 2010 to March 2011

Figure 10 : Process of SAPCC Preparation



The working group was represented by members from different relevant sectors/departments who contributed to the sectoral action plans prepared by the working group. These working groups were chaired by Principal Secretary of the respective sector with a designated nodal officer. In addition to

the experts from the concerned department/ministry, the working groups had participation of experts from the Science and Technology, academia, research, NGOs and Civil Societies. The working groups were sensitised with the climate change issues in Haryana. Orientation for approach and methodology to be followed in the preparation of SAPCC was conducted in early September 2011. One-day Inception Workshop on 13th October 2011 was held at Chandigar which was well represented by line department heads, officers, experts from academia, research, NGOs and civil society representatives. Deliberation and discussions made were used as the guiding principle in formulating the action plan for various sectors. Extensive consultations within the working group members and other concerned stake holders were carried out. Actions, budget and period of implementation of the proposed actions across the sectors based on the above deliberations were drafted in to action plans. Draft report was further circulated to the stakeholders for comments. The draft report was updated with the comments duly received.

Chapter 2

Climate – Current Baseline and Climate Projections

Chapter 2 - Climate – Current Baseline and Climate Projections

The long term trends in observed seasonal precipitation and temperature over Haryana using IMD gridded rainfall and temperature at daily time scales has been performed to arrive at current baseline climatology for the basin. Summary is presented in the following paragraphs.

Data used

- IMD gridded rainfall at 0.5 degree spatial resolution for the time period 1971-2005 (35 years)
- IMD gridded maximum and minimum temperature at 1 degree spatial resolution for the time period 1969-2005 (37 years)

Observed Precipitation trends

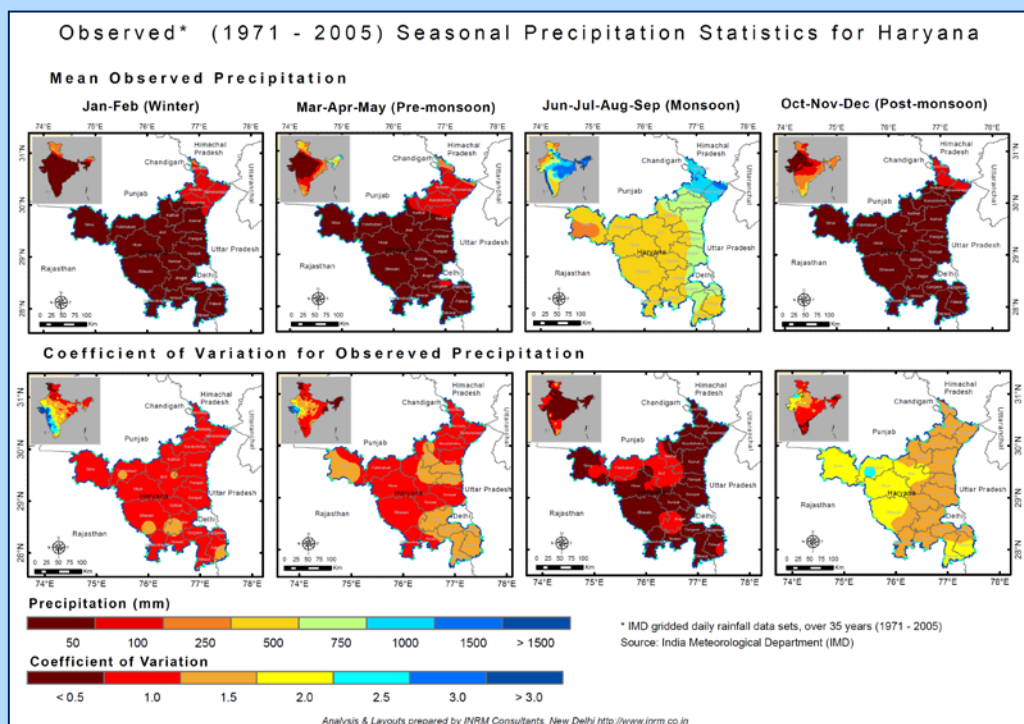
Rainfall in the state of Haryana varies considerably both in space and time from year to year. Table 10 gives the summary of observed rainfall statistics for Haryana.

Table 10: Observed Rainfall Statistics average over the time period 1971-2005 (35 years) for Haryana

Season	Statistics	Value	Contribution in Annual Rainfall (%)
Annual	Average (mm)	544	
	Range - Average (mm)	295.4-1228.9	
Winter (JF)	Average (mm)	23.2	4.3
	Range - Average (mm)	11-54.8	
Pre Monsoon (MAM)	Average (mm)	42.6	7.8
	Range - Average (mm)	14.4-84.2	
Monsoon (JJAS)	Average (mm)	446.5	82.1
	Range - Average (mm)	230.4-1008.3	
Post Monsoon (OND)	Average (mm)	31.8	5.8
	Range - Average (mm)	12.2-81.6	
Annual	Range- Inter-annual variation	0.3-0.6	
Winter (JF)	Range- Inter-annual variation	1.1-2.2	
Pre Monsoon (MAM)	Range- Inter-annual variation	0.8-0.6	
Monsoon (JJAS)	Range- Inter-annual variation	0.3-0.6	
Post Monsoon (OND)	Range- Inter-annual variation	0.6-1.1	
<i>Source: IMD Gridded rainfall data (1971-2005)</i>			

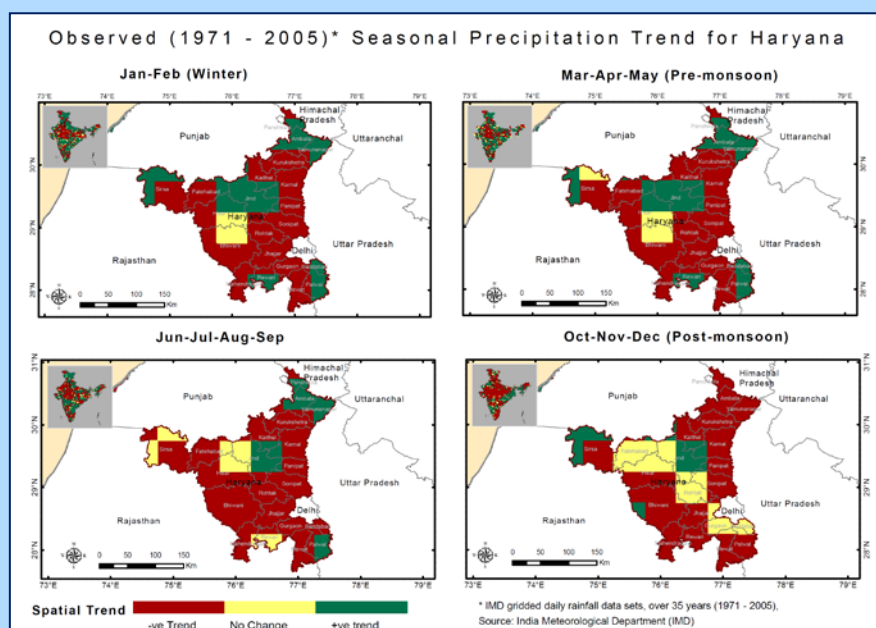
The mean south-west monsoon (June, July, August and September) rainfall (447 mm) contributes 82% of annual rainfall (544 mm). Mean monthly rainfall during August (163 mm) is highest and contributes about 30% of annual rainfall, followed by July which contributes about 29.5%. The mean rainfall during June is slightly lower and contributes about 10% of annual rainfall. September rainfall contributes 13 % of annual rainfall. Contribution of pre-monsoon (March, April and May) rainfall and post-monsoon (October, November and December) rainfall in annual rainfall is 8% and 5.8% respectively. Inter annual variation in rainfall is very marginal (Figure 11).

Figure 11 : Inter annual variation in seasonal rainfall in Haryana



Temporal variation in monthly, seasonal and annual rainfall over IMD grids belonging to Haryana has been made for the period from 1971 to 2005. Long term changes in rainfall determined by Mann-Kendall rank statistics and linear trend has also been carried out. Figure 12 shows the spatial variation in the trend in seasonal precipitation.

Figure 12 : Observed seasonal rainfall trend in Haryana



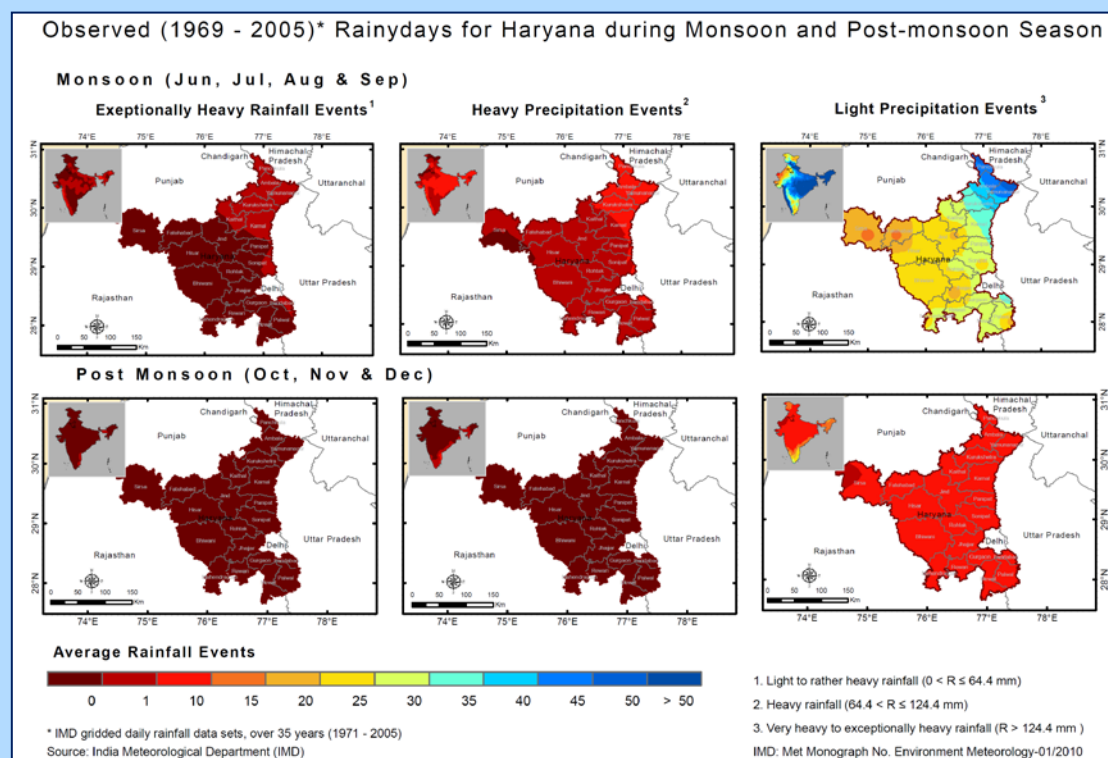
Parts of Bhiwani, Faridabad, Fatehabad, Gurgaon, Jhajjar, Jind, Karnal, Kurukshetra, Mahendragarh, Rohtak, Sirsa, Sonapat show decreasing trend in the monsoon rainfall.

Rain has been regrouped into three broad categories (Pattanaik and Rajeevan, 2010¹²) for calculating extreme rainfall, i) light to rather heavy rainfall ($0 < R \leq 64.4$ mm), ii) heavy rainfall ($64.4 < R \leq 124.4$ mm) and iii) very heavy to exceptionally heavy rainfall ($R > 124.4$ mm). Rainfall > 124.4 mm is referred as extreme rainfall events. Figure 13 shows these events during monsoon and post monsoon period.

Average number of rainy days in Haryana during the south west monsoon is about 25 days and varies spatially from 14 days to 40 days. Days when there is high rainfall events range from 1 to 3 days and similarly the extreme rainfall days are less and is about 1 day.

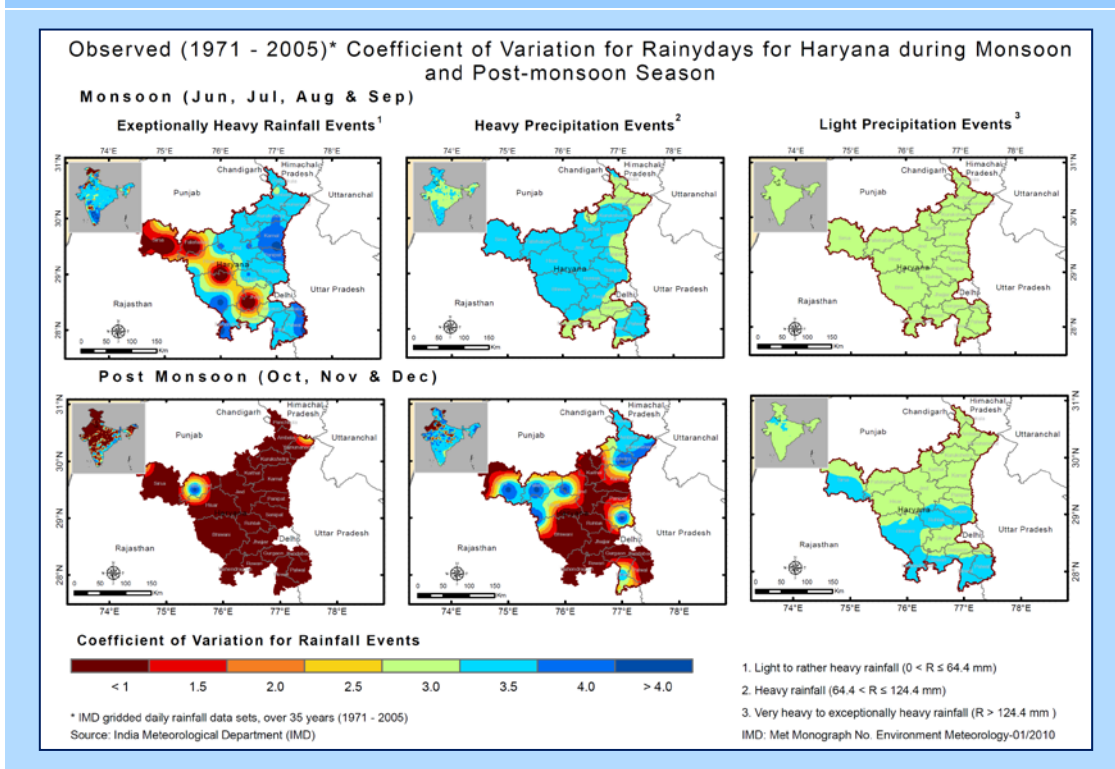
Average number of rainy days in Haryana during the post monsoon (winter) is about 2 days and varies from 1 days to 3 days. Days when there are high and extreme rainfall events are negligible.

Figure 13 : Observed rainfall Statistics –Average Seasonal rainy days - Haryana



There is a large inter annual variation in heavy rainy days. Light rainfall days show less inter annual variation (Figure 14).

¹² Pattanaik, D. R. and Rajeevan, M., 2010, Variability of Extreme Rainfall Events over India During Southwest Monsoon Season; 2010, Meteorological Applications Vol. 17, 88-104

Figure 14 : Observed rainfall Statistics – Inter annual variation in rainy days - Haryana

Observed Temperature trends

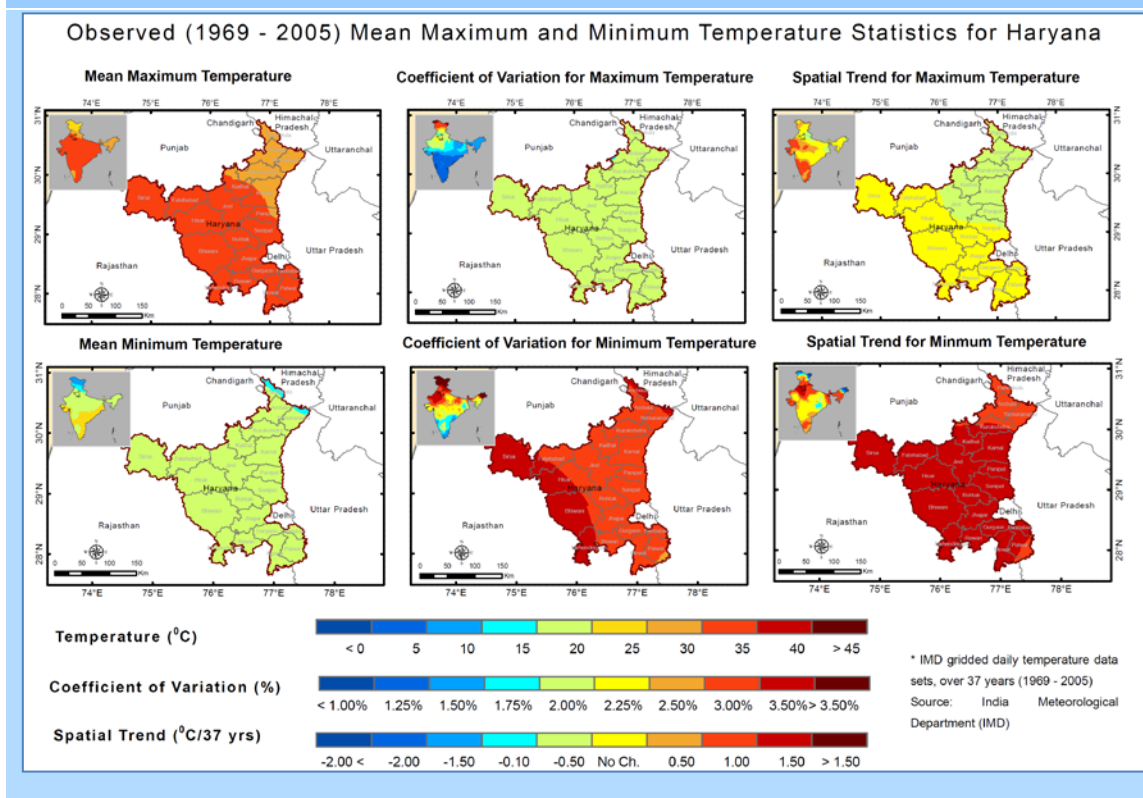
The state of Haryana shows a spatial as well as temporal variability. Table 11 gives the summary of annual and seasonal temperature statistics.

Table 11: Observed Temperature Statistics average over the time period 1969-2005 (37 years) for Haryana

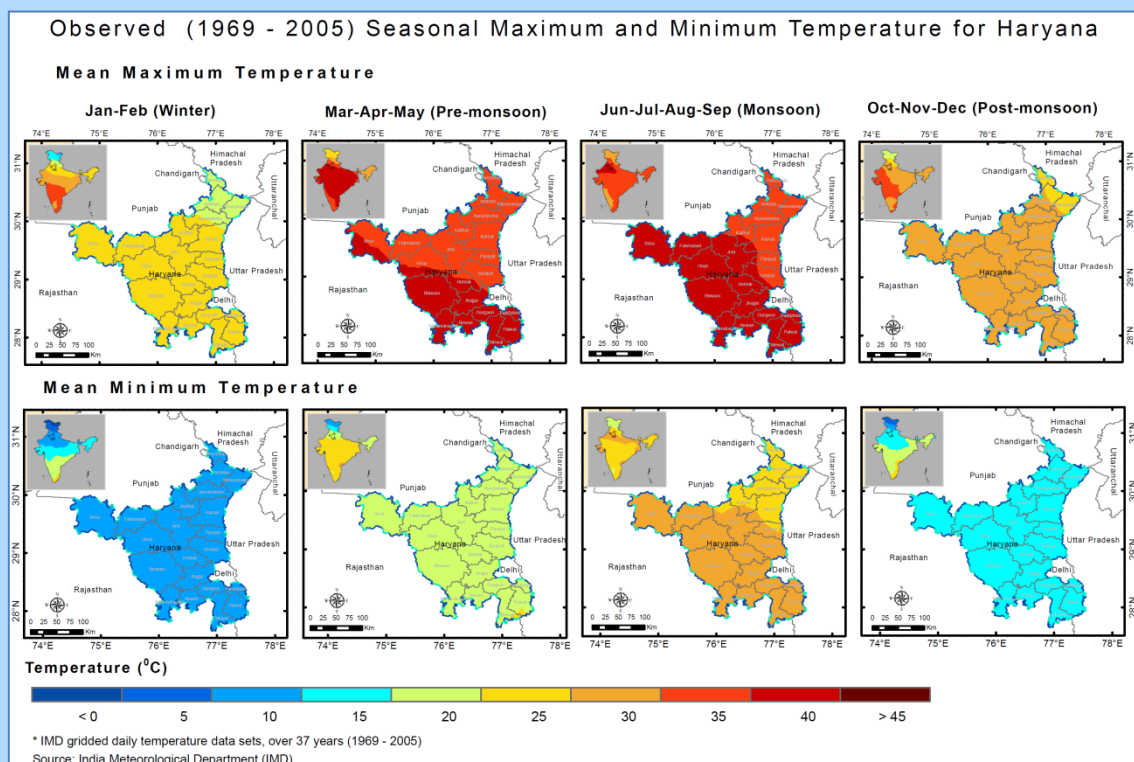
Season	Statistics	Maximum Temperature	Minimum Temperature
Annual	Average (mm)	31.4	17.4
	Range - Average (mm)	30.9 - 31.9	17 - 17.8
Winter (JF)	Average (mm)	21.9	7.3
	Range - Average (mm)	21.5 - 22.5	6.9 - 7.6
Pre Monsoon (MAM)	Average (mm)	35.1	19.0
	Range - Average (mm)	34.6 - 35.8	18.5 - 19.6
Monsoon (JJAS)	Average (mm)	35.8	25.4
	Range - Average (mm)	35.4 - 36.2	25.2 - 25.7
Post Monsoon (OND)	Average (mm)	28.2	11.9
	Range - Average (mm)	27.7 - 28.7	11.3 - 12.5
Annual	Range- Inter-annual variation	0.02 - 0.02	0.03 - 0.03
Winter (JF)	Range- Inter-annual variation	0.04 - 0.04	0.13 - 0.14
Pre Monsoon (MAM)	Range- Inter-annual variation	0.03 - 0.04	0.04 - 0.04
Monsoon (JJAS)	Range- Inter-annual variation	0.02 - 0.03	0.02 - 0.02
Post Monsoon (OND)	Range- Inter-annual variation	0.04 - 0.04	0.06 - 0.07

Diurnal temperature varies from 31.4°C to 17.4°C. There is no significant trend in the mean maximum temperature, minimum temperature shows an increase of about 1.0°C to 1.2°C in 37 years. Districts of Fatehabad, Jhajjar and Karnal show higher increase in the minimum temperature (1.1°C to 1.3°C). Inter annual variation is not significant. Spatial variation in annual maximum and minimum temperature found to be around 2°C. Figure 15 depicts spatial variation in the long term statistics for mean maximum and minimum temperatures.

Figure 15 : Observed mean maximum and minimum temperature in Haryana



As seen in Table 11, seasonal average maximum temperature is higher during pre monsoon and monsoon season and ranges between 35.4°C to 36.2°C. Similarly seasonal average minimum temperature is lowest during winter period and ranges from 6.9°C to 7.6°C. Figure 16 shows the daily seasonal spatial variation in maximum and minimum temperature.

Figure 16 : Observed seasonal temperature in Haryana

Climate Change Scenarios

The IPCC scenarios provide a mechanism to assess the potential impacts on climate change. Global emission scenarios were first developed by the IPCC in 1992 and were used in global general circulation models to provide estimates for the full suite of greenhouse gases and the potential impacts on climate change. Since then, there has been greater understanding of possible future greenhouse gas emissions and climate change as well as considerable improvements in the general circulation models. The IPCC, therefore, developed a new set of emissions scenarios, published in the IPCC Special Report on Emission Scenarios (IPCC SRES November 2000¹³). These scenarios provided input into the Third and Fourth Assessment Reports and were the basis for evaluating climatic and environmental consequences of different levels of future greenhouse gas emissions and for assessing alternative mitigation and adaptation strategies. These scenarios refer to the predictions made for future conditions mainly related to precipitation, sea level rise and temperature changes based on 'storylines' of the alternate greenhouse gas emissions. There are four storylines (A1, A2, B1 and B2) identifying alternate states of future economic and technological development that takes place over the next few decades as summarized in Table 12

¹³ IPCC SRES (2000), Nakićenović, N., and Swart, R., ed. (book), Special Report on Emissions Scenarios: A special report of Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press.

Table 12: Summary of IPCC SRES Scenarios

IPCC SRES Scenarios	
A1 World: Market Oriented Economy: Rapid economic growth. Population: Peaks in 2050 and then gradually declines. Governance: A convergent world - income and way of life converge between regions. Extensive social and cultural interactions worldwide. Technology: There are three subsets to the A1 family A1FI - fossil-fuels intensive. A1B - balanced on all energy sources. A1T - non-fossil energy sources.	A2 World: Divided World Economy: Regionally oriented, lowest per capita income Population: Continuously increasing population. Governance: independently operating, self-reliant nations Technology: Slower and more fragmented
B1 World: Convergent Economy: service and information based, lower growth than A1 Population: Same as A1. Governance: global solutions to economic, social and environmental stability Technology: clean and resource efficient technologies	B2 World: Local Solutions Economy: Intermediate levels of economic development Population: Continuously increasing population, but at a slower rate than in A2. Governance: local solutions to economic, social and environmental stability Technology: more rapid A2, less rapid more diverse A1/B1
Source: IPCC 4th Assessment Report (2007)	

Climate models are mathematic models used to simulate the behaviour of climate system. They incorporate information regarding climate processes, current climate variability and the response of the climate to the human-induced drivers. These models range from simple one dimensional models to complex three dimensional coupled models. The latter, known as Global Circulation Models (GCM), incorporate oceanic and atmospheric physics and dynamics and represent the general circulation of the planetary atmosphere or ocean. The GCMs are usually run at very coarse grid (about $3^{\circ} \times 3^{\circ}$) resolution whereas the processes that are of interest for studies such as this one, such as precipitation, are highly influenced by the local features namely orography and land use. These local characteristics are not properly represented at the coarse scale of GCM and contribute to prediction errors on the impact of climate change at the sub-grid scale. Therefore, these GCMs are strengthened with the incorporation of local factors and downscaled, in general with a grid resolution of about $0.5^{\circ} \times 0.5^{\circ}$ or less. The downscaling can be of dynamic or statistical type. These models are referred to as Regional Climate Models (RCM) and improve the quality of climatic prediction for specific local areas.

A RCM is a model of the atmosphere and land surface which has high horizontal resolution and consequently covers a limited area of the earth's surface. A RCM cannot exist without a 'parent' GCM to provide the necessary inputs. The RCMs provide an opportunity to dynamically downscale global model simulations to superimpose the regional detail of specified region. RCM provide climate information with useful local detail including realistic extreme events and also they simulate current climate more realistically.

A regional climate model:

- Is comprehensive physical high resolution (~50km) climate model
- Covers a limited area of the globe

- Includes the atmosphere and land surface components of the climate system
- Contains representations of the key processes within the climate system (e.g., cloud, radiation, rainfall, soil hydrology)

Advantages of Regional climate models include

- highly resolved information
- physically based character
- many variables
- better representation of the mesoscale and weather extremes than in GCMs.

Disadvantages of Regional climate models include

- computational expensiveness, particularly for long runs
- lack of two way nesting (feedback with the forcing GCM input)
- dependence on usually biased inputs from the forcing GCM
- errors in the GCM fields that could result in errors in the regional climate scenarios
- availability of fewer scenarios.

Providing REgional Climates for Impact Studies (PRECIS) is an atmospheric and land surface model of limited area and high resolution which is locatable over any part of the globe. Dynamical flow, the atmospheric sulphur cycle, clouds and precipitation, radiative processes, the land surface and the deep soil are all described and lateral boundary conditions (LBCs) are required at the limits of the model's domain. Information from every aspect may be diagnosed from within the model (Noguer et al., 1998¹⁴).

PRECIS can be applied easily to any area of the globe to generate detailed climate change predictions and is used for vulnerability and adaptation studies and climate research.

Regional Climate Scenarios for India Using PRECIS

PRECIS is the Hadley Centre portable regional climate model, developed to run on a PC with a grid resolution of $0.44^\circ \times 0.44^\circ$. High-resolution limited area model is driven at its lateral and sea-surface boundaries by output from global coupled atmosphere-ocean (HadCM3) and global atmospheric (HadAM3) general circulation models. PRECIS captures important regional information on summer monsoon rainfall missing in its parent GCM simulations.

Indian RCM PRECIS has been configured for a domain extending from about 1.5°N to 38°N and 56°E to 103°E . IPCC SRES A1B Scenario¹⁵– Q14 Qump (Quantifying Uncertainty in Model Predictions¹⁶) for

¹⁴ Noguer M, Jones R, Murphy J (1998) Sources of systematic errors in the climatology of a regional climate model over Europe. *Clim Dyn* 14:691–712

¹⁵ PRECIS A1B, which is a mid path scenario, a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies, with the development balanced across energy sources

the time slices of present (1961–1990), mid century (2021–2050) and end century (2071–2100) has been made available by IITM Pune.

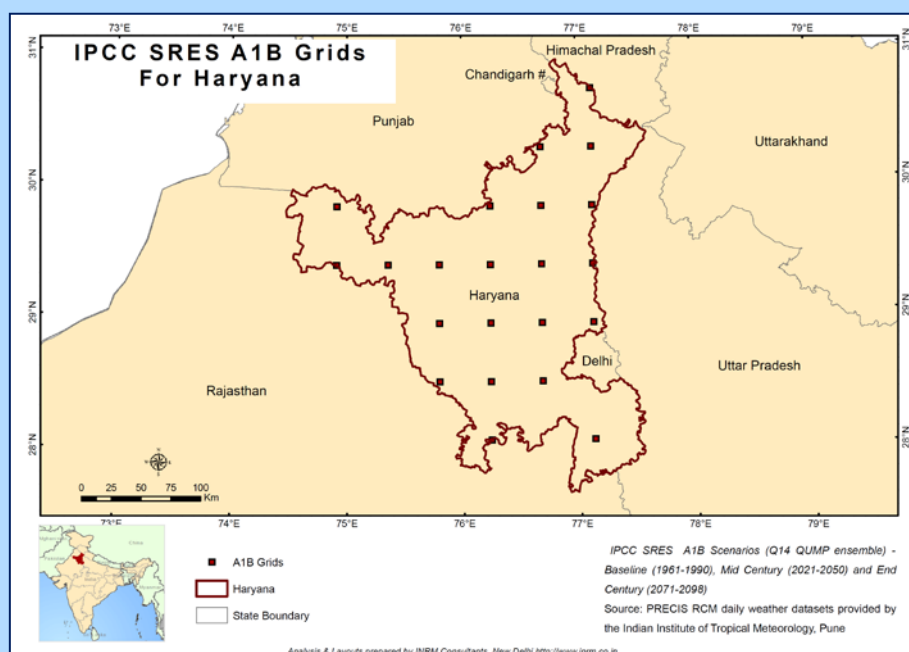
Simulations from a seventeen-member perturbed physics ensemble (PPE) produced using HadCM3 under the Quantifying Uncertainty in Model Predictions (QUMP) project of Hadley Centre Met Office, UK have been used as LBCs for 138 year simulations of the regional climate model PRECIS. The QUMP simulations, comprise 17 versions of the fully coupled version of HadCM3, one with the standard parameter setting and 16 versions in which 29 of the atmosphere component parameters are simultaneously perturbed (Collins et al., 2006¹⁷).

Climate change Data Extraction

Data for many different variables (physical quantities, Rainfall, Temperature, Solar Radiation, Relative humidity, Wind speed) at a variety of different timescales; Daily, monthly are used for the study area. All model data represent grid cell averages, i.e. an average quantity over a 2500 km² (50 km X 50 km) and are available in binary format.

Special data extraction software is used to extract the relevant grids for the study areas. The RCM grids for Haryana are shown in Figure 17.

Figure 17 : PRECIS Data grids of Haryana



¹⁶ The basic approach involves taking a single

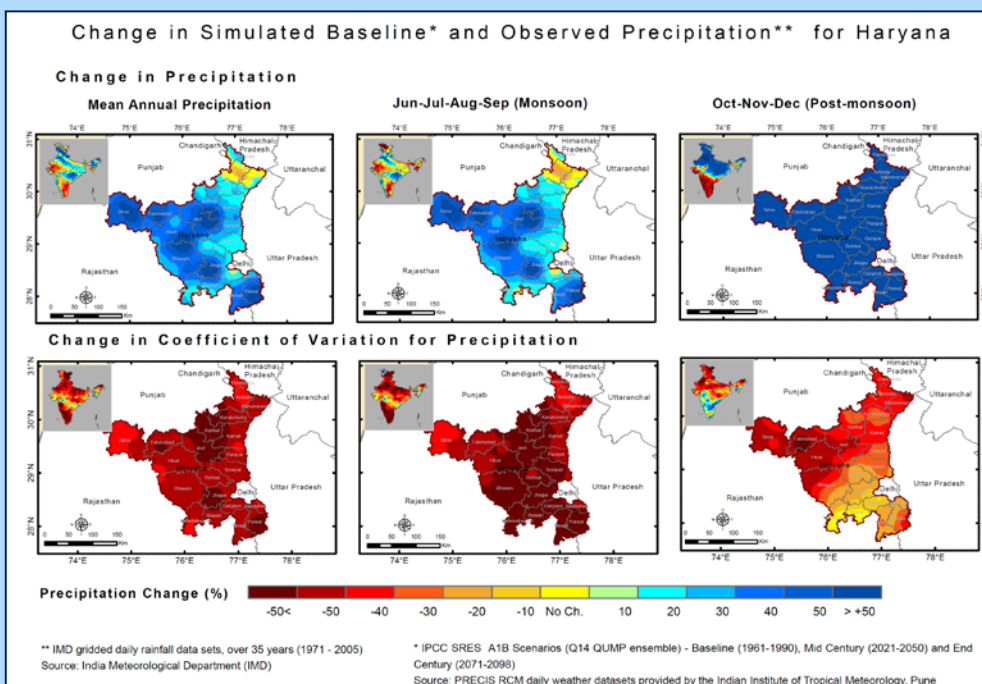
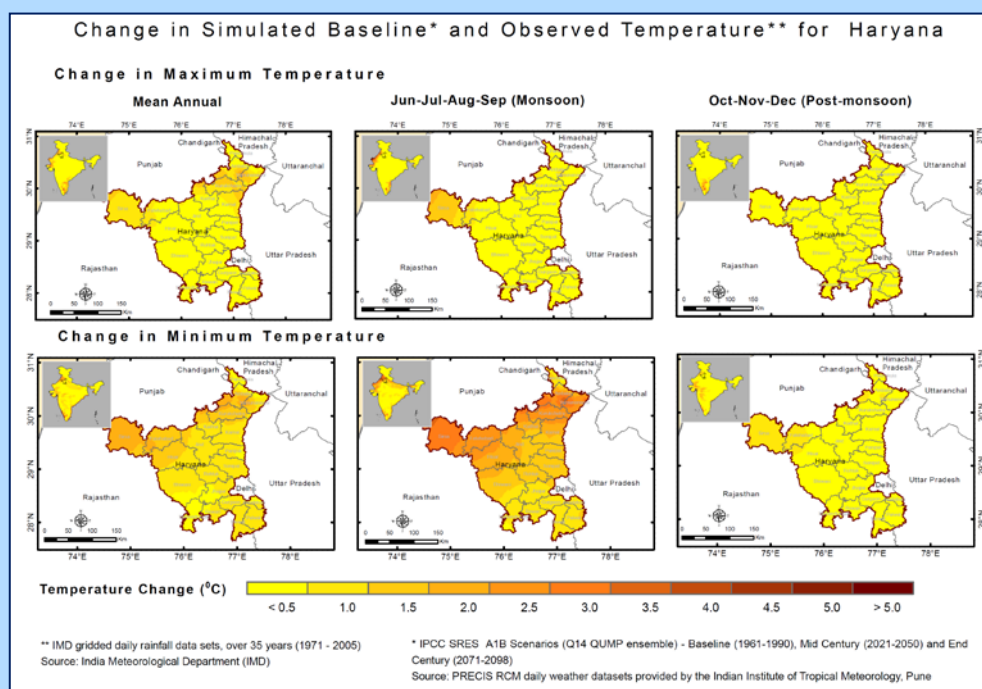
model structure and making perturbations to the values of parameters in the model, based on the discussions with scientists involved in the development of different parameterization schemes

¹⁷ Collins, W.D., V. Ramaswamy, M.D. Schwarzkopf, Y. Sun, R.W. Portmann, Q. Fu, S.E.B. Casanova, J.-L. Dufresne, D.W. Fillmore, P.M.D. Forster, V.Y. Galin, L.K. Gohar, W.J. Ingram, D.P. Kratz, M.-P. Lefebvre, J. Li, P. Marquet, V. Oinas, Y. Tsushima, T. Uchiyama, and W.Y. Zhong, 2006: Radiative forcing by well-mixed greenhouse gases: Estimates from climate models in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). J. Geophys. Res., 111, D14317

Comparison of Observed and Simulated Temperature and Rainfall

A comparison of the simulated baseline temperature and rainfall was made to examine the model simulation capability. Figure 18 shows spatial distribution of temperature and rainfall at annual and summer and winter monsoon. It can be seen that simulated baseline reproduces the observed temperature statistics well.

Figure 18 : Comparison of Observed and Simulated baseline Temperature and Rainfall - Haryana



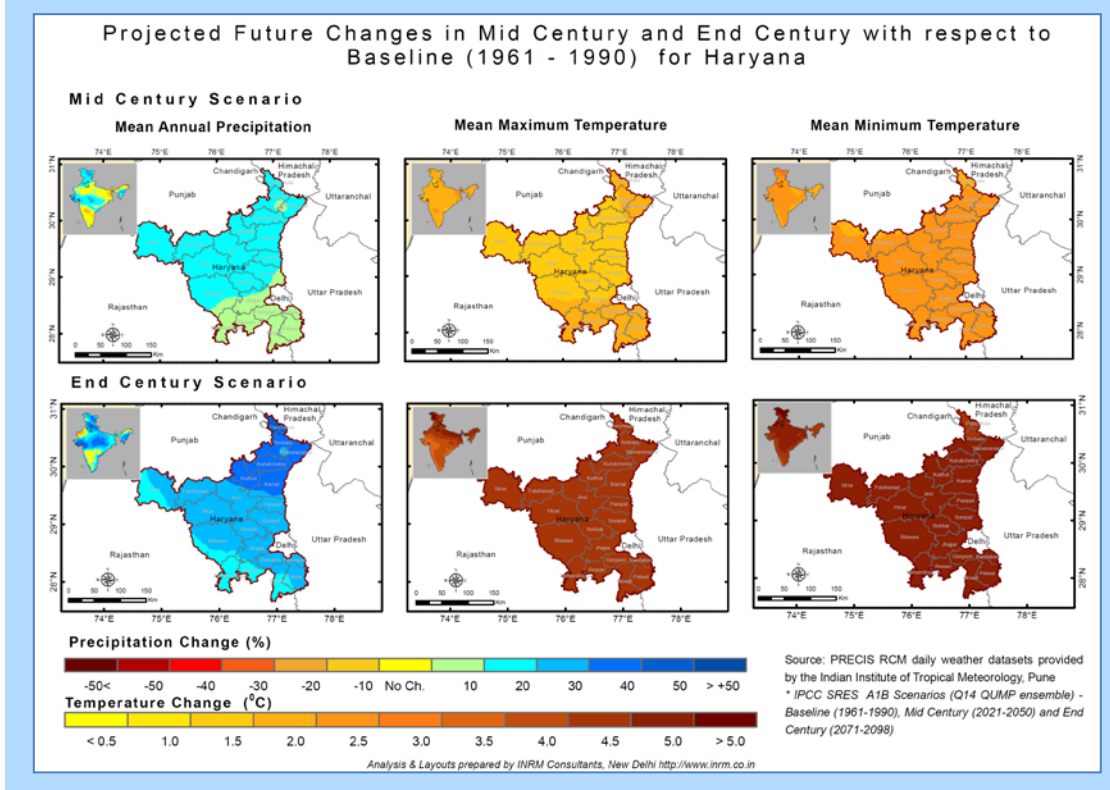
$Change (\%) = 100 \times (BL - IMD) / IMD$: +ve over simulation and vice versa

Simulated baseline rainfall for monsoon months, JJAS, shows volumetric difference of about 20 to 30% increase. Ambala, Panchkula and Yamunanagar on the north of Haryana show good agreement between simulated baseline and IMD rainfall, where as Sirsa, Fatehabad, Hissar, Jind, Jhajjar, Palwal show 20 to 30% over simulation of rainfall in the baseline as compared to IMD rainfall. Eastern part of Haryana shows over simulation by 20% as compared to IMD rainfall. Baseline simulated rainfall shows less inter annual variation than IMD rainfall.

Analysis of the Climate Change Data

The PRECIS data on precipitation, maximum and minimum temperature have been analysed for Haryana. Preliminary inferences on the variations of these entities have been presented in Figure 19. Mean maximum temperature is projected increase by 1.3⁰C and mean minimum temperature by 2.1⁰C towards mid century. The increase in mean maximum temperature is projected to be 4.2⁰C and mean minimum temperature 4.7⁰C towards end century respectively. Decrease is projected for average annual rainfall by 3.0% for mid century scenario and increase by 17% for end century scenario.

Figure 19 : Projected Change in mean annual precipitation and temperature in Haryana



PRECIS Temperature

The HADCM3 simulations downscaled with PRECIS indicate an all-round warming over the Indian subcontinent associated with increasing greenhouse gas concentrations. Seasonal mean daily maximum and mean daily minimum temperatures from the PRECIS simulation of the A1B scenarios for Haryana are given in Table 13.

Table 13: Characteristics of simulated seasonal and annual temperature

Temperature for IPCC SRES baseline and A1B scenario as simulated by PRECIS for Haryana						
Mean Daily Maximum Temperature (°C)						
		JF	MAM	JJAS	OND	Annual
Haryana	Baseline	21.4	38.2	34.5	24.5	29.7
Haryana	Mid Century	22.6	40.3	36.2	24.9	31.0
Haryana	End Century	25.7	42.8	38.8	28.2	33.9
Mean Daily Minimum Temperature (°C)						
Haryana	Baseline	5.8	21.2	26.5	11.7	16.3
Haryana	Mid Century	7.6	23.7	28.3	13.8	18.4
Haryana	End Century	10.3	26.5	30.6	16.7	21.0
Comparison of projected changes in temperatures for IPCC SRES scenario with respect to baseline **						
Change in Mean Daily Maximum Temperature (°C)						
		JF	MAM	JJAS	OND	Annual
Change from Baseline to Mid Century		1.2	2.1	1.7	0.4	1.3
Change from Baseline to End Century		4.3	4.6	4.3	3.7	4.2
Change in Mean Daily Minimum Temperature (°C)						
Change from Baseline to Mid Century		1.8	2.5	1.8	2.1	2.1
Change from Baseline to End Century		4.5	5.3	4.1	5	4.7

** Positive change indicates warming in Future and negative change indicates cooling in future

Both maximum and minimum temperatures are projected to rise significantly under the PRECIS A1B scenario. Increases in the monsoon season would be lower than in the dry seasons. Seasonal Temperatures are shown in Figure 20.

Figure 20 : Characteristics of simulated seasonal and annual temperature - Haryana

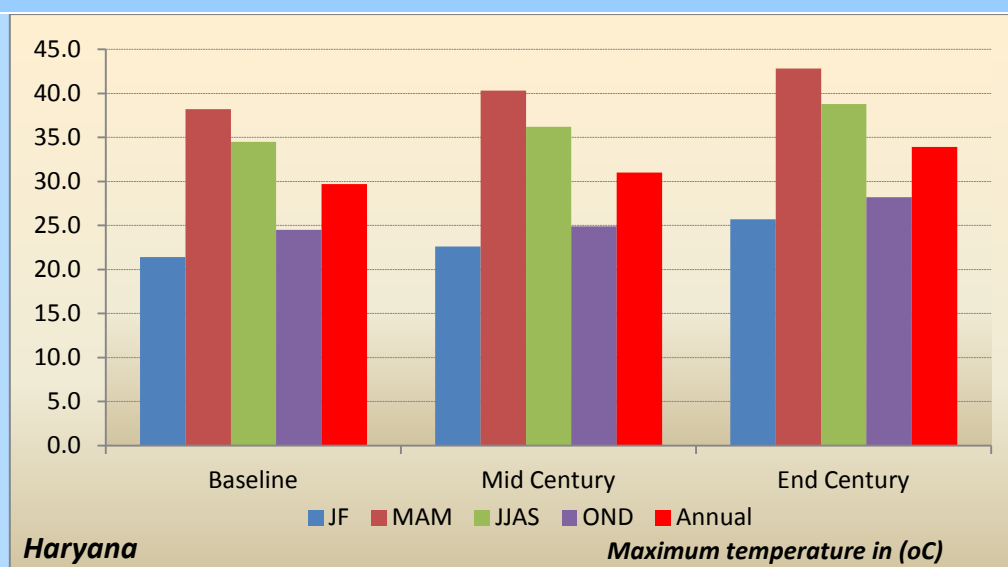
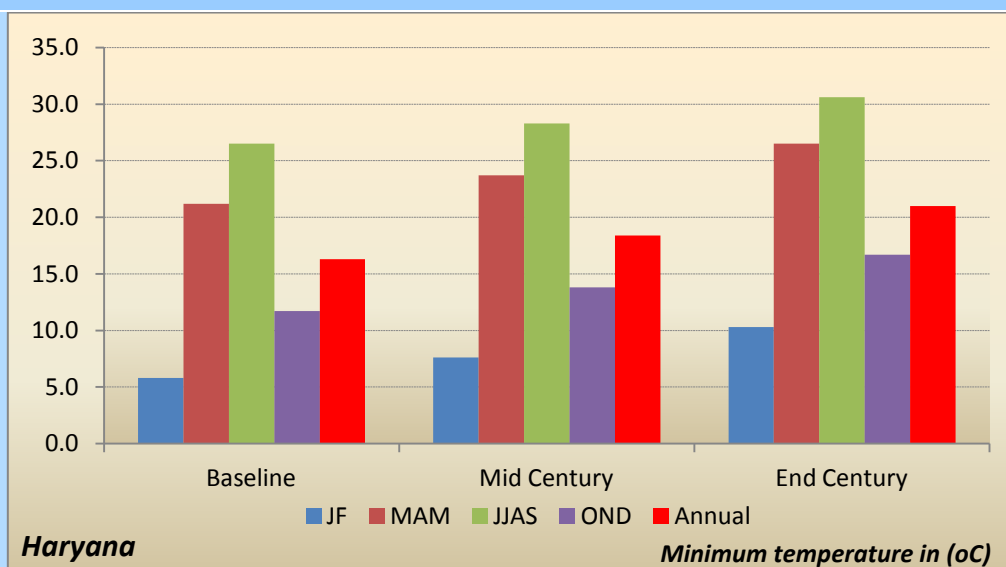


Figure 20 : Characteristics of simulated seasonal and annual temperature - Haryana



Spatial variation in the change in the mean daily maximum and minimum temperature is shown in Figure 21.

Figure 21 : Projected Change in seasonal temperature in Haryana

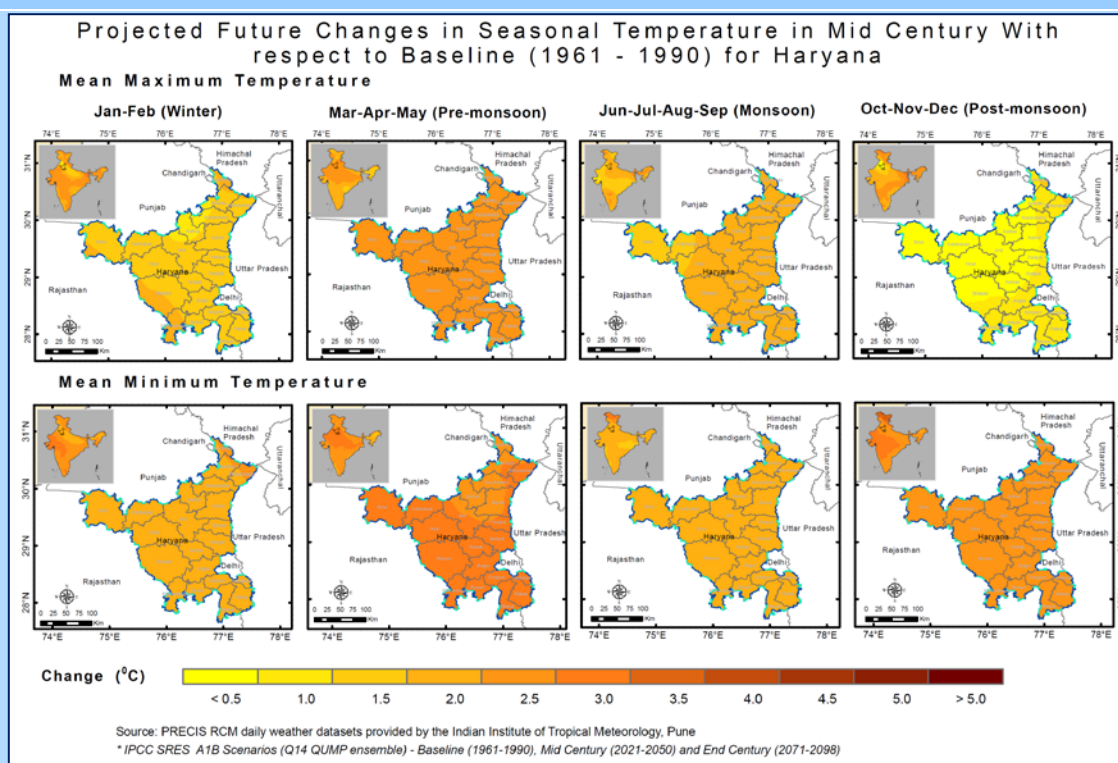
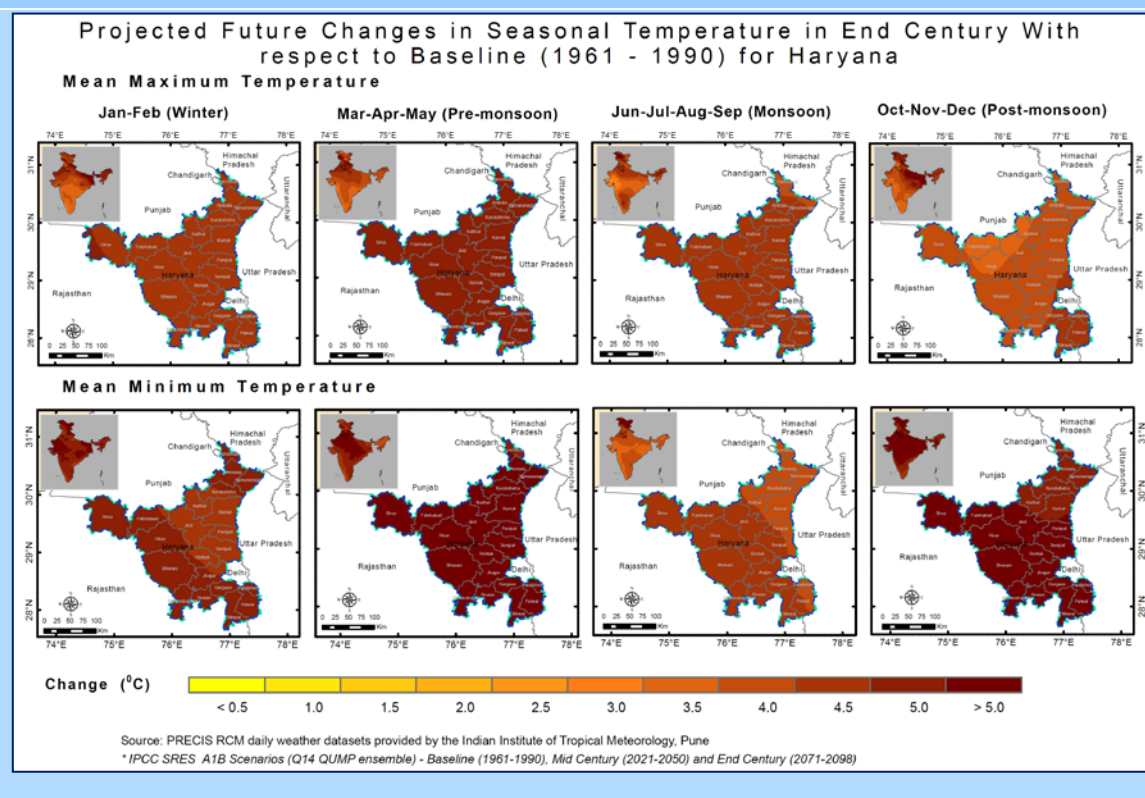


Figure 21 : Projected Change in seasonal temperature in Haryana

It can be seen from the figure that the projected change in minimum temperature higher than the change in maximum temperature. Maximum changes are noticed in pre and post monsoon season.

PRECIS Precipitation

Haryana receives most of its rain during the monsoon season, which starts in late June. The mean seasonal precipitation amounts simulated by PRECIS are as shown in Table 14. Data are presented for four seasonal periods: JF - January, February; MAM - March, April, May; JJAS - June, July, August, September; OND - October, November, December. Projected changes to mid and end-century is also presented.

Under the A1B scenario, mean annual rainfall is projected to decrease marginally for Haryana by about 63 mm (3%) by mid century and increase by about 347 mm (17%) by end century. Monsoon months, JJAS show marginal to 14% increase in mid and end century scenarios respectively. Figure 22 shows the characteristics of rainfall for Haryana.

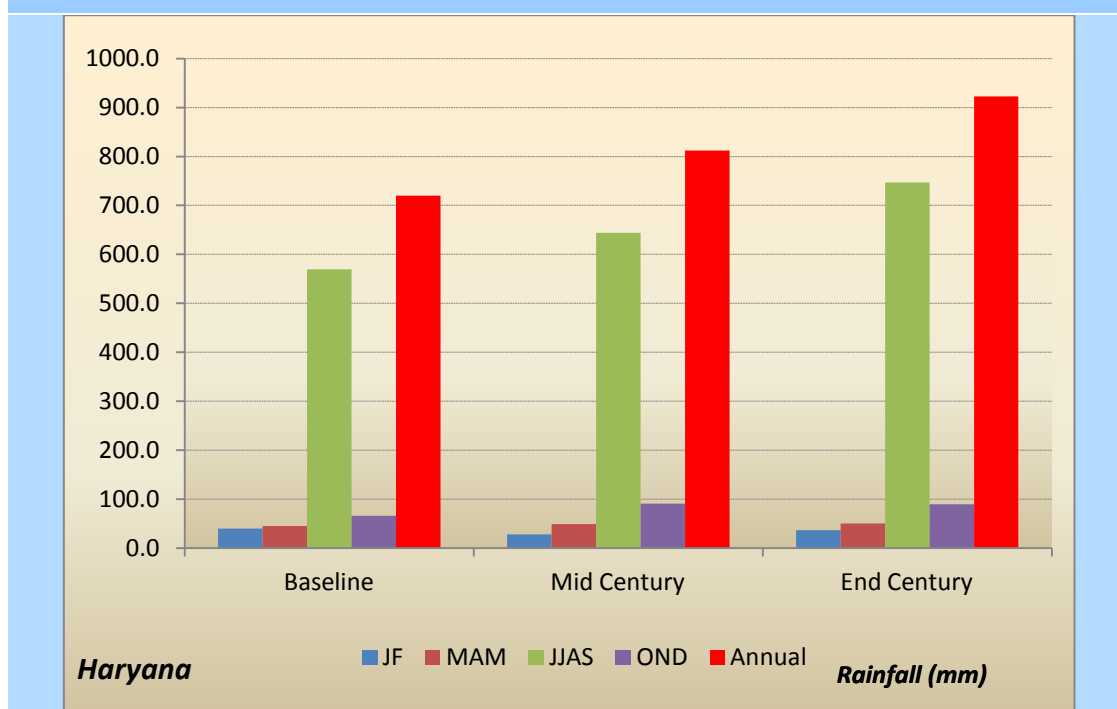
Table 14: Rainfall Statistics for Haryana

IPCC SRES baseline and A1B scenario as simulated by PRECIS for Haryana						
Rainfall (mm)						
		JF	MAM	JJAS	OND	Annual
Haryana	Baseline	88.5	470.2	1299.6	227.1	2085.4
Haryana	Mid Century	67.8	449.2	1302.8	201.9	2021.7
Haryana	End Century	83.1	575.7	1481.2	292.3	2432.3
Comparison of projected changes in seasonal and annual rainfall (mm) for IPCC SRES scenario with respect to baseline **						
Change in rainfall (%)						
Change from Baseline to Mid Century		-23.4	-4.5	0.2	-11.1	-3.1
Change from Baseline to End Century		-6.1	22.4	14	28.7	16.6

** Positive change indicates increase in future and negative change indicates decrease in future

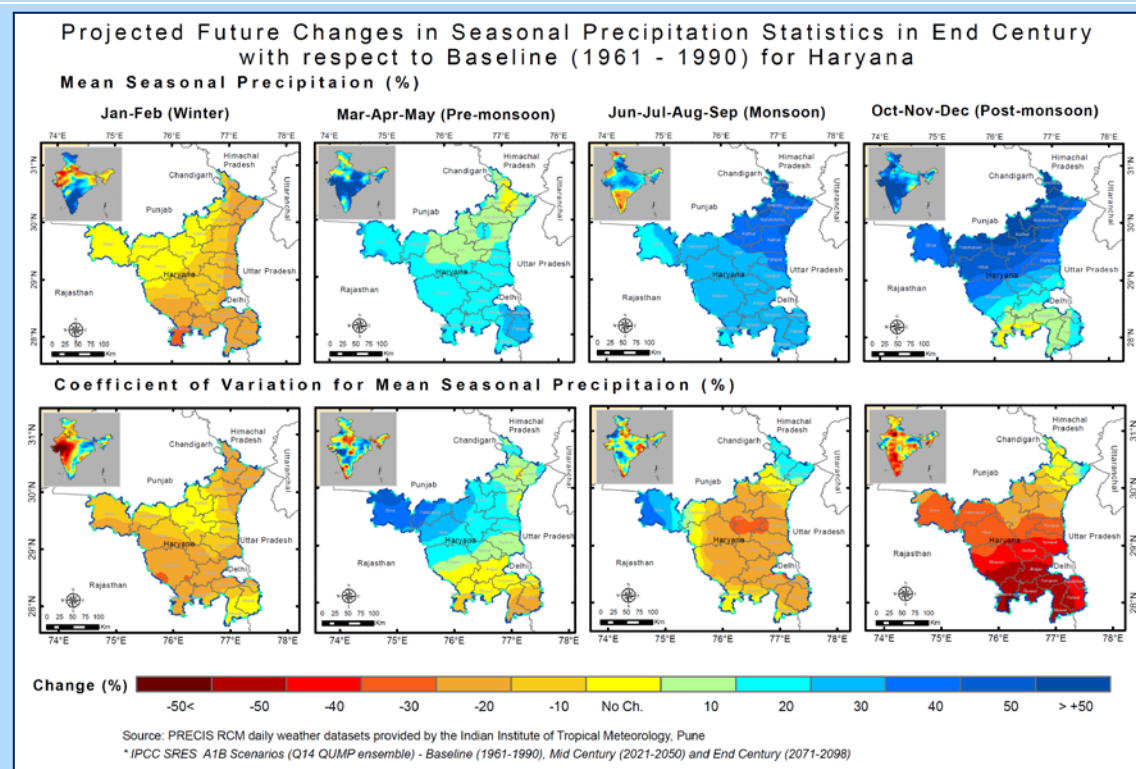
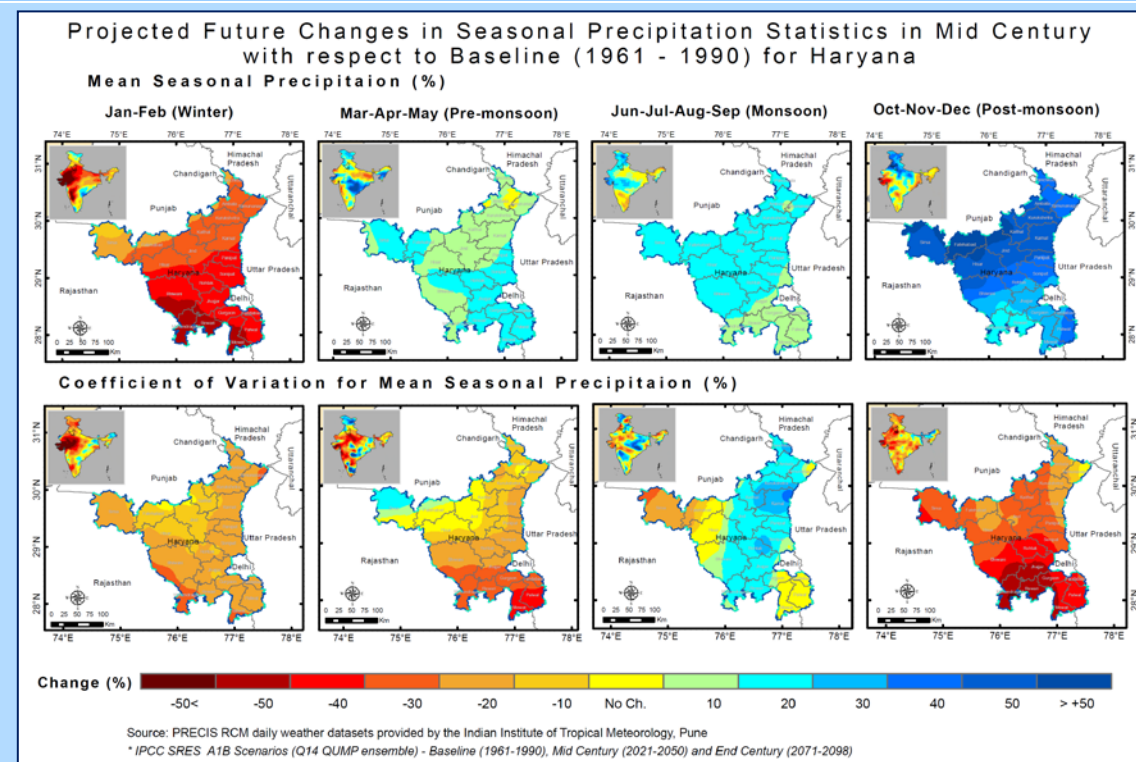
JF - January, February; MAM - March, April, May; JJAS - June, July, August, September; OND - October, November, December

Figure 22 : Characteristics of simulated seasonal and annual rainfall and temperature



Spatial distribution of seasonal rainfall is depicted in Figure 23.

Figure 23 : Projected Change in seasonal precipitation in Haryana



Intense Rainfall Events: The analysis did not show any significant change in the number of extreme rainfall events.

Temperature Humidity Index (THI)

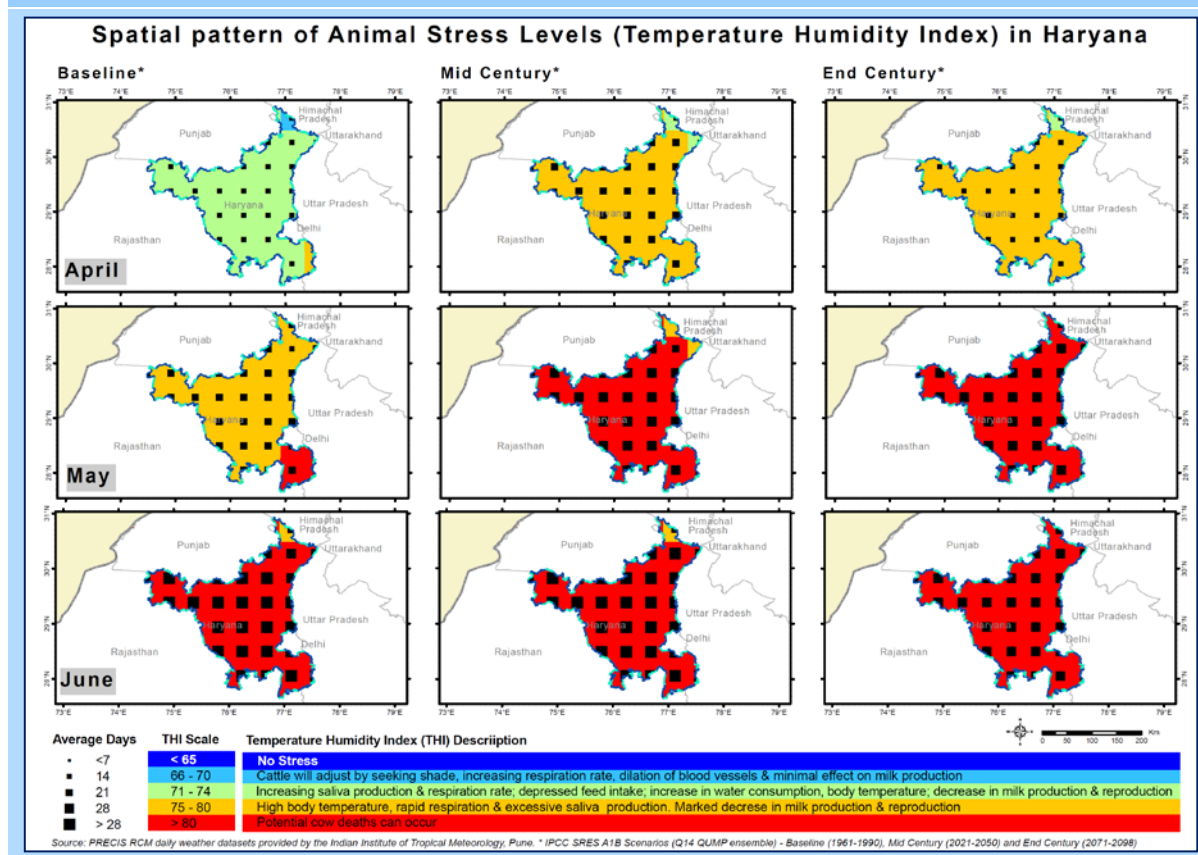
Temperature Humidity Index (THI) is a measure is an easy way to assess the risk of heat stress. It accounts for the combined effects of environmental temperature and relative humidity. Animal stress level categorise¹⁸ are shown in Table 15.

Table 15: Temperature Humidity Index (THI) Stress level Scales

THI	Stress Level	Comments
<65	None	
66-70	Mild	Dairy cows will adjust by seeking shade, increasing respiration rate and dilation of the blood vessels. The effect on milk production will be minimal
71-74	Moderate	Both saliva production and respiration rate will increase. Feed intake may be depressed and water consumption will increase. There will be an increase in body temperature. Milk production and reproduction will be decreased.
75-80	Severe	Cows will become very uncomfortable due to high body temperature, rapid respiration (panting) and excessive saliva production. Milk production and reproduction will be markedly decreased
>80	Danger	Potential cow deaths can occur

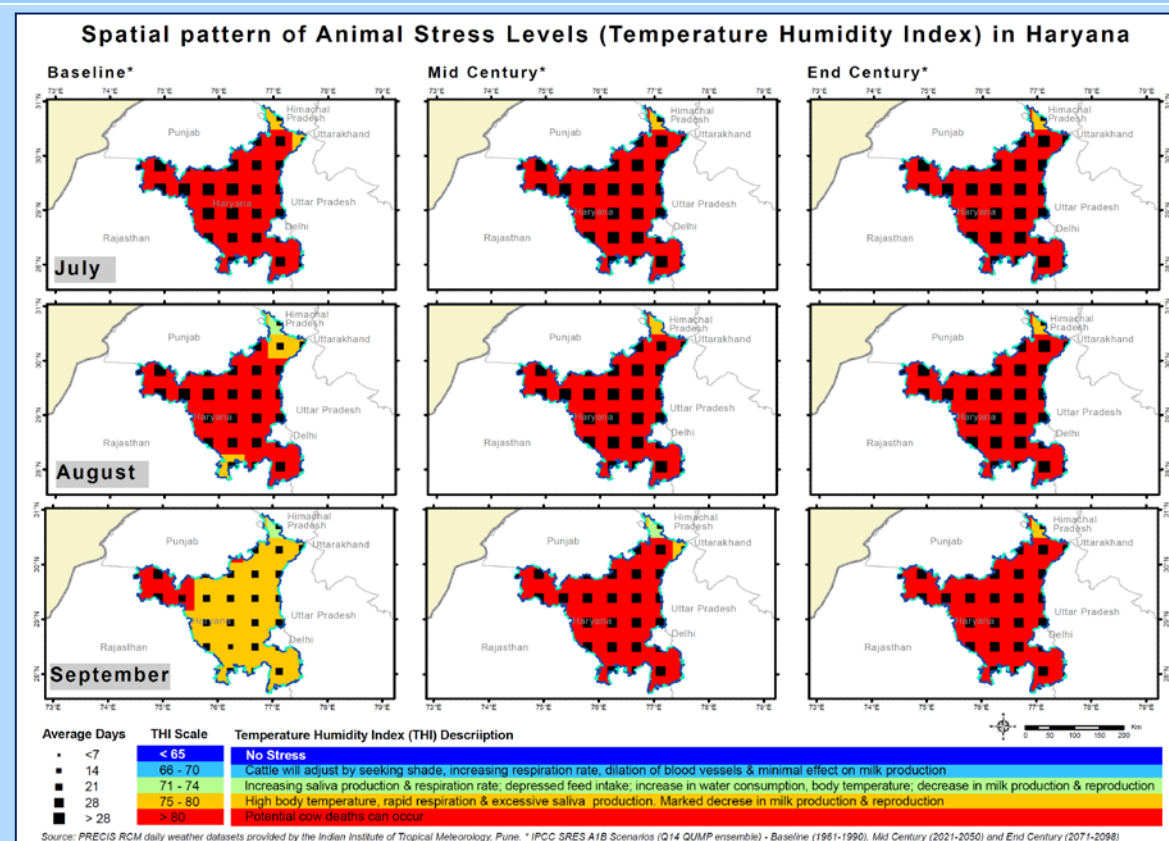
THI has been calculated for Haryana using PRECIS baseline, mid century and end century scenarios data. Months from April to September are significant on account of either high temperature or high humidity. Figure 24 shows the long term monthly THI values across Haryana.

Figure 24 : Projected THI for different months in Haryana



¹⁸ <http://www.icar.org.in/files/reports/icar-dare-annual-reports/2010-11/climate-change-AR-2010-11.pdf>

Figure 24 : Projected THI for different months in Haryana



The colour shows the average THI values and the size of the dots show average number of days in that month which will have that average monthly THI value. It can be seen from Figure 24 that during April, the situation will deteriorate towards mid and end century with number of days having severe animal stress level will increase. Similarly the month of September also shows more number of days in the danger stress level as compared to the baseline.

Heat Stress - Human Health

Changes in weather and climate affect health, both directly and indirectly. More intense and frequent extreme events directly give rise to several weather-related diseases¹⁹. Heat Index describes the combined effect of temperature and humidity on human body. This combined effect is causing a serious threat to the health of people because of the changing climate.

Humidex

The humidex is an index number to describe how hot the weather feels to the average person, by combining the effect of heat and humidity. The humidex is a unit-less number based on the mean air temperature, relative humidity and vapour pressure. The humidex combines the temperature and humidity into one number to reflect the perceived temperature. Because it takes into account the two most important factors that affect summer comfort, it can be a better measure of how uncomfortable the air feels than either temperature or humidity alone.

Table 16 gives the range of humidex value and the comfort or discomfort level with each range.

¹⁹ McMichael, A. J. et al. (eds), Climate Change and Human Health, World Health Organization, Geneva, 1996.

Table 16: Range of humidex and Degree of comfort or discomfort

Range	Degree of comfort or discomfort
Less than 85	Little or no discomfort
85 to 95	Noticeable discomfort
95 to 103	Evident discomfort
103 to 115	Intense discomfort; avoid exertion
115 to 129	Dangerous discomfort
Above 129	Heat stroke probable

Source: <http://www.csgnetwork.com/canhumidexcalc.html>

Humidex has been calculated for Haryana using PRECIS baseline, mid century and end century scenarios data. Months from April to September are significant on account of either high temperature or high humidity. Figure 25 shows the long term monthly humidex values across Haryana. The colour shows the average humidex range and the dots show the number of days in a month with the average humidex range. Smaller size indicates that the rest of the days in the month will experience higher ranges of discomfort.

It can be seen that though the months of April and May have average comfortable range, the number of days with this condition reduces towards mid and end century scenarios. June shows increase in comfortable days towards mid and end century as compared to the baseline. July, August and September show increase in uncomfortable days towards mid and end century as compared to the baseline.

Figure 25 : Projected Humidex for different months in Haryana

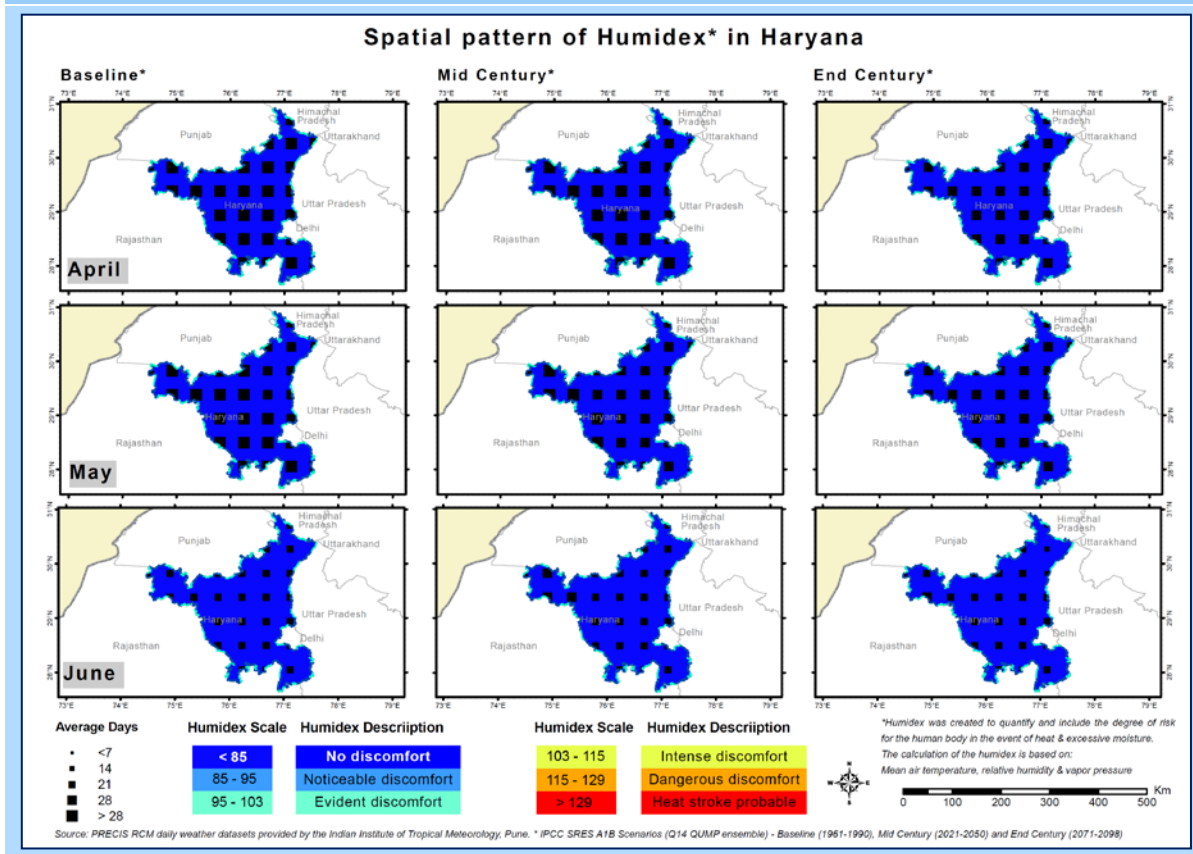
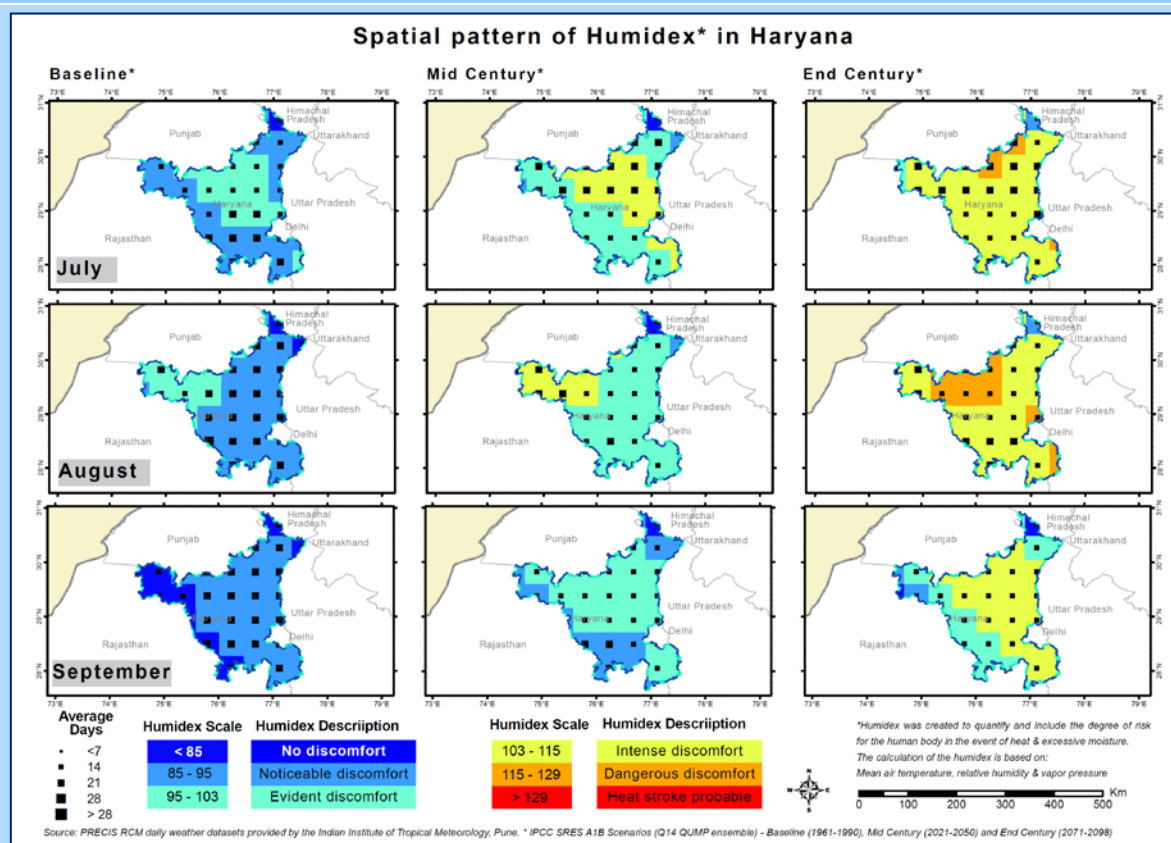


Figure 25 : Projected Humidex for different months in Haryana



Wet Bulb Global Temperature (WBGT)

The simplified formula for calculation of WBGT published by the Australian Bureau of Meteorology²⁰ has been used to calculate the WBGT for Haryana, using dry bulb temperature and vapour pressure (function of temperature and relative humidity). Though this is an approximation to the WBGT and has limitations as compared to a real measured WBGT, this is an easy measure for general heat-stress index.

Heat stress is an important aspect in the lives of people working under exposed conditions for long hours. Climate change may lead to significant increase of heat exposure during the hot seasons in most parts of India, where heat in outdoor work and indoor work without air conditioning already creates major human heat stress. Such heat stress causes health risks and a decrease in work productivity that can have a negative impact²¹. Table 17 gives the range of WBGT value and the comfort or discomfort level with each range.

Table 17: Wet Bulb Global Temperature (WBGT) Scales

Category	WBGT °F	WBGT °C	Non-acclimated	Acclimated
1	<=79.9	<=26.6	Monitor personnel and enforce water intake. Caution should be taken.	Normal duties.

²⁰ www.bom.gov.au

²¹ S. K. Dash and T. Kjellstrom, 2011, Workplace heat stress in the context of rising temperature in India, Current Science, VOL. 101, NO.4,

Category	WBGT °F	WBGT °C	Non-acclimated	Acclimated
2	80-84.9	26.7-29.3	Use discretion in planning intense physical activity. Limited intensity of work and exposure to sun. Provide constant supervision.	Normal duties.
3	85-87.9	29.4-31.0	Strenuous exercises such as close order drills and physical training will be cancelled. Outdoor classes in the sun will be cancelled.	Use discretion in planning intense physical activity. Limit intensity of work and exposure to the sun. Provide constant supervision.
4	88-89.9	31.1-32.1	ALL physical training, strenuous activities, and parades will be cancelled.	Strenuous outdoor activities will be minimized for all personnel with less than 12 weeks training in hot weather. Thoroughly acclimated personnel can carry on limited activity for periods not exceeding 6 hours a day.
5	=>90	=>32.2	Strenuous activity and non-essential duty will be cancelled for all personnel.	

http://heat_index.tripod.com/

Figure 26 shows the long term monthly WBGT values across Haryana. The colour shows the average WBGT range and the dots show the number of days in a month with the average WBGT range. Smaller size indicates that the rest of the days in the month will experience higher ranges of discomfort.

Figure 26 : Projected WBGT for different months in Haryana

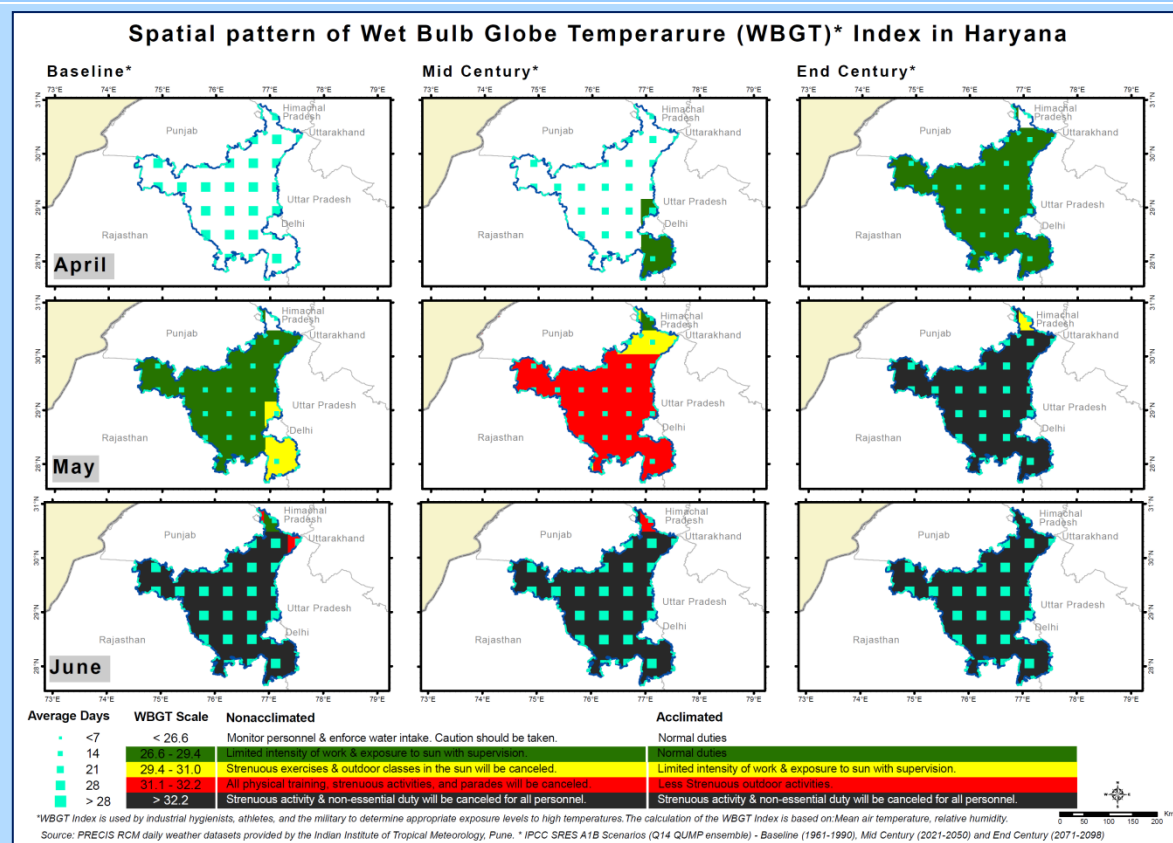
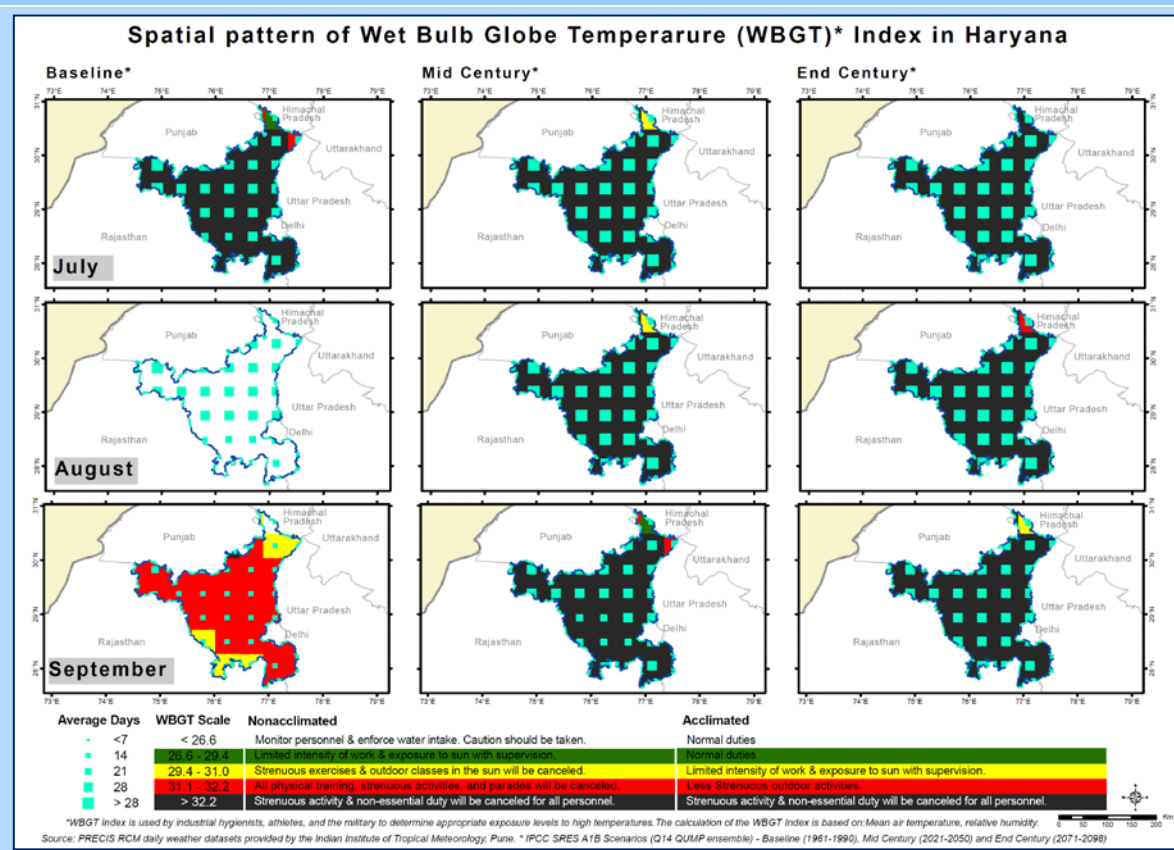


Figure 26 : Projected WBGT for different months in Haryana



It can be seen that number of working days is throughout the month in April for baseline and starts getting slightly exposed towards the end century scenario. Month of May the working conditions deteriorate from baseline to mid and end century. June, July the number of working days decreases, August shows the situation worsen towards mid and end centuries. September month also show similar trend.

Chapter 3

State GHG Emission

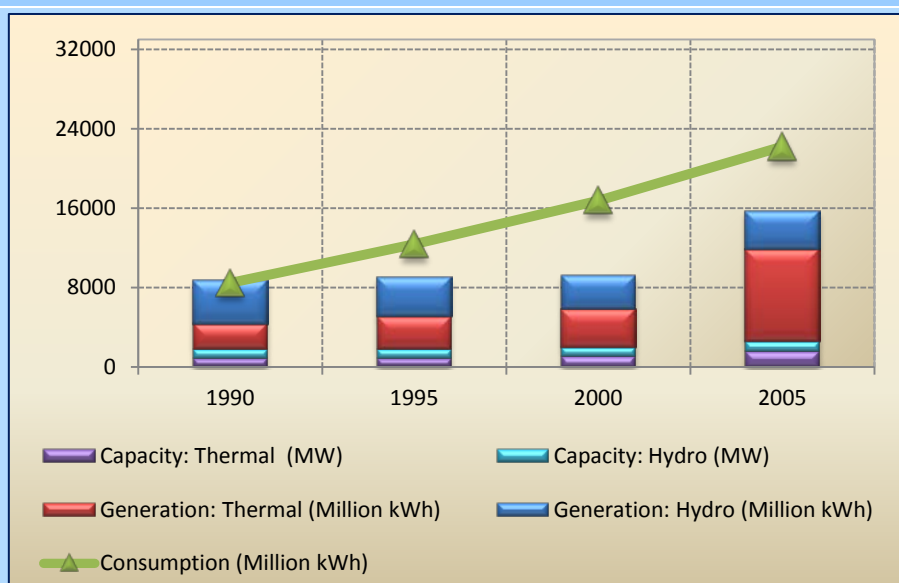
Chapter 3 - State GHG Emission

A greenhouse gas (GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. GHGs of anthropogenic origin in the atmosphere such as carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) contribute directly in increasing the warming of the earth's surface. GHG inventory is estimated for all the IPCC sectors except LULUCF (Land use, land change and forestry), since no state level estimates are available and LULUCF sector was insignificant to India's national GHG inventory²². Current GHG emission and relative increase in GHG emission at district level and for different sectors is covered in the following paragraphs.

Assessment of existing GHG emissions gases

Haryana emits nearly 2% of national greenhouse gases (GHG). Fossil fuel consumption, power generation and agricultural activities being major factors responsible behind this. Haryana represents about 3% of national fossil fuel consumption and 2% of national electricity consumption. Power generation in the state covers about 47% of the state CO₂ emissions and 2% of national power related CO₂ emissions. The trends of power generation and consumption can be seen from Figure 27. Thermal based power generation in the state has increased at a rate 8.8% per annum since 1990. Similarly, total power consumption has also increased (6.6% per annum).

Figure 27 : Power generation capacity, generation and consumption in Haryana



Petroleum products consumption during 1990 to 2005 can be seen from. Figure 28 It has increased at a rate of 6% per annum during the same period.

²² India: Greenhouse Gas Emissions 2007, 2010, Ministry of Environment and Forests, Government of India

Figure 28 : Petroleum product consumption in Haryana (000tonnes)

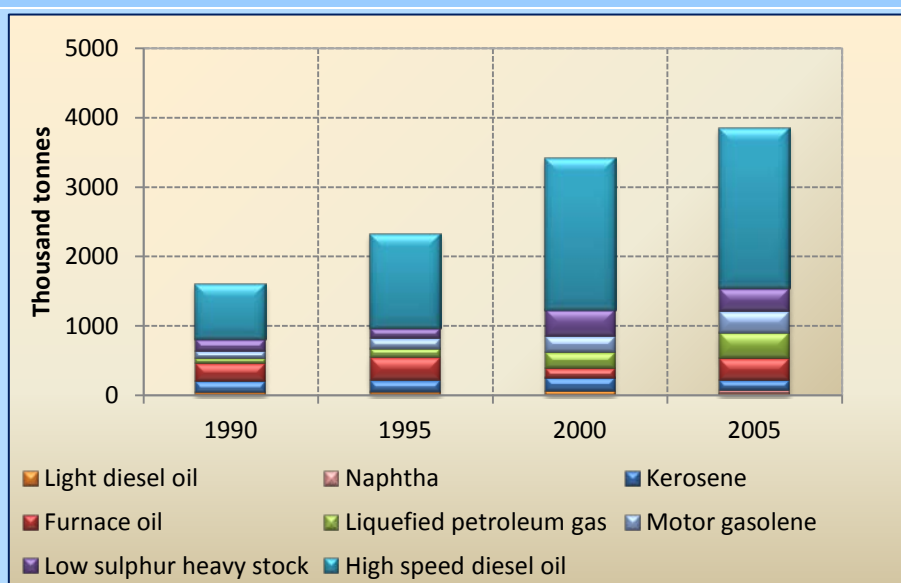
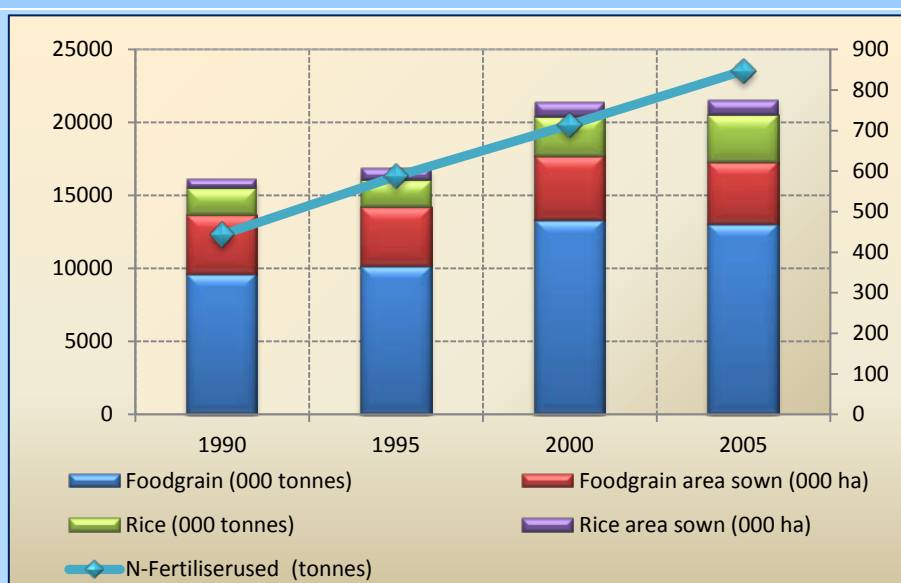
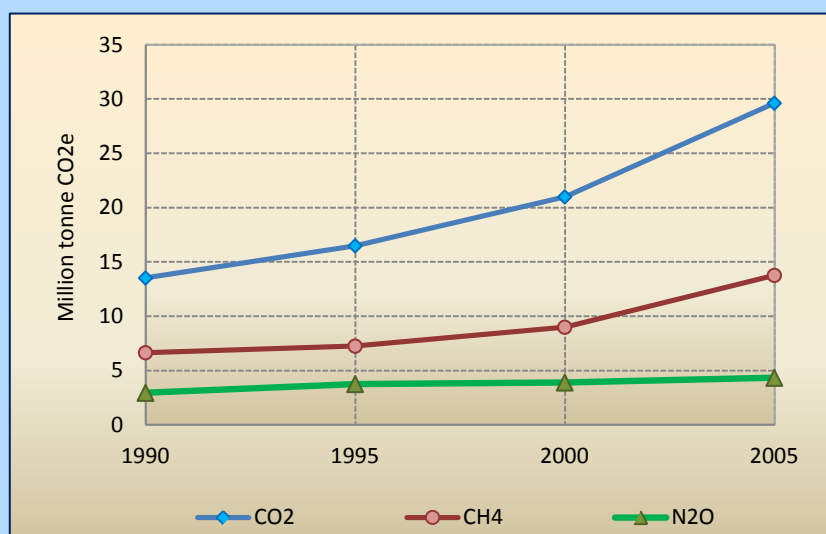


Figure 29 indicates the major driving forces of non-CO₂ emissions - nitrogenous fertilizer application, foodgrain and rice production in Haryana. As can be seen, fertilizer usage has grown at a rate of 4.4% per annum against 2.1% growth rate of each of foodgrain and rice production.

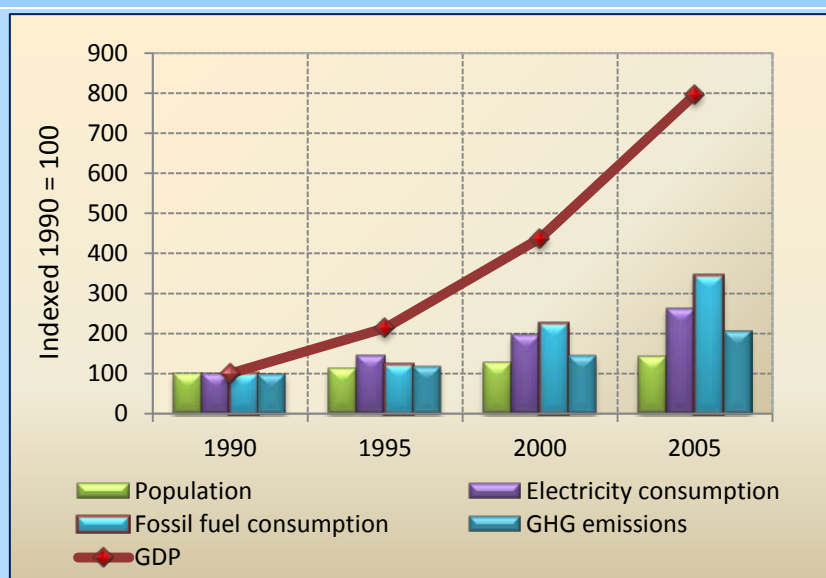
Figure 29 : Nitrogen fertilizer application and rice production in Haryana



CO₂, CH₄ and N₂O emissions of Haryana during 1990 to 2005 can be seen from Figure 30. Total 48 Tg CO₂e GHGs have been emitted during the year 2005. CO₂ emissions have increased at 5.4% CAGR since 1990, as compared to 5% and 2.6% CAGR of CH₄ and N₂O emissions respectively. CO₂ contributes about 62% of the state's GHG emissions followed by CH₄ (29%) and N₂O (9%).

Figure 30 : District level emissions of various greenhouse gases in Haryana during 2005-2006

The trend of GHG emissions and other indicators of Haryana state during 1990 to 2005 can be seen from Figure 31. GDP and population, the main driving force of GHG emissions, have increased at 14.8% and 2.4% CAGR respectively. Fossil fuel consumption and electricity consumption both have increased at the rate 8.6% and 6.6% per annum respectively. While GHG emissions have increased at 4.9% CAGR. Per capita emissions of Haryana are 2.0 ton, and have increased at 2.5% CAGR since 1990. This value is similar to the national average of 1.8 ton CO₂e per person. The state has continuously improved efficiency of its economy and has reduced GHG intensity of its GDP by 74% during the same period.

Figure 31 : Relative increase in GDP, population, electricity consumption and GHG emissions in Haryana (Indexed 1990 = 100)

Spatial variation showing district level emissions of various greenhouse gases in Haryana is shown in Figure 32.

Figure 32 : District level greenhouse gas emissions (excluding LULUCF) in Haryana during 2005-06

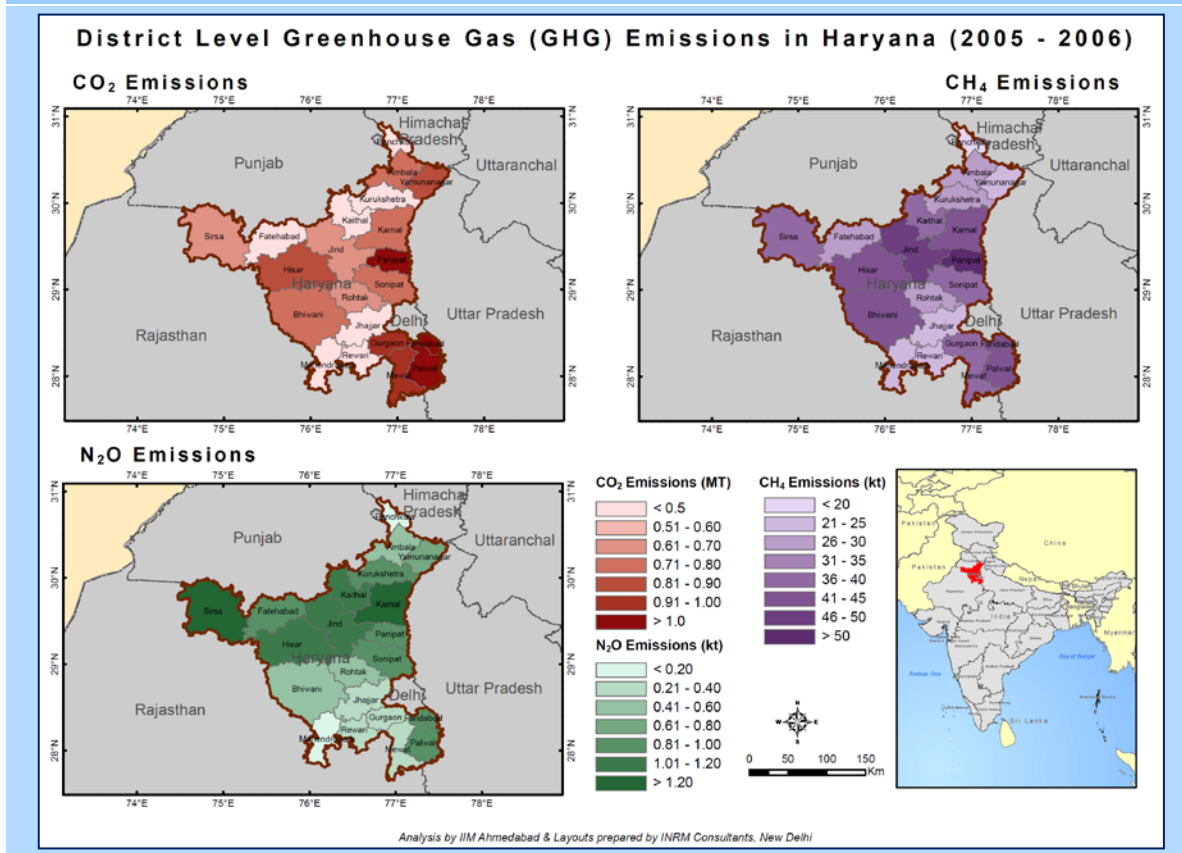


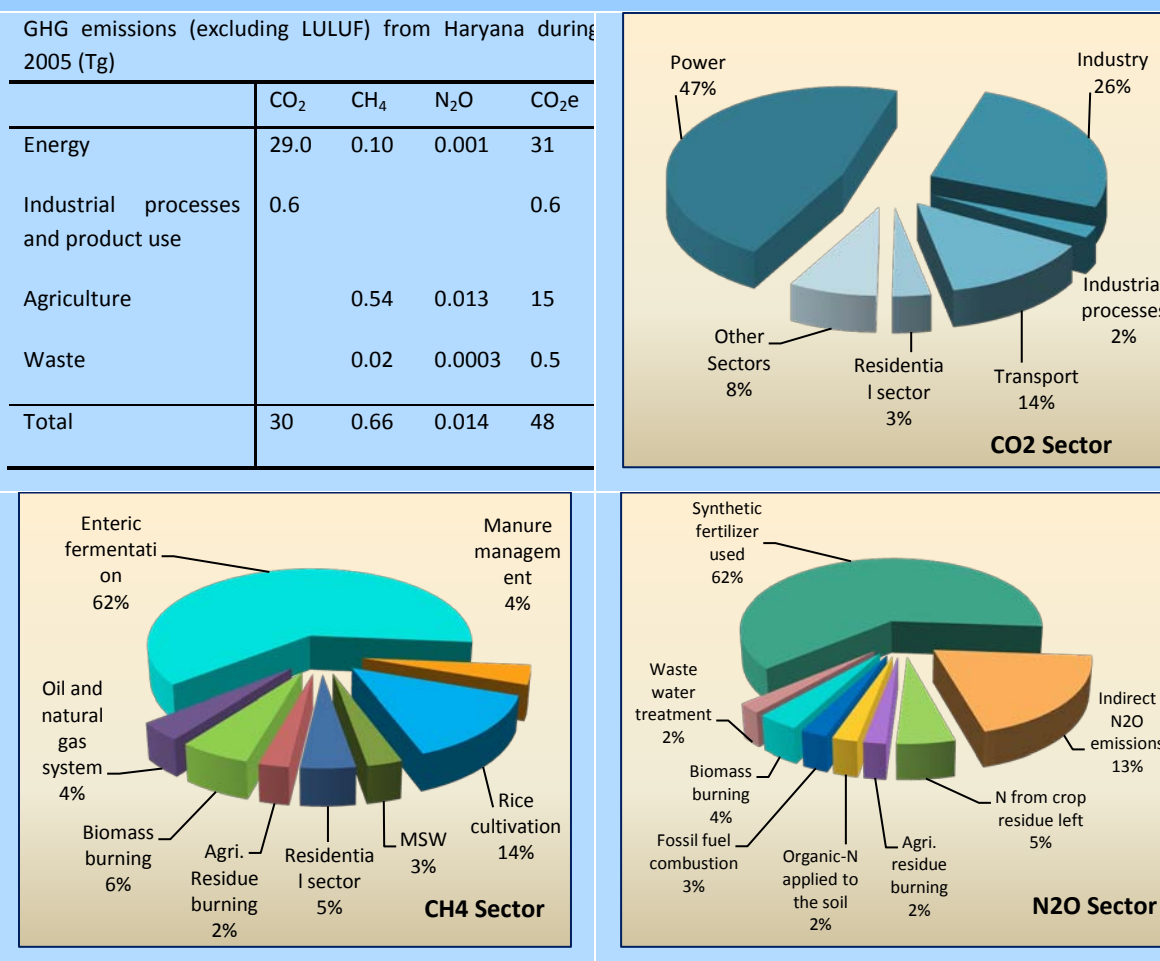
Figure 32 indicates district level emissions of various greenhouse gases in Haryana. CO₂ emissions, being major component of GHG emissions of the state, exhibits similar pattern like GHG emissions map. Panipat, Faridabad and Karnal are the three highest emitting districts during 2005, contributing to 34%, 12% and 5% GHG emissions of the state respectively. Coal based power plant of 1360 MW capacity and refinery with 6 million tonne capacity are the main source of Panipat district. 180 MW coal based and 430 MW gas based thermal power plants in Faridabad are the major CO₂ emission sources in this district. In case of CH₄ emissions, Panipat, Jind and Karnal are the highest emitting districts. In Panipat, oil refining and enteric fermentation are responsible for around 48% and 35% of the district CH₄ emissions respectively. Enteric fermentation account for about three fourth of CH₄ emissions in Jind and Karnal districts. Karnal, Sirsa and Hisar are the highest N₂O emitting districts contributing about 11%, 9% and 8% of the state N₂O emissions respectively. Synthetic nitrogen application is the main N₂O emissions source in these districts.

Assessment of existing GHG emissions by sector

Source activities and their relative share in Haryana GHG emissions can be seen from Figure 33 where as emissions from various categories a) energy, b) industrial process and product use, c) agriculture, forestry and other land use and d) waste are given in table in Figure 33. About 66% of GHG emissions from Haryana come from energy category. This category includes emissions due to

fossil fuel and biomass burning within power plants, manufacturing industries, transport sector and residential sector. Ammonia production as well as limestone and soda ash consumption are the major source of industrial process and product use emissions. Agriculture sector contributes about 82% and 91% of CH₄ and N₂O emissions of the state. Majority of CH₄ emissions occur from enteric fermentation of livestock (62%) followed by rice cultivation (14%) and biomass burning (6%). While majority of N₂O emissions occur from application of synthetic nitrogenous fertilizer (62%) followed by indirect N₂O emissions (20%) and nitrogen from crop residue left (5%). Municipal solid waste and domestic waste water treatment contribute about 3% and 2% to CH₄ and N₂O emissions of the state respectively.

Figure 33 : Sectoral greenhouse gas emissions (excluding LULUCF) from Haryana during the 2005-06



Chapter 4

Climate Change Impacts and Vulnerability

Chapter 4 - Climate Change Impacts and Vulnerability

A brief summary of assessment of the impact of projected climate change on water, forest and energy sectors carried out by IIT Delhi, IISc., Bangalore and IIM Ahmedabad is presented here.

Impact of climate change on water resources of Haryana

Methods and Models: An assessment of the impact of projected climate change on water resources in Haryana is made using the hydrologic model SWAT²³ (Soil and Water Assessment Tool). The model requires information on terrain, soil profile and landuse of the area as input which have been obtained from the global sources. These three entities are assumed to be static for future as well.

The Yamuna river and Indus river basin which have their tributaries in Haryana has been modelled using the following:

Spatial data and the source of data used for the study areas include:

- Digital Elevation Model: SRTM, of 90 m resolution²⁴
- Drainage Network – Hydroshed²⁵
- Soil maps and associated soil characteristics (source: FAO Global soil)²⁶
- Land use (source: Global landuse)²⁷

The Hydro-Meteorological data pertaining to the river basin required for modelling, includes daily rainfall, maximum and minimum temperature, solar radiation, relative humidity and wind speed. Climate Change PRECIS Regional Climate Model outputs for Baseline (1961–1990, BL), near term (2021-2050, MC) and long term or end-century (2071-2100, EC) for A1B IPCC SRES scenario (Q14 QUMP ensemble) has been used.

Impacts of Climate Change on Water Resources

The climate change impact assessment on water resources of Haryana has been taken from the recent study conducted (Gosain et al, 2011²⁸) as part of the NATCOM Phase II study of MoEF. For the

²³ The Soil and Water Assessment Tool (SWAT) model (Arnold et al., 1998, Neitsch et al., 2002) is a distributed parameter and continuous time simulation model. The SWAT model has been developed to predict the response to natural inputs as well as the manmade interventions on water and sediment yields in un-gauged catchments. The model (a) is physically based; (b) uses readily available inputs; (c) is computationally efficient to operate and (d) is continuous time and capable of simulating long periods for computing the effects of management changes. The major advantage of the SWAT model is that unlike the other conventional conceptual simulation models it does not require much calibration and therefore can be used on ungauged watersheds (in fact the usual situation).

²⁴ <http://srtm.csi.cgiar.org>

²⁵ <http://hydrosheds.cr.usgs.gov/>

²⁶ <http://www.lib.berkeley.edu/EART/fao.html>

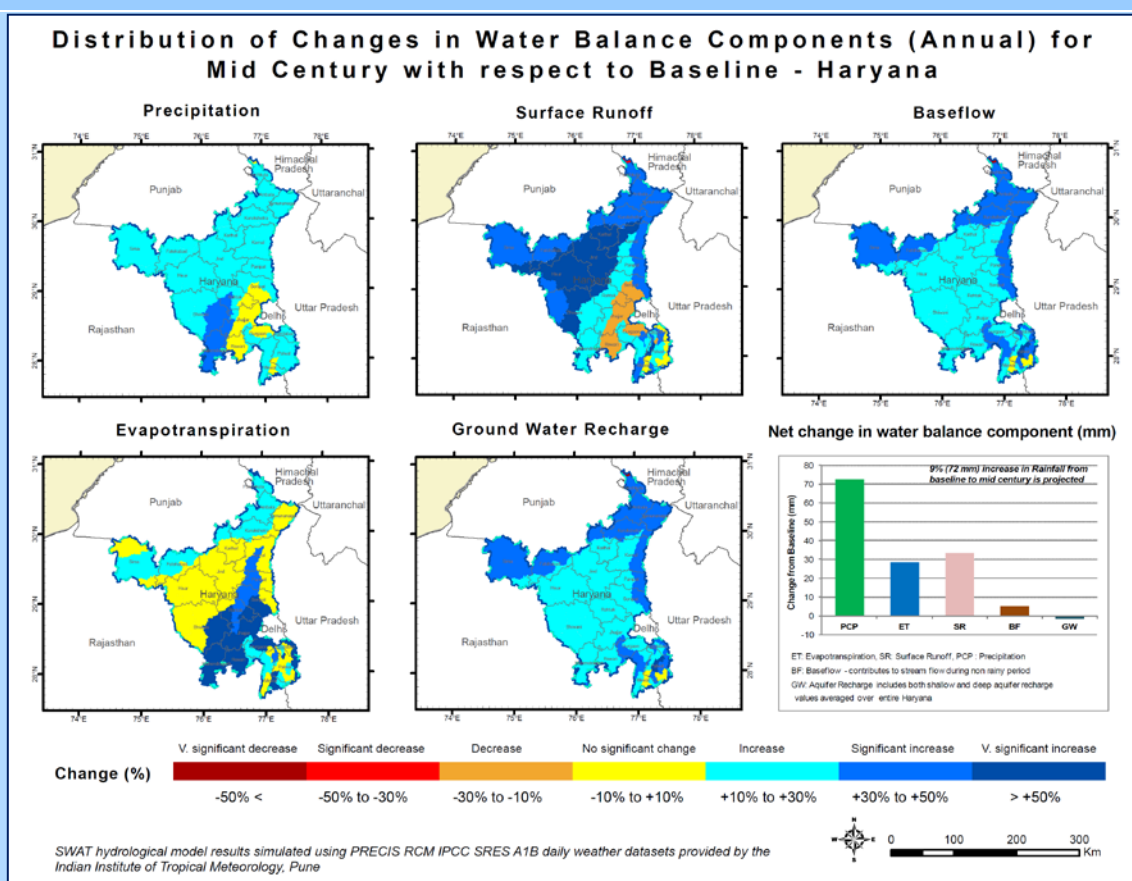
²⁷ <http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp>

²⁸ NATCOM II – Unpublished report, 2011

present, analysis pertains to the modeling of River Yamuna and Indus using the hydrologic model SWAT has been used. Discussions on the impact assessment is provided below.

For the Yamuna and Indus basins lying within Haryana, analysis projects an increase in annual precipitation of about 9% (72 mm) by mid century, this results in 46% (33 mm) increase in runoff to the stream flow and 7% (5 mm) increase in baseflow, negligible decrease to the ground water recharge is projected. Evapotranspiration is projected to increase by 39% (28 mm). During the monsoon months (JJAS) increase in precipitation is projected to be about 10% (64 mm) and increase in evapotranspiration by 11% (17 mm). The indication is that in parts of the basin surface runoff would be increased under the A1B mid century scenario (Figure 34). Similarly during the Rabi season (OND), precipitation is projected to increase by 23% (17 mm) resulting in increase in runoff by 48% (8 mm) and negligible change in ground water recharge. Evapotranspiration is projected to increase by 25% (4 mm) and baseflow is projected to increase by 17% (3 mm).

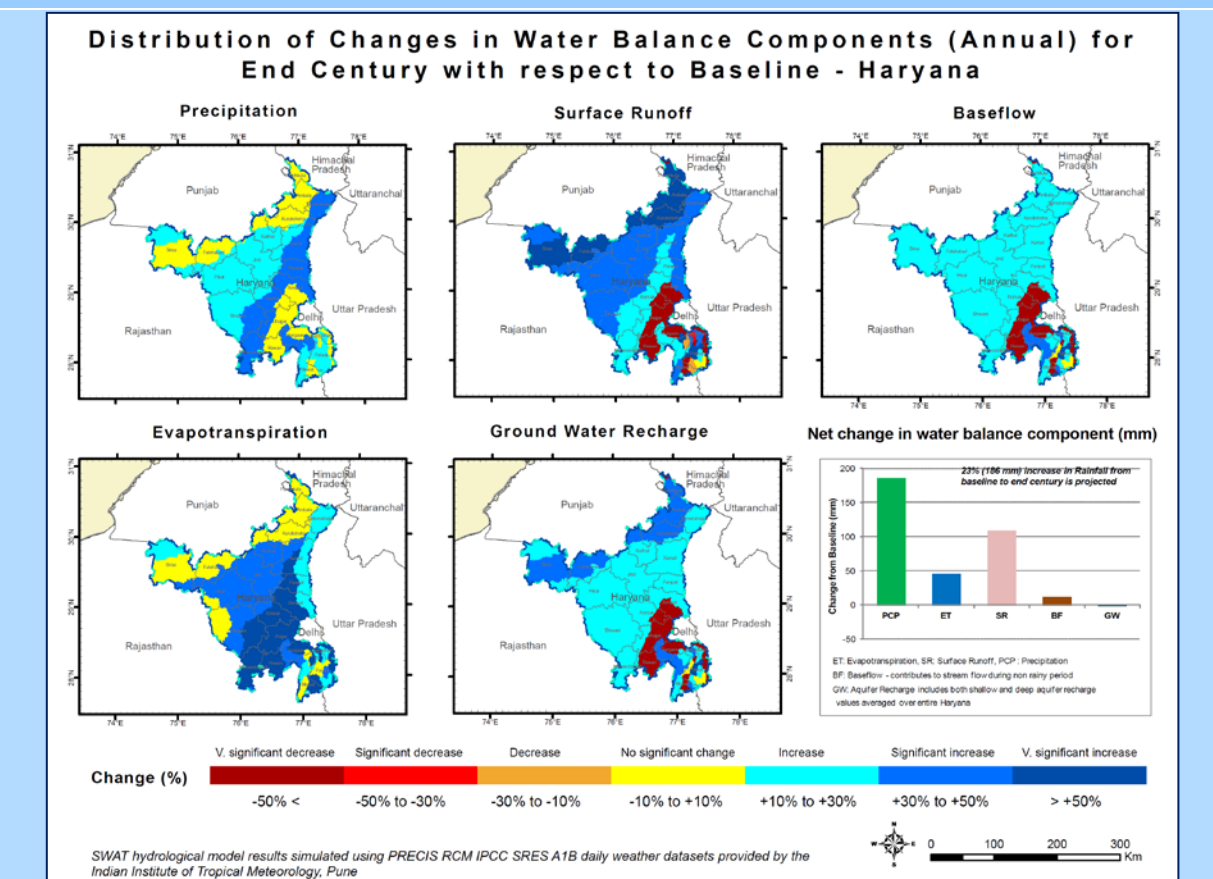
Figure 34 : Change in water availability towards 2030s with respect to 1970s (IPCC SRES A1B scenario) in Haryana



Increase in annual precipitation of about 23% (186 mm) by end century is projected, resulting in increase in runoff by 58% (108 mm) and about 6% (11 mm) returns to stream as baseflow. Evapotranspiration is projected to increase by 25% (46 mm). Negligible changes in ground water recharge is projected. During the monsoon months (JJAS) increase in precipitation is projected by about 27% (178 mm), most of this results in runoff (57%, 102 mm) and baseflow (4%, 7 mm) contributing to the stream flow. About 2% (4 mm) of this increase in precipitation is contributed to

the ground water recharge. Increase in evapotranspiration is projected by 34% (19 mm). The indication is that in parts of the basin surface runoff would be increased under the A1B end century scenario and would offer opportunities for increased water harvesting and groundwater recharge (Figure 35). Similarly during the Rabi season (OND), precipitation is projected to increase by 9% (7 mm) resulting increase in baseflow contribution to the stream flow. Reduction in ground water recharge and substantial increase in evapotranspiration is projected

Figure 35 : Change in water availability towards 2080s with respect to 1970s (IPCC SRES A1B scenario) in Haryana



Agricultural water stress indicator

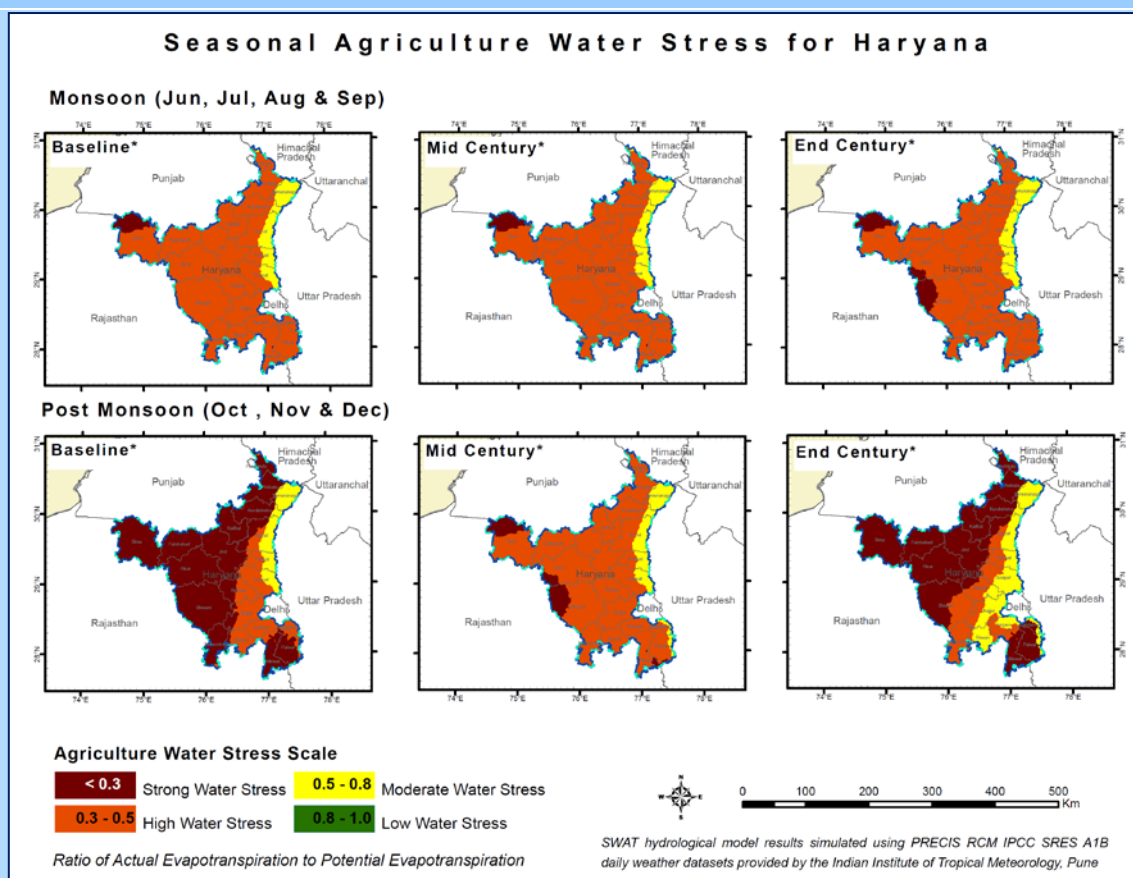
Agriculture faces water stress if the water requirements of crops are not met. To detect the severity and spatial occurrence of water stress in the basin, the relative evapotranspiration (ETrel) expressed as the ratio of actual evapotranspiration (ETa) over potential evapotranspiration (ETp) has been used. For relative evapotranspiration, it is generally recommended that this ratio does not drop below 0.70 throughout the year (Bos et al., 2005)²⁹. Bastiaanssen et al., (2001)³⁰ used an 'operational range' and an 'acceptable range' for this indicator. If the indicator remains within the operational range, crop yield will deviate less than 10% from the target value. If the indicator moves

²⁹ Bos, M. G.; Burton, M. A.; Molden, David J. 2005. Irrigation and drainage performance assessment: Practical guidelines. Wallingford, UK: CABI. viii, 158p

³⁰ Bastiaanssen, W.G.M., Brito, R.A.L., Bos, M.G., Souza, R., Cavalcanti, E.B. and Bakker, M.M. (2001) Low cost satellite data applied to performance monitoring of the Nilo Coelho irrigation scheme, Brazil. Irrigation and Drainage Systems 15, 53–79

out of the acceptable range yield reductions of over 20% occur. For ETrel, the operation range was set at 0.8-1, and the acceptable range at 0.7-1. The relative evapotranspiration (ETrel) is calculated for the basins of Yamuna and Indus lying within Haryana on seasonal basis. The results of seasonal agricultural water stress are presented in Figure 36. The figure shows that water stress is higher in winter and season. It is higher in the western part of Haryana with less average annual precipitation (maroon tones) when compared to the eastern part (orange to yellow tones). The agriculture water stress is going to exacerbate towards end century.

Figure 36 : Change in Agriculture Water Stress for baseline, mid century and end century scenarios (IPCC SRES A1B scenario) in Haryana



Impact of climate change on forests of Haryana

Observed climate change and implications for forestry: The forest resource in Haryana is vulnerable not only to climate change resulting in increased mean annual temperature but also due to lower and irregular rainfall in the whole of Haryana. The south-western region receives very less and irregular rain fall resulting in the reduced survival of plantation and change in vegetation type. The scanty rainfall has also led to less ground water recharge. This lowering of water table may lead to change in species and growth of trees and biomass production. The fodder production from trees is a very important source of food for the cattle in south and west part of the state. The new variety of species need to be identified zone wise suitable for the new soil and moisture conditions to increase the tree cover to achieve the National and Haryana State Forest policy of 20% tree cover at the earliest in a phased manner.

The observed changes in climate are as follows:

- Higher mean annual temperatures
- Erratic and reduced rainfall and other precipitations
- Extreme events such as floods, droughts and cyclones.

These observed adverse conditions could potentially affect the native vegetation and also the afforestation efforts of the Forest Department and associated livelihoods of the people in the state. The productivity of forests (biomass/ha/year) and trees can reduce due to change in optimum condition. The rising mean temperature and reduced precipitation and reduced rainy day has forced the farmers to draw more and more ground water resulting in the lowering of water table. This has significant impact on the growth of trees on adjoining forest strip land and farm lands. The number of dead trees has increased many folds in last 10 years forcing the Haryana Forest Department to restrict the extraction of dead trees only which surpasses the working plan prescription for annual harvesting of trees from forests. The felling of green trees has virtually stopped except for emergency felling for development projects such as widening of roads. The long spell of dry season has caused delay in start of plantation activities which usually coincided with monsoon in June end during 1980s. The plantations are normally raised during August – September, which results in reduction of the growing period before the onset of winter in November. The extreme winter frost takes heavy toll of the frost sensitive species and large scale casualty occurs and the survival of young saplings drops considerably.

The reduced productivity of crop has led to increase in sown area on the common land, which were hitherto were under tree plantations and preserved as ‘Village Forests’ have been diverted for cultivation to meet the food grain requirement. The plantations raised by HFD have decreased in last 15 years due to non availability of community land for plantation due to competing land use in favor of food crop. However, schemes have been revised to associate other stakeholders to plant trees and HFD provides around 3.0 crore seedlings free every year. The reduced growing period has led to change in species choice and drought and frost resistant species are preferred. This has led to changes in the composition of species in the state. Shisham and kikar trees are drying in the state. This is indicated by the fact that the proportion of dead trees harvested by Production Circle in total wood harvested has increased in last ten years (Table 18).

Table 18: Wood harvested by Production Circle Haryana

Year	Volume Felled (cum)			% of Dead/Dry
	Green	Dead/Dry	Total	
2001-02	25813	108537	134350	81
2002-03	41508	105502	147010	72
2003-04	33802	73180	106982	68
2004-05	49749	70725	120474	59
2005-06	49582	47409	96991	49
2006-07	41776	52965	94741	56
2007-08	55210	35811	91021	39
2008-09	50526	43544	94070	46
2009-10	60521	26687	87208	31
2010-11	30283	44579	74862	60
Total	438770	608939	1047709	58

Climate impact assessment using dynamic vegetation models

Methods and Models: An assessment of the impact of projected climate change on forest ecosystems in Haryana is made using the following:

- Climate impact model; global dynamic vegetation model (IBIS³¹)
- Climate change scenario; A1B scenario
- Period of assessment; short-term (2021-2050) and long-term (2071-2100) periods.
- Input data; monthly mean cloudiness (%), monthly mean precipitation rate (mm/day), monthly mean relative humidity (%), monthly minimum, maximum and mean temperature (C) and wind speed (m/s), soil parameter (percentage of sand, silt and clay) and topography.

Impacts of climate change on currently forested grids

The dynamic global vegetation model has been validated by IISc for its suitability to Indian conditions³². The impacts are assessed at regional climate grid scales (about 50 X 50 km). It can be observed from Table 8 that during the short-term period of 2030s, out of the 14 forested grids in Haryana, 4 (28.57%) will be impacted by climate change.

Table 19: Number of currently forested grids projected to be impacted by climate change during 2030s and 2080s in Haryana

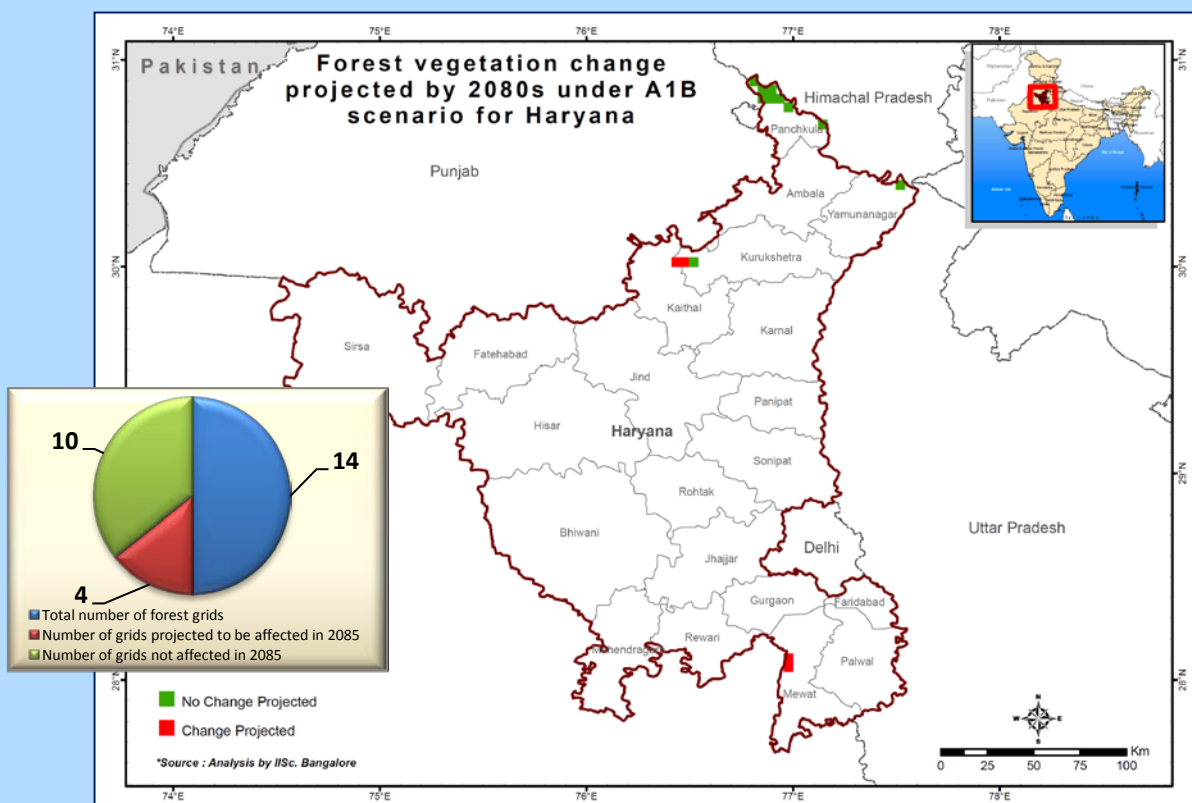
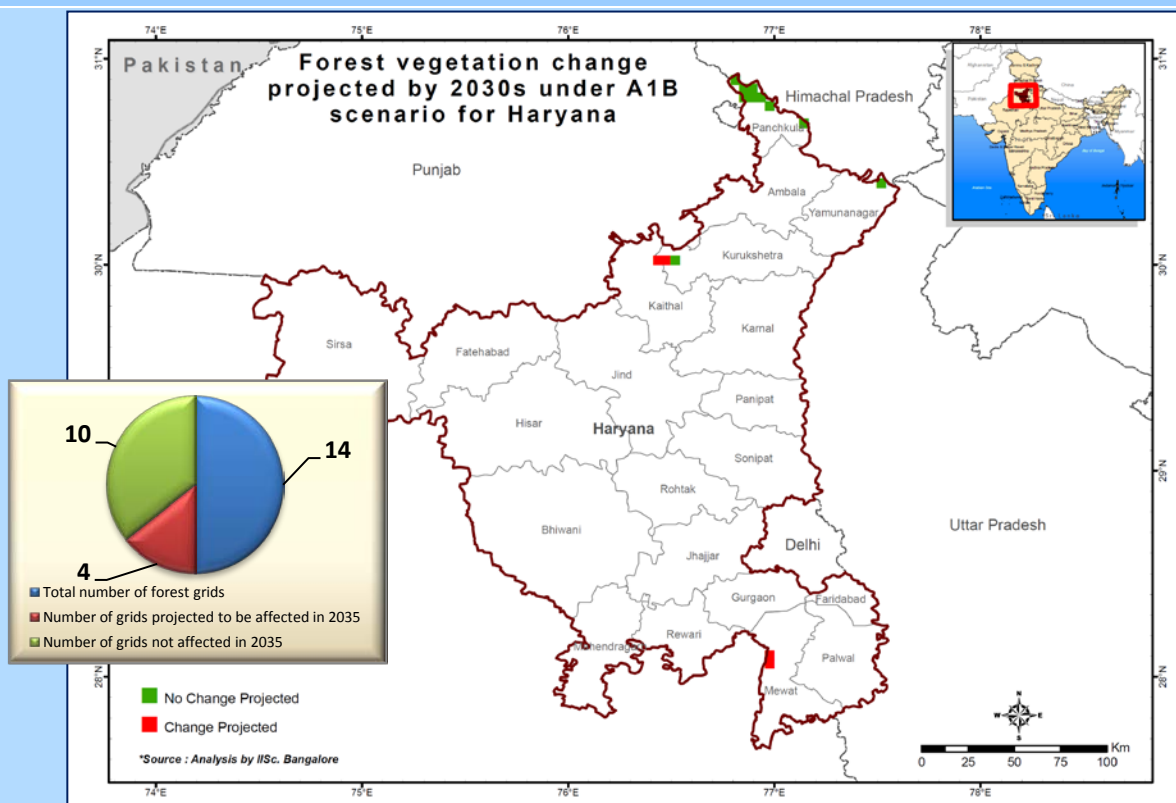
	Number of grids affected
Total number of grids	14
Number of grids projected to be affected in 2035	4
Number of grids not affected in 2035	10
Number of grids projected to be affected in 2085	4
Number of grids not affected in 2085	10

The distribution of forested grids projected to be impacted by climate change is presented in Figure 37 for 2030s and 2080s. It can be observed that the number of currently forested grids projected to be impacted by climate change remain the same.

³¹ Foley, J. A., I. C. Prentice, N. Ramankutty, S. Levis, D. Pollard, S. Sitch, and A. Haxeltine. 1996. An integrated biosphere model of land surface processes, terrestrial carbon balance, and vegetation dynamics. *Global Biogeochemical Cycles* 10(4), 603-628.

³² Chaturvedi R., Gopalakrishnan R., Sukumar, R., Ravindranath N.H. (2010) Carbon management in Indian forests: a policy analysis to assess mitigation potential, *Carbon Management* (2010) 1(1), 109–117

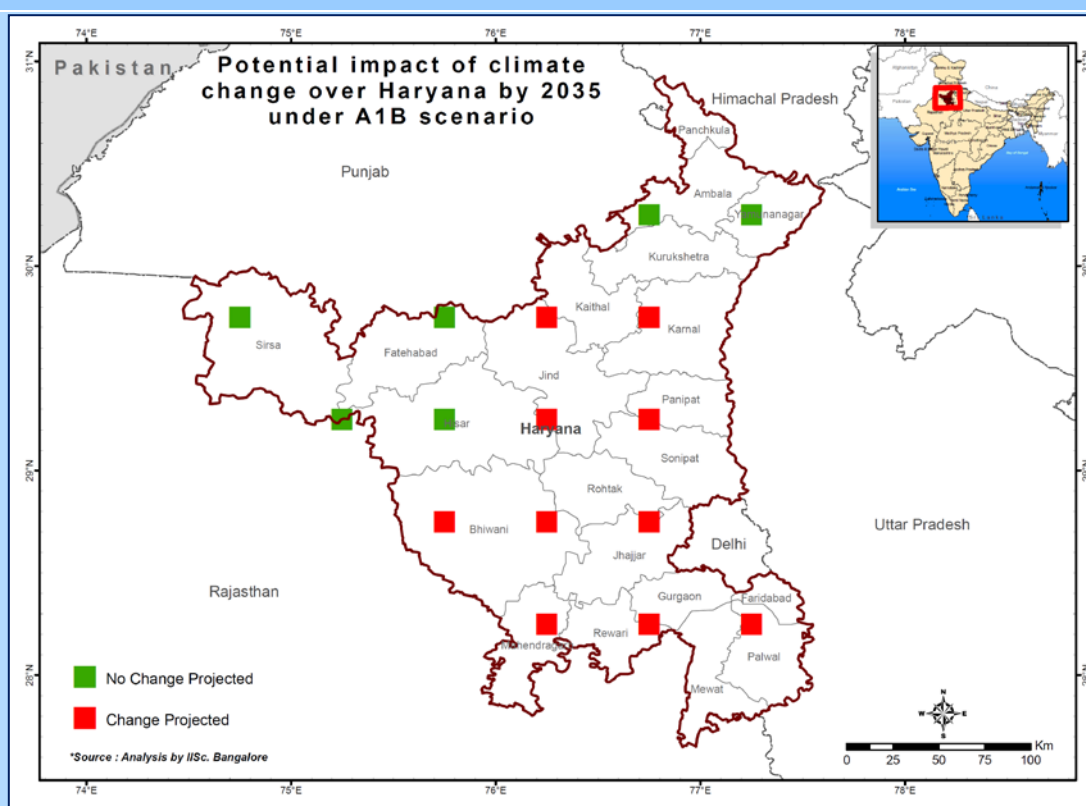
Figure 37 : Forest vegetation change projected by 2035 and 2085 under A1B scenario in Haryana

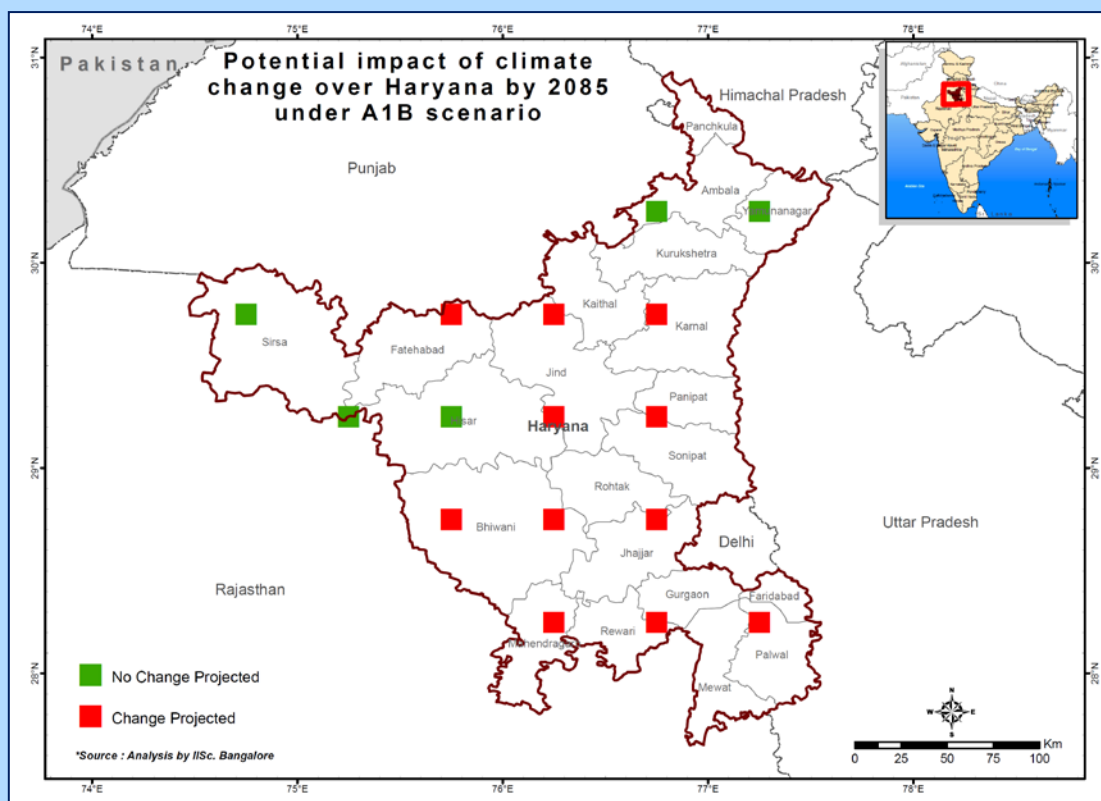


Impacts of climate change on potential future areas under forest in Haryana

The potential changes were assessed assuming existence of forest in different districts of Haryana, based on simulated forests under current as well as projected A1B scenario climatology. This analysis helps to assess the potential impacts of climate change for any future afforestation/reforestation programmes. It can be observed from Figure 38 that any afforestation programme undertaken in future, in the districts of Karnal, Panipat, Jind, Bhiwari, Sonapat, Gurgaon, etc., could be vulnerable to future climate impacts

Figure 38 : Projected impacts of climate change on potential future areas under forest by 2035 and 2085 under A1B scenario in Haryana





Likely Impacts of Climate Change on Agriculture

- short periods of exposure of wheat crops to temperatures of 28 °C to 32°C result in significant decrease in yield by 20% or more. North-Western parts of India where sowing of wheat is often delayed due to late harvest of rice and cotton in wheat-rice-cotton cropping system and range of 28 °C to 32°C temperatures are commonly encountered in the later part of the growing season. As a result, significant losses in yield occur due to heat stress during grain filling period. In view of global warming and increased total demand for wheat in India during next 12 years, development of heat-tolerant cultivars is of major concern in wheat breeding programs.
- In traditional way of irrigated rice production, rice consumes more than 50% of the water used for irrigation in Asia. Rice requires 2-3 times more water per unit grain produced than crops such as wheat and maize. Traditional rice irrigation faces threat with projected less water availability in future.
- Indian mustard cultivation is adversely affected by drought and salinity stress causing production losses as seedlings and mature plants show stress related symptoms including delayed germination, poor growth and poor flowering. With projected increase in drought frequency, erratic rainfall in future mustard yield may be severely affected.
- unpredictable moisture deficits during crop growth are a major constraint to productivity, adaptation and stability of chick pea performance throughout the world. Due to this single factor the annual yield losses are globally very high, ranging from 30-40 %. Deficit soil moisture conditions are projected to increase in future.

- Sclerotinia stem rot has become a serious threat to the successful cultivation of Indian mustard in mustard growing areas since the last one decade, probably because of moderate temperature and high humidity at seed formation stage. For the last two years, incidence of Bacterial stalk rot has also been observed in early sown mustard just after first irrigation, when the temperature remains unusual warm in the month of November and December.
- The disease is favoured by average temperature (18-25°C) and high humidity (90-95% RH) along with wind currents

Likely Impacts of Climate Change on Livestock³³

Climate change has both direct and indirect effect on animal production, reproduction along with emergence and re-emergence of many animal diseases. It has been estimated that the annual loss in total milk production due to heat stress on livestock is around two per cent in the country, amounting to over Rs.2.661 crore.

Impact on production systems

The environmental conditions that induce heat stress on dairy animals can be calculated using temperature humidity index (THI). The heat stress begins to occur in dairy cattle wherein the THI is more than 72 (<72 no stress, 72 - 79 mild, 80 - 89 moderate, 90-98 severe and above 98 danger). The decreases in milk production can range from 10 to 25%. It has been estimated that with a temperature rise of 1.0 or 1.2°C with minor change in precipitation during May to August, milk productivity is likely to be marginally affected and during other months productivity will remain relatively unaffected. The negative impact of temperature rise on total milk production for India has been estimated about 1.6 million tonnes in 2020 and more than 15 million tonnes in 2050. An average adult cow or buffalo producing 10-15 lit milk per day requires about 40- 45 lit/day as drinking water on hot days and about 40- 60 lit for other related work thus requiring a minimum of 100 lit/ day/ animal. An organized animal farm following standard management practices and disposal of animal wastes requires additional water about 50- 100 lit/day/animal. Any deficiency in water availability will certainly lead to decline in milk productivity.

Impact on animal growth and reproduction

Heat stress due to temperature or temperature -humidity impairs reproductive functions and efficiency of almost all livestock species. Various studies have shown that heat stress challenges the reproductive performance of cattle and buffaloes (Upadhyay, R.C., et al., 2009³⁴). Impact of Climate Change on Reproductive Functions of Cattle and Buffaloes. In, Global Climate Change and Indian Agriculture – Case Studies from the ICAR Network project, edited by P.K. Aggarwal, 107-110) such as altered follicular development. Further, possible climatically associated shifts in animal breeding time and offspring born could occur in cattle and buffaloes under different agro-climatic conditions. Rising temperatures negatively impact growth and time to attain puberty of livestock species, it is likely to slow down from a growth rate of 500g/day or more to 300-400 g/day of growing cattle. Crossbreds are more sensitive to rise in THI than indigenous breeds. Analysis of the potential direct effects of climate change and global warming on Murrah buffaloes indicated that a temperature rise of more than 2°C over existing temperatures in 2050s will cause higher incidence of silent estrus,

³³ <http://www.icar.org.in/files/reports/icar-dare-annual-reports/2010-11/climate-change-AR-2010-11.pdf>

³⁴ Upadhyay, R.C., Ashutosh, Raina V.S. and Singh, S. V., (2009) Impact of climate change on reproductive functions of cattle and buffaloes In: Global Climate Change and Indian Agriculture, P.K. Aggarwal (Editor), ICAR New Delhi: pp 107-110 (Chapter 25)

short estrus and decline in reproduction efficiency of buffaloes. Such impacts are also expected on indigenous cattle.

Impact on physiological responses and functions

The sensitivity of livestock to increasing ambient temperatures under open ambient conditions and in climatic chamber have been evaluated by exposing Zebu, crossbred cattle and Murrah buffaloes to warm/hot ambient temperature (26-40°C) and low/cool temperatures (6-16°C) at NDRI Karnal. Body heat storage increased beyond their capacity to tolerate heat particularly on days, when THI exceeded 80 during summer and hot-humid conditions. The study also revealed that Zebu animals under hot dry/hot humid conditions have better heat tolerance than crossbreds or buffaloes. The sensitivity of buffaloes to temperature rise above 35°C was observed to be higher than either Zebu or crossbreds. The physiological responses, such as respiratory frequency, heart rate and energy expenditure doubled or trebled for an increase of 1.0°C in temperature.

Affect on feed and fodder

Water scarcity not only affects livestock drinking water resources, but also it has a direct bearing on livestock feed production systems and pasture yield. Rising temperatures also have an additional impact on the digestibility of plant matter. Raised temperatures increase the lignifications of plant tissues and thus reduce the digestibility and the rates of degradation of plant species. This not only affects the health of an animal but also results in the reduction in livestock production which in turn has an effect on food security and incomes of small livestock keepers. Studies have shown that dry matter intake decreases in animals subjected to high temperatures. This decrease in dry matter intake can be either short term or long term depending on the length and duration of heat stress.

Feed and Fodder Availability

In Haryana there is a shortage of green fodder availability mainly in Southern parts of the State. The State is surplus in dry fodder and rightly known as dairy State. The estimated area under fodder production is to the extent of 6-8%. The cattle feed is regulated through cattle feed order-99 for insuring qualitative feed to the livestock.

Animal diseases and livestock health

Climate change is likely to cause a rise in animal diseases that are spread by insects and vectors mainly due to temperature and humidity rise that favour their spread and growth. Climatic conditions favourable for the growth of causative organisms during most part of the year due to temperature rise will facilitate spread of diseases in other seasons and also increase area of spread. Higher temperatures and changing rainfall patterns can enhance the spread of existing vector borne diseases (Bhattacharya et al, 2006³⁵) and macro parasites, accompanied by the emergence and circulation of new livestock diseases. Climate change will modify the dispersal, reproduction, maturation and survival rate of vector species and consequently alter viral and bacterial disease transmission. In some areas, climate change is likely to generate new transmission models. Temperature and humidity variations could also have a significant increase in helminth infections, protozoan diseases such as Trypanosomiasis and Babesiasis. Some of the viral diseases (PPR or RP like diseases) may also reappear affecting both small ruminant population as well. Frequency and

³⁵ Bhattacharya, S., C. Sharma, R.C. Dhiman and A.P. Mitra, 2006: Climate change and malaria in India. Curr. Sci., 90, 369-375.

incidence of mastitis and foot diseases affecting crossbred cows and other high producing animals may increase due to increase in number of stressful days.

Impact on poultry³⁶

As the ambient temperature reached 34°C the mortality due to heat stress was significantly high in heavy meat type chickens (8.4%) as compared to light layer type (0.84%) and native type (0.32%) chickens. Feed consumption decreased from 108.3 g/bird/day at 31.6°C to 68.9 g/bird/day at 37.9°C. Egg production also decreased both in broiler (by 4.5%) and layer (6.4%) breeders as compared to their standard egg production. The body temperature increased from 41 °C to 45°C as the shed temperature rose from 28°C to 42°C and the critical body temperature at which the birds succumbed to death was 45°C, which was observed at the shed temperature of 42°C. Naked neck birds performed significantly better than the normal birds with respect to thermo tolerance, growth, feed efficiency and immunity at high temperatures.

Likely Impacts of Climate Change on Human Health

Some of the fundamental impacts of climate change as indicated on human health are listed below (Source: Protecting health from climate change – Connecting Science Policy and People, WHO, 2009):

- Extreme air temperature leading to heat waves are a direct contributor to deaths from cardiovascular and air pollution to respiratory disease, particularly among elderly people. High temperatures also raise the levels of ozone and other air pollutants that exacerbate cardiovascular and respiratory disease, and pollen and other aeroallergens that trigger asthma.
- Floods, droughts and contaminated water raise disease risk as more variable precipitation is occurring, with an increase in the frequency and intensity of both floods and droughts. At the same time, higher temperatures are hastening rates of evaporation of surface waters and melting the glaciers that provide fresh water for many populations. Lack of fresh water compromises hygiene, thus increasing rates of diarrhoeal disease. In extreme cases, water scarcity results in drought and famine. Too much water, in the form of floods, causes contamination of freshwater supplies and also creates opportunities for breeding of disease carrying insects such as mosquitoes.
- Rising temperatures and changing patterns of rainfall are projected to decrease crop yields, stressing food supplies. This is deleterious for small and marginal farmers as they are unlikely to have enough income to buy food. This situation is expected to translate directly into wider prevalence of malnutrition. In turn, malnutrition and under nutrition increase the severity of many infectious diseases, particularly among children.
- Expected increases in the frequency and severity of flooding and storms will result in the destruction of homes, medical facilities and other essential services, impacting particularly on people in slums and other marginal living conditions.
- Many of the major infectious diseases transmitted by water and contaminated food, and by insect vectors are highly sensitive to climatic conditions and weather extremes. Climate change threatens to slow, halt or reverse current progress against many of these infections.

³⁶ <http://www.icar.org.in/files/reports/icar-dare-annual-reports/2010-11/climate-change-AR-2010-11.pdf>

Chapter 5

Present Policies and Programs and Linkages with NAPCC

Chapter 5 - Present Policies and Programs and Linkages with NAPCC

At the national level, the integration of climate change in national development is guided by the Prime Minister's Council on Climate Change, which includes representation of key Ministries, as well as experts, and representatives of industry and of media. The Council provides overall strategic guidance on mainstreaming climate change in development, identifies key intervention priorities, and monitors the implementation of these interventions.

The National Committee to Assess the Impacts of Climate Change is chaired by the Principal Scientific Advisor to the Prime Minister, and includes meteorologists, climate modelers, hydrologists, energy economists, as well as representatives of key Ministries. The Committee is evaluating the impact of climate change on key development activities, and assessing options to mitigate climate risks.

The NAPCC identifies measures that promote development objectives which also result in co-benefits for addressing climate change. There are eight National Missions, which form the core of the NAPCC, representing a "multi-pronged, long-term and integrated strategies for achieving key goals in the context of climate change".

Eight Missions of National Action Plan on Climate Change

National Solar Mission (renamed as 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 (NMEEE) 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 programs

National Mission on Sustainable Habitat aims to promote energy efficiency as a core competent 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 % 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 afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23 % to 33 % of India's territory.

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 modeling and increased international collaboration to develop adaptation and mitigation technologies.

Linkages with NAPCC

As a follow up to the Prime Minister's Action Plan for combating the impacts of climate change several steps have been taken by the Government of Haryana.

Water Mission - Existing State Policies and programs

Haryana has formulated its draft state water policy to address major issues relating to the water sector, joining a few state in India which have come out with such policies. The state does not have any independent source of surface water and remains dependent on neighbouring states for water. The main focus of the proposed policy would therefore be on water conservation. The policy would also become an operational action plan for implementation of National Water Policy of 2002 for Haryana state. The policy would prioritise allocation and achieve planning, development, conservation and management in an integrated manner and based on sound environmental footing, financial sustainability with a participatory approach including private sector. The proposed policy would lay special focus on:

- equitable and judicious allocation of water, with the emphasis on poor and disadvantaged people.
- conservation of water resources and its optimum utilisation.
- effective groundwater management with the association of all stakeholders through a proposed groundwater authority.
- monitoring groundwater quality.
- use of modern information technology keeping in view the future demands on account of growth and the social, economic, geographical and other issues of the state.
- planning for water resources development on the concept of basin or sub-basin as a unit, treating surface and ground waters as unitary resource to meet the demands of various sectors.
- integrated planning of water resources sector with components, such as drainage, flood management, water conservation techniques, such as rainwater harvesting, artificial recharge and bio-drainage.

Top priorities had been laid on drinking water, irrigation, power generation, environmental allocation, agro-industries, non-agricultural industries and other uses.

Concerns related to water resources

Lack of Proper Water Database and Hydrological Information System

The existing water database is all in manual form and is not properly managed. Similarly, the Hydrological Information System (HIS) is primitive. This results in decision in water resources

development and management which are not based on any scientific basis, rather all decisions in the field of water resources are based on age-old wisdom and intuition and therefore may not necessarily be good decisions.

Gap between demand and supply

Since the state does not have any permanent source of surface water and the state is dependent upon inter-state shares in various rivers, there is a gap between demand and supply. Even the groundwater, despite extensive and intensive exploitation, is not enough to fill the gap. This gap in demand and supply is a major concern of the state and necessitates effective measures for conservation of water. The impact of climate change is expected to further increase this gap and the state will have to seriously plan massive efforts in reducing the gap.

Pollution of water resources

On one hand the state has to bear the shortage of supply of water and on the other side unabated pollution of water resources is another major concern. The pollution in question is point source as well non point source pollution. The industrialization, urbanization and lack of appropriate technologies and infrastructure for treatment are some of the major reasons for water pollution in the state.

Flood management

Floods are one of the major disasters which cause substantial loss of life and property each year. Though the department takes many preventive measures yet impact of climate change on situation of flood will necessitate more concerted steps. The state gives priority to flood management in the state and the added impact of climate change impact is another concern of the state.

Waterlogging and soil salinity

Waterlogging and soil salinity are other concerns of the state. A vast area of the state is affected by Waterlogging, which makes the land unusable for any useful purpose. Other concern is soil salinity as quite a large area of land in the state is affected by soil salinity. These two issues are major concerns for the state and the impact of climate change is likely to aggravate this situation further.

Overexploitation of groundwater

Because availability of surface water in the state is not sufficient to cater to the demand of water for irrigation and other uses, there is unabated exploitation of groundwater. The unplanned and unchecked growth of groundwater uses has resulted in depleting groundwater and the state is quite concerned of the issue. The climate change scenario is likely to further increase the unabated usage of groundwater.

Diminishing water bodies

The age old practice of creating and maintaining water bodies in each village has given way to urbanization which has resulted in diminishing water bodies in the state. Even the large water bodies are either diminishing or shrinking on account of unabated development or lack of proper maintenance. The absence of the water bodies shall also contribute to the inability of the society to cater to the impacts of climate change and this issue is another area of concern for the state.

Adaptation of New Technology

There have been significant technological advancements in the field of water resources management the world over and the state is alive to this potential and shall be keen in making use of the potential of the technology to its benefit. However, the water resources management is yet to come to terms with the new technological innovations globally.

Under the rural development department, the following Watershed Development Programmes are implemented:

Integrated Watershed Management Programme (IWMP)

- Ongoing Watershed Projects under Desert Development Programme (DDP)

Funding pattern: Central Government 75% and State Government 25%

Scheme Details: The programme has been launched by Government of India during the year 1995-96 in the 47 blocks of district Bhiwani, Hisar, Fatehabad, Sirsa, Jhajjar, Rewari and Mohindergarh. Normally, an area of 500 hectares of a village or group of village is taken up for development activities like land leveling, field binding, forestry, digging of ponds etc. the estimated cost of each project is Rs. 30 lakhs and the period of each project is 5 year. Since 1995-96, 1189 Micro Watershed Projects under DDP have been sanctioned by Government of India in these districts and 696 projects have been completed so far whereas 234 projects have been foreclosed and 259 projects are ongoing.

- Ongoing Integrated Wasteland Development Programme (IWDP)

Funding pattern: 11:1 Centre and State Share

Scheme Details: This programme covers 13 non DDP districts namely Ambala, Faridabad, Gurgaon, Jind, Mewat, Rohtak, Sonapat, Panchkula, Panipat, Palwal, Karnal, Kaithal and Yamunanagar. The size of the IWDP Project ranges between 3000-5000 hectares of land. Since 1995-96, 26 IWDP projects have been sanctioned in Haryana out of which 8 Projects each of district Faridabad, Kaithal, Panipat, Rohtak, Y/Nagar MDA Nuh and Panchkula (2).have been got completed whereas 5 projects each of district Jind (2), Gurgaon, Karnal and Ambala have been foreclosed due to non performance and rest of the 11 are ongoing.

As per instructions of Government of India all ongoing projects of DDP and IWDP have to be completed up to 31-12-2012.

It is pertinent to mention here that Rural Development has spent an amount of Rs. 317.31 lakh from the period 2006-07 to 2011-12 (up to August 2011) on watershed development projects under Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWDP).

- Integrated Watershed Management Programme (IWMP)

Funding pattern: 90:10 Centre and State Share

Scheme Details: In pursuance of the Common Guidelines, the Ministry of Rural Development, Department of Land Resources, Government of India has merged the schemes of Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWMP) into Integrated Watershed Management Programme (IWMP) from the year 2008-09. This consolidation is for optimum use of resources, sustainable outcomes and integrated planning. The Preliminary Project Reports (PPRs) in respect of 7 districts namely; Ambala, Bhiwani, Hisar, Mahendergrh, Rewari, Panchkula and Yamunanagar were prepared proposing 47 projects covering an area of 179531 ha for the year 2011-2012 with an estimated project cost of Rs. 222.42 crores. These proposals were submitted to the Government of India after the approval of the State Level Nodal Agency (SLNA) constituted for the State of Haryana for the purpose. In its meeting held on 18th August, 2011, the Steering Committee of the Ministry of Rural Development, Department of Land Resources for IWMP appraised and cleared all the 47 projects covering an area of 179531 ha. in 7 districts of Haryana for the year 2011-12 with total projected cost of Rs. 215.44 crores comprising of 194 crores as Central Share.

Green India Mission Forests and Horticulture - Existing State Policies and programs

In order to increase the forest and tree cover, the Haryana Forest Department (HFD) has undertaken a massive afforestation programme on Government lands, Institutional Lands, Panchayat lands, Common lands and wastelands. The area afforested annually under various programmes in Haryana is 21,000 ha. Saplings are also distributed to farmers, other government departments, institutions, schools, village panchayats etc. for planting in their lands. Due to large scale afforestation initiated by the Forest Department on non-forest land i.e community lands, panchayat lands, institutional lands, private wastelands etc. as well as adoption of tree farming by farmers on their holding, the tree cover of the state has increased to 7.13% as per the state of forest report published by the Forest Survey of India in 2005. The HFD had a target to achieve 10% of forest and tree cover by 2010.

The Government of Haryana had initiated Joint Forest Management in the state in the late seventies, much before it became a policy of the Ministry of Environment and Forests. The model developed in Sukhomajri village of Haryana, through participation of people in protecting forests, who were given rights over water and forest produce in return, is now world famous. Practice of participatory approach in forestry operations and forest management has continued in the state. Village level forest committees (VFC) have been constituted in over 817 villages under National Afforestation Programme (NAP). Besides this, 1135 VFCs have also been constituted under Japan International Cooperation Agency (JICA) funded Integrated Natural Resource Management Project and Haryana Community Forestry Project (HCFP). In all these programmes/projects, there is a special thrust to empower women by providing them assistance in forming self-help groups and training them to start some income generation activity to improve their economic well being. However, it has been increasingly felt that it will be virtually impossible to prevent degradation of forests in Haryana without the active involvement of the local people in their protection and maintenance.

The Haryana Government has adopted a State Forest Policy-2006 which targets at the following:

- Afforestation for maintenance of environmental stability and restoration of ecological balance affected by serious depletion of forests, woodlands and water.

- Conserving bio-diversity in natural forests of the State, containing genetic resource base of the rare species.
- Development and protection of habitat in protected areas and conservation and development of water resources in forests.
- Checking the denudation of forests.
- Increasing the productivity of forests to meet the essential needs of people on a sustainable basis by using genetically superior seedlings and better management practices.
- Checking soil erosion in the catchments of the rivers, rivulets and reservoirs for soil and water conservation.
- Checking the extension of sand dunes in the semi-arid areas of the State to save the infrastructure in that region.
- Reclamation of salt affected areas irrespective of the ownership by afforestation techniques.
- Increasing tree cover in the State through afforestation and social forestry programmes on wastelands.
- Production of industrial wood from non-forest lands by promoting agro-forestry.
- Encouraging efficient utilization of forest produce and also promoting wood substitutes.
- Creating a massive people's movement with the involvement of women and school children, for achieving these objectives and to minimize pressure on natural forests.
- Institution building at village level for Joint Forest Management and participation in Forestry activities.
- Formation of self help groups, particularly of women for their empowerment through forestry based and other income generation activities.
- Conservation and development of medicinal plants and development of eco-tourism.
- Development of timber markets for stabilizing the prices of forest produce.

Forestry and Wild Life preservation Programmes

Various Forestry schemes implemented in Haryana in 2009-10 by various wings are:

- Externally Aided Project: Integrated Natural Resource Management and Poverty Reduction Project
- State Schemes
 - o Development of Agro-Forestry Clonal and Non-Clonal
 - o Special Component Plan for Scheduled Caste
 - o Forestry Activity in SC Villages
 - o Social & Farm Forestry Scheme for SC
 - o Green Belt in Urban Areas
 - o Revitalization of Institutions in Arravali Hills
 - o Rehabilitation of Degraded Forests
 - o Strip Plantation on Govt. Land
 - o Compensatory Afforestation
 - o Desert Control
 - o Schemes Without Plantation Targets
- Centrally Sponsored Schemes on Sharing Basis

- Integrated Forest Protection
 - Development of National Parks & Sanctuaries
- Wild Life Preservation
 - Protection of Wild Life
 - Extension of Zoo & Deer Parks

Tree Improvement schemes (Plantation)

Plantation schemes have been formulated for different agro climate zones and plantation targets are allotted to different forest divisions.

- Development of Agro-Forestry Clonal and Non-Clonal
- Special Component Plan for Schedule Castes
- Forestry Activity in SC Villages
- Social & Farm Forestry Scheme for SC
- Green Belt in Urban Areas
- Revitalization of Institutions in Aravali Hills
- Rehabilitation of Degraded Forests
- Strip Plantation on Govt. Land
- Compensatory Afforestation
- Desert Control

Soil and Moisture Conservation

Soil conservation on watershed basis including cho-training are implemented in forest area. Check dams, water harvesting dams, percolation dams and village ponds are developed for soil and water conservation. Massive plantation is done on the catchment areas and around the pond and water harvesting structures.

Biodiversity Conservation

28 herbal parks have been developed after the names of medicinal plants in each districts of Haryana from 2005-06 to 2009-10. Main objectives of these gardens and parks are; conservation of medicinal plants for study and research; developing a gene-pool of indigenous and exotic plant species for conservation and propagation purposes; popularization of medicinal and aromatic plants cultivation and use in the area by local peoples; resource base establishment of sustainable medicinal plants.

Wild Life management

The wildlife is managed by separate wing headed by the Additional Principal Chief Conservator of Forests-cum-Chief Wild Life Warden Haryana at Van Bhawan Panchkula. At district level Divisional Wild Life officer is responsible for wild life protection and management of Wild Life Sanctuaries (WLS), National Parks (NP) and Conservation Reserves (CR) and report to Conservator of Forests(Wild life) Panchkula and Gurgaon (Table 20).

Table 20: National Parks in Haryana

Sr. No.	Name	Year of establishment	Area in Acre	District
1	Sultanpur National Park	1991	352.17	Gurgaon
2	Kalesar National Park	2003	11570	Y/Nagar

Sr. No.	Name	Year of establishment	Area in Acre	District
Wildlife sanctuaries				
1	Bhindawas Wildlife Sanctuary	1986	1016.94	Rohtak
2	Chilchhila Wildlife Sanctuary	1986	71.45	Kaithal
3	Nahar Wildlife Sanctuary	1987	522.25	Rewari
4	BirShikargah Wildlife Sanctuary	1987	1896	Ranchkula
5	Abubshehar Wildlife Sanctuary	1987	28492	Sirsa
6	Khaparwas Wildlife Sanctuary	1991	204.36	Jhajjar
7	Kalesar Wildlife Sanctuary	1992/1996	13431.65	Y/Nagar
8	Morni Hills KholHai Rattan	2004	12065.79	Panchkula
	Total Area of Wildlife Sanctuaries		57700.44	
Conservation Reserve				
1	Saraswati, Kaithal	2007	11003	Kaithal
2	Bir Bara Van, Jind	2007	1036	Jind
	Total Area of Mini Zoos		12039	
Mini zoos				
1	Mini Zoo, Pipli	1085-86	8	Kurukshetra
2	Mini Zoo, Rohtak	1985-86	14	Rohtak
3	Mini Zoo, Bhiwani	1982-83	51	Bhiwani
	Total Area of Mini Zoos		73	
Deer parks and breeding centres				
Sr. No.	Name	Year of Establishment	District	
1	Deer Park, Hisar	1985	Hisar	
2	Black Buck Breeding Centre, Pipli	1985-86	Kurukshetra	
3	Chinkara Breeding Centre, Kairu	1985-86	Bhiwani	
4	Crocodile Breeding Centre, BhaurSaidan	1981-82	Kurukshetra	
5	Pheasant Breeding Centre, Morni	1992-93	Panchkula	
6	Pheasant Berwala, Panchkula	2006	Panchkula	

Based on these postulates of the state forest policies, following programmes have been initiated.

- Plantation and Farm Forestry
 - o Plantation of 50 million seedlings in the state every year,
 - o Massive plantation on Government Forest land
 - o Revival and Strengthening of social and Community forestry activities by involving local community and various stakeholders.
 - o Supply of quality seedlings of valuable species and grafted fruit plants free of cost to farmers to promote agro-forestry
- Soil and Moisture Conservation
 - o Soil and moisture conservation activities by constructing check dams, water harvesting dams and other suitable structures on watershed basis,
- Biodiversity conservation
 - o Plantation of TRIVENI (three species of Bargad, Peepal and Neem etc.) in villages and preservation and development of SACRED TREE GROOVE in the village and Tree grooves of important and ecologically vulnerable species for biodiversity conservation,

- o Development and maintenance of Biodiversity Conservation Parks (Herbal Gardens) in each district to preserve and cultivate plants of medicinal value and impart education and create awareness among local community.
- Wild Life Preservation
 - o Development of National Parks (NP), Wild Life Sanctuaries (WLS) and Conservation Reserves, Mini Zoo, Wild Animal Breeding Centers, Wild Animal Rescue Centre and Elephant Habitat Development.
- Capacity Building
 - o Formation of Village Forest Committee (VFC) and Hill Resource Management Committee (HRMS)
 - o Formation of Self Help Group (SHG) and Federation of SHG of poor women and imparting training for self employment.
 - o In house training of field staffs of Forest Department
- Clean Development mechanism (CDM) Project-Sirsa
 - o Based on the standardised mechanism, the PDD for 'Small Scale Cooperative Afforestation CDM Pilot Project Activity on private lands affected by shifting Sand Dunes in Sirsa, Haryana' was submitted to the National CDM Authority, MoEF. The national CDM Authority considered the PDD on 17th March 2007 and approved and communicated to the Society on 9th April 2008 has been approved as the first CDM project. The CDM project was funded by the Forest Department, Haryana.
 - o Execution of CDM project started in April 2008 and seedling growing started. Plantation work started in June 2008. The CDM project is funded by the Forest Department, Haryana.

Energy: Existing Acts, Policies, Missions, Programs and Projects

The Energy Policy of India is concentrated around the growing energy deficit making energy conservation a priority followed by increased focus on developing the alternative sources of energy.

The BEE under the central government is responsible for improving the energy efficiency in the economy through regulatory frameworks and promotional instruments (Table 21).

Table 21: Nodal agency with existing acts, policies and programmes

Nodal Agency	Act	Policy	Programmes
Ministry of Power, Bureau of Energy Efficiency (BEE)	Energy Conservation Act, 2001		State Energy Conservation Programme (2007-08)
Ministry of Power	New Electricity Act, 2003	National Electricity Policy (2005)	Restructured - Accelerated Power
			Development and Reforms Programme (R-APDRP)
		Rural Electrification Policy (2006)	Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)

Haryana Department of Renewable Energy (HAREDA) formulates the policies, programmes related to non-conventional and renewable sources of energy and energy efficiency. Table 22 presents the acts, policies, missions under which various programmes are currently being implemented in Haryana. Details of these programmes are provided in Table 22.

Table 22: Existing policies, plans, missions and programmes promoting climate change adaptation

Policy, Plan	Mission	Programmes
National Action Plan on Climate Change (2008)	Jawaharlal Nehru National Solar Mission	Solar Photovoltaic Programme (SPV)
		Remote Village Electrification Programme
		Solar Thermal Programme
	National Mission on Enhanced Energy Efficiency	State Energy Conservation Programme (2007-08)
	National Mission on Sustainable Habitat	
Renewable Energy Policy of Haryana (2005)		

Jawaharlal Nehru National Solar Mission (JNNSM)³⁷

Ministry of New and Renewable Energy (MNRE) Govt of India has launched Jawaharlal Nehru National Solar Mission (JNNSM) with the objective to create conditions, through rapid scale up of capacity and technological innovation to drive down costs towards grid parity.

Grid Based Solar Power Generation

The Mission anticipates achieving grid parity by 2022 and parity with coal based thermal power by 2030. The Mission is divided into three phases. Phase I targets to add grid connected solar power generation of 1000 MW by 2013, followed by an additional 3000 MW by 2017 (Phase II) and 20,000 MW by 2022 (Phase III) through mandatory use of Renewable Purchase Obligation (RPO) by utilities backed with a preferential tariff.

The first phase for solar power generation for grid-based centralized application has been segregated as follows:

- I. Large capacity solar PV and thermal power projects in the range of 5 MW to 100 MW

Under this programme, projects of 5 MW capacity in case of Solar Photo Voltaic (SPV) and 5 MW to 100 MW in case of Solar Thermal of total 1000 MW solar power projects to be implemented by NTPC Vidyut Vyapar Nigam Ltd. (NVVN) for which proposals were invited on 17.08.10. These projects were to be connected to the grid at 33 KV level and above for which the developers were to enter into power purchase agreement with the NVVN. The NVVN shall later enter into Power Sale Agreement with the State Utilities on the tariff notified by the CERC by bundling it with equal quantity of conventional unallocated power. CERC has notified tariff of Rs. 17.91 per unit for SPV projects without accelerated depreciation benefits and Rs. 14.95 per unit if the developer has claimed accelerated depreciation benefits. Similarly, for solar thermal projects, tariff of Rs. 15.31 per unit without accelerated depreciation benefits and Rs. 12.85 per unit if the developer has claimed accelerated depreciation benefits has been fixed.

Haryana Power Generation Corporation Ltd. (HPGCL) is in the process of setting up a 6.5 MW Grid interactive Solar Power Plant at Power House –D, WYC Hydrel, Yamunanagar as a Pilot Project.

³⁷ Introduction to JNNSM. Retrieved December 2011, from HAREDA: (<http://hareda.gov.in/?model=pages&nid=162>)

Administrative approval was obtained from the Government of Haryana on 26.08.2011, while decision on the tariff from HERC is still pending.

II. Small capacity solar PV projects in the range of 100 KW to 2 MW

Under this programme, smaller solar projects including rooftop installations ranging from 100 KW to 2 MW capacity (total 100 MW in phase-I in the country) to be implemented by Indian Renewable Energy Development Agency (IREDA) through State Nodal Agencies shall be promoted. These projects shall be connected to the grid at below 33 KV level. The State Utilities for which the State Electricity Regulatory Commission is required to notify the tariff shall directly purchase the power. Under this programme, Ministry shall provide Generation Based Incentives (GBI) to the State Utilities equal to the difference between CERC tariff and base rate i.e. Rs. 5.50 per unit with 3% annual escalation through IREDA for 25 years.

a. Solar Photovoltaic Programme

Haryana State Govt has declared HAREDA as a Competent Authority for pre-registration of Solar Power Projects under JNNISM. Accordingly, HAREDA had invited proposals through press advertisement for pre-registration of SPV power projects of 100 KW to 2 MW capacities under JNNISM. In response to the advertisement, 141 developers have submitted their proposals of 195.16 MW capacities. Out of the 141 proposal received for pre registration, HAREDA has shortlisted the 22 proposals being eligible for the production of 20 MW Solar power in Haryana. After pre-registration, these developers entered into MoU with Haryana Power Purchase Centre and applied for final online registration with Indian Renewable Energy Development Agency (IREDA). After the release of initial shortlist by IREDA, 10 shortlisted developers entered into PPA with Haryana Power Purchase Centre for 9.8 MW capacities and had submitted their papers to IREDA for issue of final registration.

As of 30.11.11, the Government of India has approved nine solar power projects of 8.8 MW capacity to be set up in Haryana by independent power producers. These projects were to get commissioned by September 2011.

b. Solar Thermal Programme

The Solar Thermal Programmes includes Solar Water Heating Systems Programme (2007) and Solar Cooking Programme (2010).

- Solar Water Heating Systems Programme³⁸

Solar Water Heating Systems Programme was made mandatory for water heating application in all functional buildings where hot water is required. The Haryana Urban Development Authority has adopted the mandatory provisions on HAREDA vide their letter dated 28.11.05. The Department of Urban Local Bodies, Haryana has also amended the Haryana Municipal Building Byelaws vide Notification dated 16.11.07.

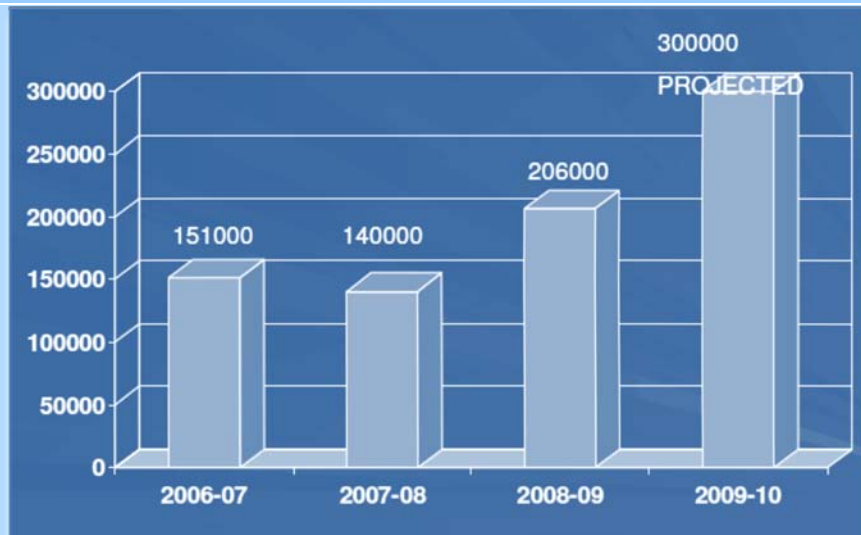
³⁸ Solar Water Heating Programme. Retrieved December 2011, from HAREDA: (<http://hareda.gov.in/?model=pages&nid=78>)

The use of solar water heating systems will be mandatory in the following categories of buildings, namely:

- o Industries where hot water is required for processing
- o Hospitals and Nursing homes including Government Hospitals.
- o Hotels, Motels and Banquets halls
- o Jail Barracks, Canteens
- o Housing Complexes set up by Group Housing Societies/Housing Boards
- o All residential buildings built on a plot of size 500 square yards and above falling within the limits of municipal committees/corporations and Haryana Urban Development Authority sectors
- o All Government buildings, Residential schools, Education Colleges, Hostels, Technical/Vocational Education institutes, District Institutes of Education and Training, Tourism Complexes and Universities etc.

During 2008-09, 384 solar water heating systems of 2,06,000 LPD were installed in the state which is 147% more than the previous year's installation leading to peak load shaving of 2 MW. During 2009-2010, so far, SWHS of 1,65,000 liters capacity installed against a target of 3,00,00 lpd (Figure 39). One of the largest SWHS of 50,000 liters capacity was installed in the Chelsea Textile Mills, Gurgaon. Since inception of the programme, about 1450 SWHS of 13,00,000 liters capacity has been installed in the State.

Figure 39 : Installed Solar Water Heating Systems in the past four years



- Solar Cooking Programme³⁹

Haryana is one of the few States in the country where solar cookers are being promoted by providing subsidy on box/dish type solar cooker. The Government of India is also promoting dish

³⁹ Solar Cooking Programme. HAREDA. Retrieved December 2011, from HAREDA: (<http://hareda.gov.in/?model=pages&nid=79>)

type solar cookers by providing subsidy @ Rs. 2100/- per m² of the collector area limited to 30% cost of the cooker and box type solar cookers @Rs.3600/- per m² of the collector area.

During the year 2010-11, there is a target of distribution of 1750 solar cookers in the State with State subsidy provision of Rs.20.0 lakhs. Also, 1000 Dish Type Solar Cookers with the financial assistance of GoI and Shivalik Development Agency, Ambala is to be provided in District Yamuna Nagar in the Shivalik Area.

Offgrid decentralised solar applications⁴⁰

In order to create a sustained interest within the investor community, MNRE has decided to support viable business models with the objective to promote off-grid application of solar energy (both SPV and Solar Thermal). Details of the programmes are given below.

I. Remote Village Electrification Programme

All villages of the State of Haryana have been electrified, yet there are few hamlets (dhanies) in the hilly shivalik belt of Dist. Panchkula, which are still un-electrified. These hamlets are having very less number of households and are not accessible by road. One has to reach in these hamlets on foot on narrow hilly tracks. People in these hamlets were using Kerosene etc. to meet their lighting needs. The electrification with the conventional grid electricity is not economically feasible due to hilly terrain and less number of houses in each hamlet.

Ministry of New and Renewable Energy (MNRE), Government of India has launched a scheme for electrification of un-electrified hamlets/villages with renewable energy technologies for which Ministry is providing central financial assistance @ 90% of the benchmark cost fixed by the Ministry. The remaining cost is to be borne by the concerned nodal agency/village panchayats. As per MNRE guidelines, only those hamlets/villages are to be electrified under this project which are not to be electrified with the conventional grid electricity by 2012.

Realizing the needs of the peoples living in these un-electrified hamlets of block-Morni, district Panchkula, HAREDA prepared a project proposal for electrification of these un-electrified hamlets in phased manner (Table 23).

Table 23: Village electrification programme - project at glance⁴¹

Item	Phase-I	Phase-II	Phase-III	Total
Hamlets Electrified	45	149	92	286
Households	305	320	151	776
Population	1564	1652	682	3,918
Systems Installed (i) HLS (ii) SLS (iii) Power Plant 5KW	221, 110, 7	336, 208,-	151, 99, -	708, 417, 7
Year of Commissioning	July, 2006	Nov., 2007	Aug, 2009	
Total Cost (Rs.)	2,50,19,400	1,37,56,000	65,93,800	4,53,69,200
MNRE/GOI share (Rs.)	1,46,83,170	85,57,216	42,89,348	2,75,29,734

⁴⁰ Off grid Decentralization Solar Application Programme. Retrieved December 2011, from HAREDA: (<http://hareda.gov.in/?model=pages&nid=115>)

⁴¹ Remote Village Electrification Programme. Retrieved December 2011, from HAREDA: (<http://hareda.gov.in/?model=pages&nid=48>)

HAREDA share (Rs.)	40,00,000	41,00,000	15,00,000	96,00,000
SDA share (Rs.)	63,36,230	10,98,784	8,04,452	82,39,466

Source: HAREDA (<http://hareda.gov.in/?model=pages&nid=48>)Item Phase-I Phase-II Phase-III Total

II. Solar Lantern Programme⁴²

Solar Lantern is an emergency light, which runs on with solar energy. During the daytime, solar panel convert sunlight into electricity and this is stored in a maintenance free battery. This stored energy is used to run the solar lantern. This light is very useful in the unelectrified areas and during power cuts. It is a portable device and can be carried easily anywhere. It is user friendly, easy to operate and compact and is very useful for farmers to carry it in fields during the night.

Under Solar Lantern Programme, HAREDA has been providing solar lantern of 10-watt capacity (SPV module 10 watt, CFL 7 watt and battery 12 volt 7 Ah). The cost of one such lantern is approx. Rs. 3300/- and after providing state subsidy of Rs. 1500/-, these lanterns are being provided to the individuals at the rate of Rs. 1800/-.

Now, small capacity low cost 5 watt SPV module (CFL 5 watt and battery 6 volt 4.5 Ah) has also been developed. The cost of one such lantern is approx. Rs. 1550/-. The state Government may provide subsidy Rs.550/- per system user has to bear Rs.1000/-only. This new lantern is very attractive, compact and portable and less costly. HAREDA has promoted 1500 such lanterns under Shivalik Development Agency Scheme during the year 2006-07. HAREDA has distributed 4300 solar lanterns (3300 in cluster of villages for BPL/SC and 1000 under General Programme) during 2007-08. During the year 2008-09, 1000 Solar Lanterns have been distributed under General Programme.

Haryana Energy Efficiency Programme

Haryana was the first State in the country to issue a comprehensive notification dated 29.07.2005 on Energy Conservation Measures. Energy Conservation activities under the Energy Conservation Programme were started in Haryana in 2007-08 with the launch of 5 years State Energy Conservation Action Plan by the Hon'ble Chief Minister, Haryana. The action plan envisaged energy saving potential of about 500 MW in the state through various energy conservation and efficiency measures.

Achievements in the past four years in saving energy are as follows (Table 24).

Table 24: Energy saved since inception of the state energy conservation programme in 2007-08

Year	Energy Saved in MW
2007-08	88
2008-09	131
2009-10	165
2010-11	86

Due to their impressive track record, Haryana State Development Agency has been awarded the best SDA award for the past three consecutive years.

⁴² Solar Lantern Programme. Retrieved December 2011, from HAREDA: (http://www.hareda.gov.in/?model=pages&nid=153&lang=en_us&output=json)

The initiatives taken for energy conservation in the various sectors are as follows:

1. Agriculture

- Scheme on energy conservation in Agriculture sector

The scheme pertains to mandatory use of ISI marked Motor pump sets, Power capacitor, and Foot/Reflex valves in Agriculture Sector⁴³.

Scenario: Agriculture sector is one of the most energy consuming areas in the State. In efficient agriculture pump sets while consume more electricity and draw less water on one hand, they increase the burden on the State Government in the form of power subsidy. Haryana was the first State in the country to mandate use of ISI marked pump sets and accessories in 2005.

Achievement: During the year 2009-10, 23,791 star rated/ISI marked pump sets were installed and an amount of Rs.92.5 Lakhs spent on providing financial incentives which resulted in saving of 187 MU of electricity translating into a saving of Rs.748 crores in the electricity bills annually and reduction of 140063 tones of CO2 emission.

During the year 2010-11, 27901 star rated/ISI marked pump sets were installed by the power utilities which resulted in saving of 219.31 MU of electricity translating into a saving of Rs. 919.00 crores in the electricity bills annually and reduction of 164263 tones of CO2 emission. For the year 2011-12, an amount of Rs. 125.4 lac has been provided to the power utilities for demonstration of 5 star rated pump sets by replacing 205 inefficient agricultural pump sets at Mohanpur feeder at Kurukshetra district.

2. Buildings and Industry

- Mandatory use of Compact Fluorescent Lamp (CFL) in Government Buildings/Government Aided Institutions/ Boards/Corporations

Scenario: About 25% of the Energy Consumption in the State was for the lighting purposes and the Government offices were a major consumer of electricity for this purpose. Haryana is the first State in the country to have decided to replace the ordinary bulbs and conventional tube lights with energy efficient lights by 1.1.09 in all Government offices and buildings.

Achievement: As of 2011, 1,22,705 CFLs and 1,30,771 T-5 energy efficient tube lights have been got replaced in the state in Government buildings.

- Scheme on energy audit for industries, commercial buildings, Government buildings and institutions etc

Scenario: HAREDA has initiated a scheme of energy audit of Government and institutional buildings to identify the areas of large energy consumption where energy conservation measures can be introduced.

Achievement: Haryana is the first State in the Country where new scheme for energy audit has been introduced in the financial year 2009-10 for promoting investment grade energy audit in private,

⁴³ Scheme on energy conservation in agriculture sector . Retrieved December 2011, from HAREDA: (<http://hareda.gov.in/?model=pages&nid=131>)

Government, Semi-Government, industrial, Institutional and commercial buildings. Under the scheme, owners of the buildings shall be provided financial assistance @ 50% of the investment grade energy audit cost with maximum limit of Rs. 50,000/- provided, they undertake to implement the energy audit report. Under this scheme, financial assistance has been provided to 19 industries/institutions/commercial buildings.

- Promotion of Energy Efficient Buildings Design through Energy Conservation Building Code (ECBC)⁴⁴.

Scenario: Buildings not only consume energy during their construction but also over their lifetime in their operation and maintenance. Being a progressive state, Haryana is witnessing a large growth in the building sector. HAREDA has initiated a scheme of energy audit of Government and institutional buildings to identify the areas of large energy consumption where energy conservation measures can be introduced. Realizing the potential for Energy Conservation in the building sector, the Bureau of Energy Efficiency, Ministry of Power, Government of India has launched the Energy Conservation Building Code in May 2007. The Energy Conservation Building Code (ECBC) sets a minimum efficiency standard for commercial buildings having a connected load of 500 KW or more. These Codes have been circulated to line departments for adoption.

Achievement: In the first phase, energy audit of 10 Government buildings was completed indicating a potential energy saving of 26,484 KWH per year. Suggested action plans were implemented by the concerned departments on their own. Later, energy audit of Haryana Raj Bhawan was also conducted and implemented resulting in saving of 1.20 lakh units of electricity amounting to Rs.3.60 lakhs with an investment of Rs.16.16 lakh⁴⁵. Subsequently, energy audit of CM residence was also carried out and implemented with an investment of Rs. 6.67 lac which has resulted in annual savings of 60000 units of electricity amounting to Rs. 2.70 lac annually with a payback period of 3 years. The energy audit of these iconic buildings by HAREDA ensured demonstration of the benefits of energy audit at the highest level of the Government and its replication.

On initiative of the Bureau of Energy Efficiency, Government of India HAREDA identified 56 government buildings for Investment Grade Energy Audit (IGEA) in 2008-09. The Investment grade Energy Audit study of 41 large Government Buildings has been completed at a cost of Rs. 15.84 lac and is under implementation by the building owners. These projects will result in saving of 2.4 million units of electricity per annum with an investment of approx. Rs. 9.65 crore.

The Haryana Government has taken an in principal decision to adopt the Energy Conservation Building Codes (ECBC) launched by the Bureau of Energy Efficiency Government of India in July 2007

A Handbook on Energy Conservation in Building Sector in Hindi and English both has been printed for creating awareness and has been distributed among the general public.

In order to build capacity among the architects, engineers and other stakeholders, a two day training Energy Conservation Building Code (ECBC) and GRIHA rating was organized on 12th and 13th Nov.

⁴⁴ Energy Conservation Building Code(ECBC). Retrieved December 2011, from HAREDA: (<http://hareda.gov.in/?model=pages&nid=30>)

⁴⁵ Scheme on Energy Audit. Retrieved December 2011, from HAREDA: (<http://hareda.gov.in/?model=pages&nid=54>)

2009 at Haryana Panchayat Bhawan, Chandigarh. The Department also organized another “Two days Training on ECBC and Green Buildings” on 15th and 16th July 2010 at Retreat Gurgaon. 51 participants attended this training. Another training programme on ECBC was organized on 16-17 February 2011 at Faridabad, which was also attended by 51 participants from the NCR region.

The Architecture Department is the state agency for preparation of architectural drawings for Government building projects. Therefore, handholding with the Architecture Department was necessitated. For this purpose, HAREDA hired the services of a renowned BEE empanelled architect to crosscheck / verify the drawings of the Department of Architecture, Haryana for their ECBC compliance. The BEE provided the financial assistance of Rs. 10,000/- per day.

To recommend amendments in the building byelaws and revision of the HSR to incorporate Energy Conservation Building code (ECBC) State Level Technical Committee (STC) has been constituted and notified in the Gazette of Haryana Government on 28.01.2010. On the request of the Department, the BEE, GOI has provided the services of TERI for amending the building byelaws. The recommendations regarding the specific modification of Municipal Building Byelaws and HUDA received from TERI have been forwarded to Stakeholders Departments for their comments so that it may be examined and discussed by Sub Committee.

Haryana is the first state in the country to incorporate the energy efficient building material, Electrical items, and Solar Water Heating System, in the Haryana Scheduled of Rates (HSR) to implement ECBC in the state. The meeting of the Direction Committee held on 14.10.10 has approved them, in principle, and accordingly the same have been included in HSR through Notification dated 4th November 2010.

For demonstration of designing and construction of 5 star GRIHA rated / ECBC compliant building, Dept. is constructing its office building “Akshay Urja Bhawan” at Sector -17, Panchkula.

On the occasion of celebration of State Level Energy Conservation Day on 18th December, 2009 Hon’ble CM, Haryana has announced to award Rs. 2.00 lac and Rs. 1.00 lakhs to the architect for designing 4 star and above and 3 star rated building respectively.

- Energy Efficiency in Industrial Sector

Scenario: Haryana has six clusters of various industries where there is a potential of improving energy efficiency through heat recovery. These clusters are:

- a) Faridabad - Light Engineering
- b) Rewari – Aluminum and Brass Industry.
- c) Panipat – Textile Industry
- d) Yamuna Nagar – Plywood and Steel Rolling
- e) Karnal – Rice Mills
- f) Gurgaon- Auto ancillary

Action Plan: In the first step, willing and potential industrial units in four of the six SME clusters namely, Faridabad, Gurgaon, Rewari, Panipat and Karnal were identified for energy efficiency campaign with financial assistance of Rs.2.0 crore from the BEE under the State Energy Conservation

Fund (SECF). The potential industries were identified through interaction meets and thereafter preliminary Walk through Energy Audit (WTEA) was conducted in 40 identified units in each of the four clusters. Walk through Energy Audit involves preliminary investigations about the process, fuel consumption and assessment of the energy saving potential. Interactive meet at Faridabad, Karnal, Gurgaon and Rewari organized with expenditure of Rs.3.00 lakhs. Sanction of financial assistance of Rs.19.2 lakhs has been given to 200 industries of Faridabad, Gurgaon, Karnal, Rewari and Panipat. WTEA report of 179 industries of Faridabad, Gurgaon, Rewari and Karnal has been received. Analysis of WTEA reports of Faridabad, Rewari and Gurgaon district have been done.

In the second step, 30 potential industries were to be selected for detailed energy audit on the basis of their response, scope of energy efficiency gains, expert recommendations and participation. The detailed energy audit is proposed to be conducted with 75:25 cost sharing basis with HAREDA support limited to Rs.1.5 lac per unit provided the units undertake to implement the technoeconomically feasible recommendations. Sanction of financial assistance of Rs.12.75 lakhs has been given to 12 industries of Faridabad and Gurgaon.

In the third step, two best detailed energy audit reports (total eight) will be selected for developing them as demonstration projects on waste recovery through WHRB, Recuperators, Economizers, Automatic voltage Regulators, Power capacitors etc. with 75:25 cost sharing basis. The financial assistance to the SMEs will be limited to Rs.7.50 lac per unit.

In the fourth step, HAREDA shall prepare a demonstration manual based on success stories of the demonstration projects and shall disseminate the results of the demonstration projects through interactive workshops so that similar projects may be replicated. Detail of these activities has been included under SECF activities.

3. Initiatives by power utilities

- Agriculture

During 2009-10, 23,891 tube well connections with energy efficient ISI marked motor pump sets were released contributing to energy saving of 187 MUs of annually. During 2010-11, 27901 tube well connections with energy efficient ISI marked/ star rated motor pump sets were released resulting in energy saving of 219.31 MUs of annually.

- Lighting

The power utilities are a major stakeholder in the energy conservation campaign in the state. Being the generator and distributor, the power utilities have a great role in practicing, enforcing and popularizing the energy conservation measures. The bachat lamp yojna in the state is implemented by the Uttar Haryana Bijli Vitran Nigam.

During 2009-10, 3,17,654 CFLs were distributed by the Power Utilities under general programme/BPL families programme/Bachat Lamp Yojna contributing to energy saving of 34.68 MUs annually. In 2010-11, 824656 CFLs/ T-5 tube lights were distributed/ installed by the power utilities under general programme/BPL families programme/ Bachat Lamp Yojna. Resulting in energy saving of 99.21 MUs.

The power utilities have made the use of CFLs for new connections mandatory.

During 2009-10, the Uttar Haryana Bijli Vitran Nigam limited (UHBVN) converted 14,595 street light points into energy efficient street light by shifting to T-5 tube lights in compliance of Haryana Government Gazette Notification dated 25.06.08 resulting in saving of about 1.79 MUs annually. During the year 2010-11, energy savings of about 643 MUs of electricity equivalent have been quantified which translates to about 86 MW capacity addition avoided. In 2010-11, the premises of 3554 such consumers were converted to energy efficient lighting premises thereby saving of about 97.29 MUs of electricity annually. In addition, the Dakshin Haryana Bijli Vitran Nigam (DHBVN) also reported replacement of 213796 CFLs/T-5 and 590 LED lamps in their area of operation thereby saving of about 16.45 MUs of electricity annually.

Regarding implementation of the State Government Notification dated 25.6.08 on energy efficient lighting in consumers with connected load of 30 KW and above and all Central Government/CPSU offices in the State, the Uttar Haryana Bijli Vitran Nigam has reported that out of 11,885 identified consumers, the premises of approximately 8000 electricity consumers with connected load 30 KW and above converted to energy efficient lighting during 2009-10 thereby saving about 201.18 MUs electricity annually.

- Energy-Star Labelled Appliances

In 2009-10, 33,813 energy efficient/star labeled transformers of 25 KVA, 63 KVA and 100 KVA each capacity procured and installed contributing to saving of 66.65 MUs annually. In 2010-11, 22000 star labeled transformers were procured and installed contributing to energy saving of 43.36 MUs annually.

- Efficiency In Power Generation

- o Renovation, Modernization and Capacity Addition

HPGCL has been implementing various R&M schemes under various programmes. The R&M of Panipat Thermal Power Station (PSPT) 110 MW units 1 and 2 have been completed, and Units 3 and 4 are in progress.

- o ISO Certification for HPGCL Power Plants

HPGCL has become the first State sector power generation utility in the country to get certified for ISO:9001, ISO:14001 and OHSAS:18001 for its power stations in Yamunanagar and Panipat and corporate office at Panchkula.

- o Energy Efficient Buildings

The design of Urja Bhawan of HPGCL at Panchkula is energy efficient, environment friendly with elements of green architecture and ECBC compliant. The building is also equipped with an efficient rainwater harvesting system as per the design of Central Ground Water Board. The building also has 500 litre capacity to meet the requirement of hot water.

- o Energy Savings by reducing Consumption

By improving the efficiency of the power plants substantial reduction has been achieved in the fuel consumption. The auxiliary power consumption, which was around 12% during 1998-99, has been brought down to 10.06% during 2010-11.

During 2009-10, the specific coal consumption in Haryana Power Generation Corporation Ltd. generation stations improved from 712 gm per unit to 706 gm per unit thereby saving 90000 tonnes of coal contributing to equivalent energy saving of 127.47 MUs annually. During 2009-10, the specific oil consumption in HPGCL generating stations improved from 2.87 ml to 1.61 ml per unit thereby, saving 18745 kl of oil contributing to equivalent energy savings of 74.98 MUs annually.

o Energy Audit Tests

HPGCL has carried out energy audit tests of units 1 to 6 of PSPT, Panipat during 2010 through M/S Evonik Energy services under the supervision of energy audit group. Most of the recommendations have been implemented and the remaining shall be implemented during the shutdown/overhauling period. The audit of 250 MW units 7 and 8 of PSPT, Panipat and DCRTTP, Yamunanagar shall be carried out on 50:50 cost sharing basis under SECF.

4. Miscellaneous

- BEE Star Labelling Of Products

Scenario: Survey of 19 designated consumers in the state completed and the survey of 715 other probable designated consumers and commercial buildings are under process. A list of 119 Energy Managers and 136 Energy auditors of the state was prepared. The study shows that out of these, only 12 energy managers and 41 energy auditors are active in the area of energy conservation. The study conducted by M/s NITCON shows that 6 energy audit firms and 3 energy service companies are located in the State. The study also identified 114 commercial buildings with load above 500 kW in the State out of which 77 are in the Gurgaon region.

Achievements: Haryana has become the only State in the country where use of BEE star rated pump sets (with minimum 4 star rating) has been made mandatory for new tubewell connections as an agriculture DSM measure with effect from 7th October 2010.

Trainings for designated consumers on e-filing of annual energy returns organized on 11.06.10 and 22.06.10 at Murthal (Sonapat) and Gurgaon respectively. Director, HAREDA also participated in a training programme for the SDA personnel of UPSDA on 23.8.09 at Lucknow as key resource person.

During 2009-10 sale of 25,560 Star Labeled refrigerators and 7,310 Star Labeled air conditioners was reported from 5 districts contributing to saving of 23.2 MUs of electricity annually. During 2010-11 sale of 55000 Star Labeled refrigerators and 15500 Star Labeled air conditioners was reported contributing to saving of 49.92 MUs of electricity annually.

Impact assessment study of EC measures taken up for the year 2009-10 conducted by the HAREDA shows a saving of 165 MW through various energy conservation measures in the State. During 2010-11, energy savings of about 86 MW was achieved due to implementation of various energy conservation measures.

- Municipal Demand Side Management

Scenario:a. Solar Water Heating Projects⁴⁶

Solar water heating technology is a viable commercial technology for water heating applications. The State Government is promoting solar water heating systems as a **DSM measure** also. The installation of 1000 solar water heating systems (SWHS) of 100 lpd capacity contribute to peak loading shaving of **1 MW** and each 100 lpd system contributes to **1.5 tons CO2** emission reduction.

To promote SWHS following schemes have been initiated in the State :

1. Rebate in electricity bills for domestic users – Rs.1200/- per year for 100 lpd system, Rs.2400/- for 200 lpd system and Rs.3600/- per year for 300 lpd system or more for three years.
2. On domestic solar water heater Capital subsidy upto Rs.8000/- for all Haryana residents and Haryana Government employees living in Chandigarh.
3. Haryana is the only state in the country where 70% financial assistance is provided on installation of solar water heating systems in social sector charitable institutions like Working Women Hostel, Destitute Childrens Home, Deaf and Dumb Rehabilitation Centres, Sports Hostels, Hostel for the SC students etc. ESCO Projects

Haryana is the first State in the Country where Energy Service Company (ESCO) projects have been conceptualized, designed and implemented by the State Designated Agency on its own. HAREDA has implemented ESCO projects in the Municipal Council, Hisar and the HUDA, Panchkula successfully.

Achievement:

a. Solar Water Heating Projects

During the year 2009-10, solar water heating systems of 3,47,000 lpd were installed.

During 2010-11, solar water heating systems of approx. 525000 LPD capacity were installed in the state which is the highest capacity installed in the state in a year. So far, approx. 2342 systems of approximately 21,00,000 lpd have been installed (as on 31/3/11) in the State resulting in a saving on 31.5 Million kWh of electricity annually translating to a peak load shaving of 21 MW and reduction of CO2 emission by 31,500 metric tonnes annually.

b. ESCO Projects

In MC, Hisar 5405 street light points have been replaced with energy efficient lighting fixtures resulting in 59.30 % saving in the energy consumption and over all saving of Rs.18.00 lakhs due to reduced electricity bills and avoided O&M costs.

⁴⁶ Solar Water Heating Systems. Retrieved December 2011, from HAREDA:
(http://www.hareda.gov.in/?model=pages&nid=82&lang=en_us&output=json)

In HUDA, Panchkula, 5273 street light points have been replaced with energy efficient lighting fixtures resulting in 66.15 % saving in the energy consumption and over all saving of Rs. 61.77 lakhs due to reduce electricity bills and avoided O&M costs.

An impact assessment study of the Hisar project, carried out by M/s NITCON in 2009 indicates that the implementation of the project has resulted in saving of 13.41 lakh KWH of energy per annum and a monetary benefit of Rs.67.00 lakh per annum.

In Panchkula, 16.96 lakh units of electricity could be saved annually after implementation of the project.

- Awareness and Publicity

In order to create awareness among the masses an interactive radio programme called HAREDA Urja Mantra is being aired from the AIR FM, Chandigarh twice a week since 4.11.08 and the programme is receiving very good response.

In addition to this, publicity campaign through press advertisements, radio jingles, wall paintings, hoardings, workshops and seminars, brochures, pamphlets, electricity bills and T.V films is being carried out regularly.

An innovative Bal Urja Rakshak Mission (BURM) was launched on the occasion of state level energy conservation day function on 18.12.08 at Gurgaon by Hon'ble Power Minister, Haryana with an objective to sensitize students of 8th and 9th standard in the areas of energy conservation, Renewable Energy, climate change and sustainable development. The project will help in bringing out attitudinal and behavioral changes in the mindset of target students and creating energy conscious youth. In the first phase, the project is being implemented in 25 selected schools of Gurgaon district at a cost of Rs.25.95 lac and aims at to sensitize 25000 students over a period of two year. The BEE has provided financial assistance of Rs.13.45 lac for the project.

Regulatory Measures: State Solar Mission and Energy Efficiency Programme

The ambitious targets set by India and subsequently by Haryana in the Solar Mission as well as in the Energy Efficiency Programme are achievable through proper regulatory mechanisms. The Government is taken proactive measures through notifications under these programmes to facilitate the success of the envisaged targets.

- Haryana Government Gazette **Notification No. 22/52/2005-5P dated 29/7/2005** for
 - i. Mandatory use of Solar Water Heating Systems
 - ii. Mandatory use of Compact Fluorescent Lamp (CFL) in Government Building/Government aided Institutions/ Boards/ Corporations
 - iii. Mandatory use of ISI marked motor pump sets, power capacitors, foot/reflex valves in Agriculture sector
 - iv. Promotion of energy efficient building design in Government Sector

The Government of India appreciated this step and the notification was emulated by several other states.

- To facilitate Government departments/agencies and prospective buyers of solar water heating systems, HAREDA has arranged a rate contract for various capacities of solar water heating systems and circulated to various State Government Departments.
- Haryana Government Gazette **Notification No 22/52/2005-5P (RE) dated 31/10/2005** on constitution of the State Level Monitoring Committee under the Chairmanship of the Chief Secretary, Haryana to monitor implementation of Energy Conservation Measures as well as Energy Conservation Act 2001.

Haryana is the first state in the Country to have such an inter departmental mechanism with participation from the Secretaries of 15 Government departments.

- Haryana Government Gazette **Notification No. 22/52/05-5P dated 7/09/2006** for mandatory use of T-5 (28 watt) energy efficient tube light system/ retrofit assembly in Government buildings/ Government aided institutions/ Boards/ Corporations.

Haryana is the **first state to ban the use of 40 watt** conventional tube lights in Government buildings.

- An **Energy Conservation Action Team (ECAT)** has been constituted under the Chairmanship of Financial Commissioner and Principal Secretary, Renewable Energy Department vide Haryana Government Order No. DRE/ECAT/2007/2020-2027 dated 17/9/2007 for formulation on State Energy Conservation Action Plan.
- The Ministry of Power, Government of India has initiated Star and Labeling Programme for various electrical appliances to encourage knowledge based purchase. **Haryana is the first State in the Country** where purchase of minimum 4 star rated products like deep Refrigerators, Air conditioners, fluorescent Tube Lights and transformers has been made mandatory for all Government Departments / Corporations through HAREDA instructions vide **Memo No. DRE/2007/4720-4919 Dated 13.11.07**.
- **Guidelines on replacement of existing lighting fixture** (ordinary bulbs and tube lights) with energy efficient lighting (CFLs and T-5 Energy Efficient Tube Lights) in Government establishments /buildings/ departments/ boards/ agencies, issued vide Memo No. 3310-3511 dated 14/9/2007.
- **Notification for mandatory Energy Efficient lighting using CFLs, T-5 Tube lights and LEDs⁴⁷**:- The Haryana Government has issued a Notification on **25.06.2008** for Energy Conservation in the lighting sector as per detail given below:
 - i) **Mandatory use of Compact Fluorescent Lamps (CFLs) and T-5 (28 Watt) Tube Lights:**
 - a) The use of Compact Fluorescent Lamps (CFLs) and/or T-5 (28 Watt) energy efficient tube lights and/or Light Emitting Diode (LED) lamps shall be mandatory for all electricity consumers in industrial, commercial and institutional sectors having connected load of **30 Kilo Watt or above**
 - b) In all **Central Government Offices and Central Public Sector Undertaking Institutions / establishments located in the State** of Haryana, the use of Compact Fluorescent Lamps (CFLs) and/or T-5 (28 Watt) energy efficient tube lights and/or Light Emitting Diode (LED) lamps shall be mandatory.

⁴⁷ Mandatory Use of CFLs and Energy Efficient Street Lights. Retrieved December 2011, from HAREDA: (http://www.hareda.gov.in/?model=pages&nid=123&lang=en_us&output=json)

The consumers under the above categories are required to replace all conventional bulbs and tube lights in their establishments with CFLs/ Light Emitting Diode (LED) Lamps/T-5 (28 Watt) tube lights on or before **15th August, 2008**, at their own cost.

ii) Mandatory use of Energy Efficient Street lights:

Street lighting in **all existing and new colonies and urban areas** notified by the Urban Local Bodies Department, Haryana Urban Development Authority sectors, Haryana State Industrial and Infrastructure Development Corporation industrial estates, housing complexes, colonies and townships developed by private / semi government/ autonomous institutions using energy efficient street lighting fixtures using **T-5 tube lights/ Light Emitting Diode (LED) Lamps/ Low Pressure Sodium Vapour (LPSV)/ High Pressure Sodium Vapour (HPSV) / induction arc lamps** shall be mandatory.

The above said organizations responsible for street lighting systems shall have to replace the conventional street lights or install energy efficient street lights on or before **31st March, 2009**, at their own cost.

In case of non-compliance of these orders, the **Power Utilities Department** shall have the power to disconnect the electricity connections after serving due notice after the expiry of the deadlines mentioned above. The Executive Engineer (Operation) of the Power Utilities Department shall be the enforcing authority of these orders and they shall send quarterly progress reports in this regard to the Additional Deputy Commissioner of their district who in turn shall submit a compiled quarterly report to the Renewable Energy Department, Haryana (the State Designated Agency under the Energy Conservation Act, 2001(52 of 2001)).

- From 2009-10, installation of **minimum 4 star rated pump sets** made mandatory for all new tubewell connections in agriculture sector. Haryana Government Gazette Notification in this regard has also been issued on 07.10.10. Haryana is the first state in the country to issue such a notification.
- Haryana is the **first state in the country** to amend the Haryana Schedule of Rates (HSR), to incorporate the energy efficient building materials, to implement the Energy Conservation Building Code (ECBC) in the state. These amendments have been notified by the Public Works Department, Government of Haryana vide their gazette notification no. SE/PWD(B&R)/Ambala/CZC/8 dated 4th November, 2010. In this notification, rates of various energy efficient materials have been included in the HSR to facilitate their use in construction activity. These materials include fly ash-lying based bricks, autoclaved aerated concrete light weight blocks, pressed clay tiles, extruded polystyrene foam, heat resistance tiles, ceramic and glazed tiles/ vitrified tiles, double glazing, insulated hot water piping, solar water heating systems and energy efficient street lighting.
- In order to facilitate various stakeholders in adoption of energy efficient lighting and new technologies, a rate contract has been arranged and issued vide no. **HAREDA/2011-12/1261-68 dated 25.5.2011**.
- The State Energy Conservation Fund (SECF) was created in Haryana vide Haryana Government Gazette Notification no. 22/7/2010-5P dated 19.2.2010. The Bureau of Energy Efficiency contributed an amount of Rs. 2.00 crore to the SECF. The State Government

provided an amount of Rs. 445.00 lac for the fund through plan allocation in 2009-10 and 2010-11.

State Renewable Power Policy

The main objective of the policy is to create conditions conducive for the involvement of private sector or public – private sector participation in Renewable Energy Sources based power projects in the State.

The State Government aims to achieve a minimum of 10%(i.e. 500 MW) of the total capacity addition of 5000 MW of conventional power to be generated through Renewable Energy Power Projects by 2012 as per Ministry of Non-conventional Energy Sources, Government of India's policy.

The measures adopted to achieve the targets set by this policy include:

- i. To promote setting up of Biomass Based Power Projects (1400 MW)
- ii. To promote Co-generation Power Projects (100-150 MW)
- iii. To promote Small Hydro Power Projects (45 MW)
- iv. To promote Wind Energy Based Power Projects (Demonstration Project)
- v. To promote Solar Energy Based Power Projects (JNNSM)
- vi. To promote Waste to Energy Power Projects based on Urban, Municipal and Industrial Waste (17 MW)

The status of the all the renewable energy projects as well as their year wise progress is presented in Table 25 and Table 26 respectively.

Table 25: Status of renewable energy projects in Haryana (As on 30.11.11)

Sr. No.	Source	Commissioned MW (Nos. of projects)	Under execution MW (Nos. of projects)
1	Small Hydro	73.30 MW (10)	10.90 MW (5)
2.	Bagasse Cogeneration	46.8 MW (6)	-
3.	Biomass Cogeneration	18.95 MW (9)	6.00 MW (2)
4.	Biomass Power	4.00 MW (1)	191.00 MW (21)
5.	Biogas Based	4.12 MW (3)	7.60 MW (6)
5.	SPV MW Scale	2.00 MW (2)	6.8 MW (7)
6.	Biomass Gasification	2.56 MW (10)	-
	TOTAL	151.73 MW (41)	222.30 MW (41)

Source: HAREDA (<http://hareda.gov.in/?model=pages&nid=155>)

Table 26: Yearwise progress of re power generation in Haryana (MW)

Year	Biomass Power Projects	Bagasse Co-gen	Biomass Co-gen	Biomass Gasifier	Small Hydro	Biogas based power generation	Solar Projects	Total
Up to 2004-05	4.0	3.0	-	0.10	62.50	-	-	69.60
2005-06	-	-	-	0.10	-	-	-	0.10
2006-07	-	-	-	0.20	-	-	-	0.20
2007-08	-	1.8	-	1.20	-	-	-	3.00
2008-09	-	-	2.00	0.60	-	-	-	2.60
2009-10	-	40.00	3.00	0.36	6.00	-	-	49.36

2010-11	-	2.00	10.45	-	2.00	4.00	-	18.45
2011-12	-	-	3.50		2.80	0.12	2.00	8.42
TOTAL	4.00	46.80	18.95	2.56	73.30	4.12	2.00	151.73

Source: HAREDA (<http://hareda.gov.in/?model=pages&nid=155>)

Energy: Actions and Demonstration Projects⁴⁸

I. LED Village Lighting Project at Shimla, Molana, Panipat

The Bureau of Energy Efficiency, Ministry of Power, Government of India has provided funds to the tune of Rs. 15.00 Lakhs for converting conventional bulbs and tube lights of the village Shimla Molana, district Panipat. Under this project, 272 incandescent bulbs of 40W have been replaced with 7 W LED Lamps, 158 incandescent bulbs of 60W have been replaced with 10 W LED Lamps and 466 fluorescent tube lights of 40 W/ 100 W incandescent bulbs have been replaced with 16 W LED Tube lights. In addition to this, 7 LED street lights of 9 W have been installed. This has resulted in peak load reduction by about 33 kW and shall result in estimated annual savings of 72000 units of electricity. The project has been completed on 20.8.2011.

II. LED Street Lighting Demo Project for Kalka Town

HAREDA had developed a Detailed Project Report for LED based municipal street lighting in the Kalka Town in March 2009. The Project aims at replacement of 900 nos. of 40-watt tube lights with 24 watt LED Street lights, replacement of 150 250-watt HPSV lamps with 120 watt LED Street lights with 7 Microprocessor timers at a total cost of Rs. 70.16 lakhs. The project is under implementation and is likely to be completed by 15.11.2011.

III. Poultry Litter Based Power Generation

HAREDA has taken up an ambitious project for power generation from poultry droppings in Barwala area of the Panchkula district, which is the poultry hub of north India. It has about 133 poultry farms with about 81.00 lac birds. The project will mitigate the problem of safe disposal of bird droppings, menace of flies and foul smell and will also help in power generation. The project is being implemented in IPP mode in two phases i.e. 1.4 MW in phase I and 4.2 MW in phase-II for which HAREDA had entered into MoU with M/s Green Indus Bio Energy Pvt. Ltd., Gurgaon on 26.10.2010. The IPP has purchased land for the project in village Bhaud, block Raipur Rani, Panchkula and is in process of obtaining statutory approvals. HERC has fixed a tariff of Rs. 6.06/Kwh for purchase of power from this project by the state utilities.

IV. Wind-Solar Hybrid Technology For Village Electrification⁴⁹

Promoting wind energy in Haryana was a real challenge with technological barriers in such low wind speed areas. It was then mooted that Haryana should go for a small wind energy system which requires average wind velocity of 4 m/s. HAREDA carried out surveys in various parts of the State and finally two villages- Chakli and Ramsar in Morni Hills in Panchkula district of north Haryana were

⁴⁸ Special Area demonstration Projects. Retrieved December 2011, from HAREDA: (<http://hareda.gov.in/?model=pages&nid=118>)

⁴⁹ Wind-Solar Hybrid for Village Electrification. Retrieved December 2011, from HAREDA: (http://www.hareda.gov.in/?model=pages&nid=156&lang=en_us&output=json)

selected for the project considering their ideal location on the top of a hill with favouring wind and solar insolation, compact size and above all being in an environmentally fragile zone like Shivalik hills. This was an added factor to look at green energy solutions to meet the energy demands of the local inhabitants. HAREDA then prepared a project proposal and sought financial assistance from the Ministry of New & Renewable Energy, Government of India. The project was envisaged as pilot cum demonstration one, and was to be the first wind solar hybrid project in the Northern India.

After the project was commissioned in September 2008, electricity connections were provided to 24 households in these villages with each having two light points and one ceiling fan. In addition, 3 streetlights were also provided in each village so that movement in the village may be safe during the night. The hybrid power plant has been generating 12 units of electricity per day on an average basis and sometimes when the wind velocity is high; the power generated is about 30 units per day. The average cost of generation power in this mode comes out to be about Rs. 15/- per unit. The plant has generated about 2865 units of electricity in one year.

The villagers are contributing Rs.50/- per month towards energy charges and are enjoying 24x7 electricity. The power availability in these villages has increased from about 50% to 100%. i.e.; from 7-12 hours in the pre project scenario to 24 hours in the post project period. The Village Energy Committee collects the charges and deposits them in the account of the Committee. After completion of five years AMC period, the collected amount will be used for maintaining the system. According to the villagers, now they enjoy supply of electricity for 24 hours of a day. This has led to more time for children to study and additional working hours for the adults for betterment of their lives.

V. Battery Operated Vehicles (Proposed)⁵⁰

Haryana Renewable Energy Development Agency (HAREDA) being nodal agency is implementing a scheme of Ministry of New & Renewable Energy, Government of India on Demonstration Programme on Battery Operated Vehicles.

The objectives of the programme are to promote BOVs, which are non-polluting and quiet in operation, conserve petroleum products, curb environmental pollution, to get feedback on the performance on the BOVs in actual operation for continuous improvement of the BOVs and also for awareness promotion for the eco-friendly vehicles among the people.

UNDP Ongoing Projects⁵¹

UNDP is committed to promoting low carbon, climate resilient and inclusive development. Towards this end, UNDP supports the Government of India in meeting national development objectives. Key areas of intervention are climate change (mitigation and adaptation), natural resource management (conserving biodiversity and addressing land degradation) and integrated chemical management (phasing out ozone depleting substances and reducing persistent organic pollutants). Table 27 and Table 28 shows selected National and state specific programs that support the renewable energy and energy efficiency steps in Haryana.

⁵⁰ HAREDA Battery Operated Vehicles (<http://hareda.gov.in/?model=pages&nid=160>)

⁵¹ UNDP INDIA – Energy and Environment(http://www.undp.org.in/whatwedo/environment_and_energy)

Table 27: Projects at National Level (Ongoing)

Program Title	Implementing Agency	Period
Enabling activities for preparation of second India's NATCOMM	Ministry of Environment & Forests	2007-2011
Sustainable Industrialization-Building Stakeholder capacity and involvement	Ministry of Environment & Forests	2007-2012
Improving energy efficiency in the commercial buildings (BEE)	Bureau of Energy Efficiency	2009-2010
Global Solar Water Heating Markets and Transformation	Ministry of New & Renewable Energy (MNRE)	2008-2012
Capacity Building for addressing climate change issues	Ministry of Environment & Forests	2010-2012
Market Development and Promotion of Solar Concentrators Based Heat Process Applications	Ministry of New & Renewable Energy (MNRE)	2010-2011

Table 28: State Specific Ongoing UNDP Projects

Program Title	Implementing Agency	Period
Removal of Barriers to biomass	Ministry of New & Renewable Energy (MNRE)	2008-2012
Energy efficiency in Steel Rolling Mills	Ministry of Steel, Government of India	2004-2012
Energy efficiency improvements in the Indian Brick Industry	Ministry of Environment & Forests	2009-2013

Sustainable Habitat Mission

Schemes and Project are being implemented by Department of Urban Development and Housing and Town planning department and Public Works department (PWD).

Town and Planning

Haryana is identified to have the potential to become a highly urban state on the basis of urban population and share of urban population in 2026⁵². To achieve its object of economic development, it require to improve on its urban areas. Apart from capacity building, integrating transport with land use planning, second generation of urban reforms is required that focuses on regulation, PPP and especially climate change initiatives. The issues of mitigation and adaptation in human settlements are addressed through energy efficiency in buildings, improved urban land use planning and shift to public transport. Apart from the above, the Mission would also facilitate adaptation to vulnerabilities arising out of climate change like adverse impacts on water resources, increased frequencies of extreme weather like droughts, storm water surge, and human health⁵³. Many cities in Haryana will be showcasing the cleaner, greener development through the JNNURM activities.

The State and its numerous agencies are trying to meet the targets of the national missions. For example, development Agencies like PWD (B and R), HUDA have to mandatorily implement ECBC (Energy Conservation Building Code) in the state to enforce the Solar Water Heating System Programme in various buildings and use of CFL Lighting and energy efficient street lighting. This is

⁵² Source: Population Projections for India, 2001-26, Registrar General of India, 2006

⁵³ Vaidya.C (2009), Urban Issues, reforms and Way Forward in India, Working Paper No 4, Depaprtment of Economic Affairs, Ministry of Finance, New Delhi. (finmin.nic.in/WorkingPaper/Urbanissues_reforms.pdf)

necessary at the time of approval of Zonal Plans of the licensed colonies and CLU permitted under Act no. 8 of 1975 and Act no. 41 of 1963 respectively.

Table 29 shows number of PPP project status in Haryana.

Table 29: Number of PPP Projects In Haryana

Infrastructure	Number		
	Completed	Ongoing	Future
PPPs including SEZs	13	31	33

Source: http://www.pppinharyana.gov.in/PPPinHaryana_PPPAAtAGlance.asp

A state-wide urban infrastructure development programme called Rajiv Gandhi Urban Development Mission, Haryana was launched in 2010 to provide affordable housing for the urban poor, water supply, sewerage, integrated solid water management and other civic amenities. The Government had already earmarked Rs.2, 500 crore for implementation of the programme over the next five years.

In the past during 2000-05, eight mini secretariat buildings were constructed at a cost of Rs 13 crores, whereas during 2005-2011, 62 such buildings were constructed at a cost of Rs 114 crores which included 26 Judicial complexes, 17 polytechnics, 45 ITI's, 44 colleges, 21 Schools, 25 Hospitals, 173 Health centres and other buildings had been constructed. Stadiums were being constructed in villages at a cost of Rs 50 lakh to 70 lakhs per stadium.

Development of Solar Cities In Haryana⁵⁴

The Ministry of New and Renewable Energy, Government of India is implementing a programme on Developing Solar Cities in Faridabad and Gurgaon. The MNRE/GOI vide its sanction dated 25.6.09 has conveyed its approval for development of Faridabad and Gurgaon cities as Solar Cities at estimated cost of Rs.48.75 lakhs and Rs. 47.45 lakhs respectively during the period of five years by HAREDA through Municipal Corporations.

Ministry has also conveyed the sanction for release of Rs.8.07, 000/- (Rs.3.7 lakhs for Gurgaon and Rs. 4.37 lakhs for Faridabad) as 50% of the grant sanctioned for preparation of Master Plan by MC, Gurgaon and Faridabad. The next grant shall be released on submission of UCs and progress reports. The grant for other activities shall be released after submission of proposal for these activities.

Action Plan: Up to Rs. 50.00 lakhs per city/town as per detail given below will be provided depending upon the population and initiative decided by the City Council:

- Up to Rs. 10.00 lakhs for preparation of a Master Plan within a year.
- Up to Rs. 10.00 lakhs for oversight of implementation during five years.
- Up to Rs. 10.00 lakhs for setting up of Solar Cell and its functioning for a period of five years.
- Remaining amount of Rs. 20.00 lakhs to be utilized in five years for other promotional activities.

⁵⁴ Solar Cities, Retrieved December 2011, from HAREDA:
(<http://hareda.gov.in/?model=pages&nid=120>)

Financial assistance for installation of various renewable energy devices and systems will be available from the Ministry as per provisions of the various schemes of the Ministry.

The programme is to be implemented through the Urban Local Bodies of the respective cities.

Public Works Distribution (Buildings and Roads)

Notification to include energy conservation measures related to buildings and related infrastructure has been included for present and future activities. The budget for the same depends on the administrative approvals. Emphasis is being made on the use of energy efficient material such as indoor lighting and outdoor lighting, energy efficient air conditioning, use of star related electrical items and use of power factor control panel in sub stations. Future plans could include construction of more energy efficient buildings, reducing energy consumption in existing buildings, implementing labels and standards for energy intensive products such as air conditioners, lighting appliances, room heating during winters, etc.

Roads

The Department is implementing road projects to improve the urban roads such as widening, re-carpeting, blacktopping and construction of drain, storm water drain and pedestrian path etc. Some of the projects have been completed in PPP mode.

- Rural Roads

National Bank for Agriculture and Rural Development (NABARD) under Rural Infrastructure Development Fund (RIDF) has sanctioned a loan of R 128.53 crore to the Haryana government for strengthening and widening of 13 Rural Roads in six districts and construction of 754 Anganwadi centres in 17 districts.

2600 km of roads have been upgraded by the state under the PMGSY till March 2011. Haryana has better rural road connectivity as compared to rest of the states in India. Cold mix technology could also be implemented for savings greenhouse gas emissions, provided incremental funding support is provided by the Central government.

Urban Transport

- Metro Cable System

To reduce the traffic Congestion, noise pollution, air pollution the department metro proposed to extend the Delhi Metro to Sikanderpur but DLF wanted to expand it to provide connectivity to its Cyber City.

The project tendered to HUDA initially was later issued to DLF in July 2008. The line will be built and operated by a consortium of real estate developer DLF and Infrastructure Leasing and Financial Services (IL&FS). The Metro rail will be completed by 2013 connecting Sikanderpur to Belvedere Towers.

- JNNURM Buses

To discourage using private transport, to reduce air and noise pollution Department of Urban Development introduced eco-friendly compressed natural gas (CNG) buses from Gurgaon, Sonapat and Faridabad to Delhi in January 2006.

Following the Delhi model, the Haryana government may soon start a scheme to build bus terminus on public private partnership (PPP) mode. The scheme will begin with Faridabad, however, soon other districts in the state including Gurgaon would get similar projects.

The first bus terminus at Faridabad will be built on 15 acres. The land has been transferred by the Haryana Urban Development Authority (HUDA) to the transport department for the purpose. The state public works development (PWD) minister Randeep Singh Surjewala told the Haryana assembly on Wednesday that the modern bus terminus will be built in Sector-12 of Faridabad.

The minister said a 13.35-km Bahadurgarh bypass will be constructed at a cost of Rs 110 crore by the year end. He said roads from Bahadurgarh to Kharkhoda via Jasore Kheri was being improved by widening, strengthening and raising at a cost of Rs 35.57 crore and it would be completed by December next year.

Health - Existing State Policies and programs

The mission of the Health Department in Haryana is to improve the quality of life of people by providing better Health Services and strives to improve work productivity and reduce risks of diseases and injury in a cost-effective way. With climate change it is likely that the health delivery system will experience stress, as the direct and indirect impacts of gradual changes in climate as well as due to abrupt extreme events are likely to exacerbate disease morbidity and mortality.

The various health programmes operational in Haryana include:

The national Rural Health mission

The National Rural Health Mission (2005-12) seeks to provide effective health care to rural population throughout the country including in Haryana. The state of Haryana through this mission is building up a pool of female health activist in each village- ASHA; preparing village health plans through community participation; it is strengthening the rural hospitals for effective curative care, the performance of which will be measurable and accountable to the community. The NRHM aims at effective integration of health concern with determinants of health like sanitation and hygiene, nutrition, and safe drinking water by preparing District Plans for Health. It is integrating all parallel Health and Family Welfare Programmes and funds for optimal utilization of the same and is strengthening infrastructure for effective delivery of primary healthcare. Also through this mission it is revitalizing local health traditions such as AYUSH (Ayurvedic, Unani, and Homeopathy) into the public health system.

In Haryana, as per mandate of NRHM, a State Health Society has been constituted under the Chairmanship of Chief Secretary, Haryana adopting multi department approach and involvement of all stake holders. Swastya Kalyan Samitis(SKS) have been constituted in all CHCs, PHCs, SDHs and DHs. Village Health and Sanitation Committees (VHSCs) have been constituted and merged with VLC of WCD department (a constitutional sub-committee of Gram Panchayat). Sakshar Mahila Samooch

(SMS) associated with IEC/BCC activities of Health Department. About 160 PHCs is being made 24x7. 40 FRUs, 2 FRUs have been identified for up gradation as per IPHS Standards. 502 delivery huts have been established to provide safe deliveries 24x7. Jachha Bachha Scheme launched on 15th August 2008. Health services is provided at doorstep in rural areas with all health personnel making regular visits on prefixed days. 3 Mobile Medical Units have been placed in service and 3 more are in pipeline. 100 clinics on wheels approved for outreach services in underserved areas. Fixed Day Outreach Approach introduced to provide RCH services on pre – notified days on a regular basis. Outreach schedule is notified to the Sarpanch and VHSC head and Displayed in schools and Anganwadis. Decentralized community based planning are being carried out with involvement and Accountability of village Panchayats.

National Vector Control Diseases Programme (NVBDP)

This programme covers 6 vector borne diseases in the country. It undertakes surveillance, anti vector and anti larval measures, curative measures and research to control vector borne diseases. Of these, Malaria has been prevalent throughout in Haryana.

Currently, the state is in the process of mapping of all the Districts to identify the Blocks/PHC/Sub Centers where likelihood of the disease is moderate (API > 5) or severe (API > 10). Data of the disease in the last five years in whole of the state/district is being analyzed. A map accordingly should be prepared, on the basis of which rest of the action plans will be prepared.

The Health Department has brought out notification, dated 6-4-2011, on Vector borne diseases, valid upto March 2012, where by an inspection and curative action can be taken by the malaria workers by entering any premise residential or commercial for fever surveillance, anti larval, fogging measures, and for questioning. Similarly the Urban Local Body Department of the Government of Haryana has brought out a Haryana Municipal by law-2010, where by the above measures can also be acted upon in the urban areas by the urban local bodies if proof of mosquito breeding is seen (Source: Annual Report of Implementation of National Vector Borne Diseases Control Programme in Haryana, 2010. Directorate of Health Services (Malaria).

Revised Tuberculosis Control Programme (RNTCP)

In the earlier phase only 5 districts of Faridabad, Gurgaon, Jind, Karnal and Sonapat were implementing RNTCP covering nearly 36% of the State population since year 2000. Later whole of the State was approved for coverage under RNTCP with assistance of USAID. 6 more districts (Ambala, Fatehabad, Mahendragarh, Panchkula, Rewari and Yamunanagar) started service delivery during 4th quarter 2003. Remaining districts started service delivery latter and by 1st quarter 2004 whole of the State was covered under RNTCP. The RNTCP looks after all the preventive and curative aspects of Tuberculosis in Haryana⁵⁵.

Integrated Disease Surveillance Programme (IDSP)

The integrated Surveillance Project was launched in the state of Haryana in Nov. 2004 to establish decentralized State based system of surveillance for communicable and non-communicable diseases so that the timely and effective public health action can be initiated and to improve the efficiency of the existing surveillance activities of the diseases control program and facilitates sharing of relevant

⁵⁵ http://mohfw.nic.in/NRHM/Documents/Non_High_Focus_Reports/Haryana_Report.pdf

information with the health administration, community and other stakeholders. The objectives of IDSP is to establish a decentralized district based system of surveillance for communicable and non-communicable diseases so that timely and effective public health actions can be initiated in response to health changes in the urban and rural areas and To integrate existing surveillance activities to avoid duplication and facilitate sharing of information across all disease control programmes and other stake holders so that valid data is available for health decision making in the district, state and national levels. All 21 districts of Haryana report Weekly surveillance data and outbreak reports to CSU and simultaneously entered in IDSP portal www.idsp.nic.in . Total no. Of reporting units have increase from 248 in 2006 to 3231 in 2009. Reporting of disease outbreak from the state has started. In 2008 Haryana has reported 10 outbreaks. So far 87 Master Trainers, 22 DSOs, 2523 Health Workers, 58 District Lab Technicians, and 86 Peripheral Lab Technicians have been trained⁵⁶.

National Programme for Health care for the elderly (NPHCE)

Program was launched in Haryana in 2010. Modalities for implementing this are being worked out in the state, as 50% of the total incidences of diseases reported in Haryana is that of the elderly population. The National Programme for the Health Care for the Elderly (NPHCE) is an articulation of the International and national commitments of the Government as envisaged under the UN Convention on the Rights of Persons with Disabilities (UNCRPD), National Policy on Older Persons (NPOP) adopted by the Government of India in 1999 and Section 20 of The Maintenance and Welfare of Parents and Senior Citizens Act, 2007 dealing with provisions for medical care of Senior Citizen.

National Program for Prevention and Control of Diabetes, Cancer, Cardiovascular diseases and Stroke (NPCDCS)

For control and management of Non Communicable Diseases was also launched in Haryana in 2010. The objectives of the NPCDCS is to Prevent and control common NCDs through behaviour and life style changes, Provide early diagnosis and management of common NCDs, Build capacity at various levels of health care for prevention, diagnosis and treatment of common NCDs, Train human resource within the public health setup viz doctors, paramedics and nursing staff to cope with the increasing burden of NCDs, and Establish and develop capacity for palliative and rehabilitative care. The operational guidelines have been formulated and are being internalized in the various states including Haryana.

Strategic Knowledge Mission

Climate change poses a serious threat to development and poverty reduction in the poorest and most vulnerable regions of the world. An establishment's knowledge management system and skill development is the collection of information technologies used to facilitate the collection, organization, transfer and distribution of knowledge between departments/institutions/offices about the climate change strategy. Impact of climate change on various sectors will alter the distribution and quality of natural resources and adversely affect the livelihood of the people dependent on the respective resources. Some of the existing State Policies/Programs and Rules/Regulations include:

⁵⁶ http://mohfw.nic.in/NRHM/Documents/Non_High_Focus_Reports/Haryana_Report.pdf

- Scientific studies to recommend specific vulnerability reduction measures suitable for different vulnerable areas.
- Existing/Scope of Research and Development capabilities on climate science and vulnerability reduction measures.
- Vulnerability to the impacts of climate change is a function of exposure to climate variables, sensitivity to those variables, and the adaptive capacity of the affected community.
- Use of modern data sources such as Satellite data, total Station, GIS software, and other hardware, software & latest technologies.
- Pattern of Land & Water Uses.
- Technical capacity and Adaptation capabilities of the state/departments to handle the climate change impacts.
- Current Documentation/Database management system of various departments.
- Identifying critical areas which need to be addressed and prioritizing.
- Identifying Area of Research
- Existing Information/knowledge Dissemination channels etc.
- Identification and documentation of existing technologies both within the country and abroad.

Chapter 6

Sectoral Climate Change Strategy and Action Plan

Chapter 6 - Sectoral Climate Change Strategy and Action Plan

List of programs and policies as perceived by the State to synergize sustainable development and reduction of vulnerability to climate change as identified by state departments have been discussed below:

Forestry

Greening India Mission

The Government of India has formulated a large Greening India Mission aimed at mitigation and adaptation to climate change in the forest sector. Greening is meant to enhance ecosystem services such as carbon sequestration and storage, biodiversity conservation and provision of biomass and NTFPs. The Mission aims at responding to climate change by combination of adaptation and mitigation measures which would aim at;

- Enhancing carbon sinks in sustainably managed forests and other ecosystems
- Adaptation of vulnerable species/ecosystems to the changing climate and
- Adaptation of forest dependent communities.

Thus under the State Action Plan, both adaptation and mitigation projects could be proposed for addressing climate change impacts on forest ecosystems as well as to mitigate the climate change through enhancing the carbon sinks.

Adaptation programme under the Greening India Mission

It was shown earlier that forests in Haryana are vulnerable to climate change risks and any afforestation/reforestation programme to be implemented under the Greening India Mission could also be vulnerable to climate change impacts. Thus there is a need to incorporate adaptation measures. There are no scientific studies to recommend specific adaptation measures suitable for different vulnerable forest types and regions. There is a need for conducting preliminary studies to identify and prioritize landscapes for implementing the adaptation measures. Potential projects under the adaptation programme could be adoption of short rotation species, sustainable harvesting of timber and non-timber products, promoting agro-forestry and Social Forestry (increasing biomass and creating carbon sink) with multiple species and incorporation of anticipatory planting of species.

Mitigation projects under the Greening India Mission

Forest sector provides a large opportunity for mitigation of climate change, in particular through reducing CO₂ emissions by reducing deforestation and forest degradation as well as increasing carbon sinks in the existing forests, and creating new sinks in degraded lands through afforestation. The consequences of climate change will need to be countered by various mitigation measures. Some of the potential climate change related measures considered by Haryana are as follows:

- Plantation and tree resource as carbon sink and biodiversity conservation and employment generation
 - o Plantation of degraded forest land.
 - o Plantation on the village community and panchayat lands.
 - o Agro Forestry plantation on agricultural field, farm boundary and in block.
 - o Plantation of clonal plants of suitable agro forestry species.
 - o Bio drainage plantation in water logged areas.
 - o Plantation in Urban and Peri-Urban areas on waste land, parks, industrial areas and urban housing colonies for enhancing the tree cover.
 - o Tree grove plantation in schools, religious places, village ponds and bus queue shelters.
- Soil and Moisture Conservation
 - o Check dams
 - o Gully plugging
 - o Small and big water harvesting structures
 - o Water collection ditches in plane and staggered trenches on hill slopes
 - o Rain water harvesting in urban areas and forests
 - o Digging and renovation of village ponds
- Wild Life Management
 - o Development and maintenance of NP, WLS, Mini Zoo and Breeding Centers.
- Research
 - o Identification of new drought resistant, pest resistant and frost resistant species for farm forestry with high yield with less water.
 - o Modern plantation techniques.
 - o Modern logging techniques and tool
 - o Establishment of modern nurseries and High tech Mist Chamber and laboratory.
- Capacity Building and awareness
 - o Establishment and training of SHG, VFC and HRMS
 - o Training of field staffs in modern forestry, forest and general management, Law, social science and humanity.
 - o Publicity of Government schemes and extension activities by conducting field visits of various stake holders.
 - o Publicity and extension by audio visual and print media.

The GIM has identified several sub-missions and several activities or interventions under these sub-missions. The proposed mitigation programmes and projects under the GIM are presented in Table 9, along with area proposed and the investment cost required.

Sub Mission 1: Enhancing quality of forest cover and improving ecosystem services

- 20,000 ha of moderately dense forests show increased cover and density
- 100,000 ha of degraded forests are regenerated/afforested and sustainably managed
- 20,000 ha of degraded scrub/grasslands are restored and put under sustainable multiple uses.

Sub-mission 3: Enhancing tree cover in Urban and Peri-urban areas

- 10,000 ha of urban forest lands and institutional lands are under tree cover

Sub-mission 4: Agro-forestry and Social Forestry (increasing biomass and creating carbon sink)

- 100,000 ha of Community and Panchayat land are under tree cover
- 1,000,000 ha of degraded agricultural lands and fallows are brought under agro-forestry
- 10,000 ha of corridor areas, critical to wildlife migration are secured

The area and investment costs as provided by the State Forest Department of Haryana are used to estimate the mitigation potential and investment required to implement the different missions (Table 30). Carbon sequestration rates as provided by the Greening India Mission document are used for estimating the mitigation potential.

Table 30: Mitigation projects proposed under the Greening India Mission

Sub-missions of National Mission for a Green India	Categories under the sub-missions	Area (ha)	Unit Cost/ha (Rs)	Total investment (INR Cr)
Sub Mission 1: Enhancing quality of forest cover and improving ecosystem services	Moderately dense forest cover, but showing degradation	20000	40000	80
	Eco- restoration of degraded open forests	100000	65000	650
	Restoration of grasslands	20000	40000	80
	Total	140000	145000	810
Sub-mission 3: Enhancing tree cover in Urban and Peri-urban areas	Avenue, city forests, municipal parks, gardens, households, institutional lands, etc.	10000	50000	50
	Total	10000	50000	50
Sub Mission 4: Agro-forestry and Social Forestry (increasing biomass & creating carbon sink)	Agroforestry	1000000	50000	5000
	Community and Panchayat land are under tree cover	100000	10000	100
	Corridor	10000	100000	100
	Total	1110000	160000	5200
Total (for all the sub-missions)		1260000	355000	6060

Mitigation potential of the proposed projects under Greening India Mission

Mitigation potential of proposed activities (Table 10) is estimated using COMAP model and carbon sequestration rates used in the Greening India Mission. The annual incremental mitigation potential (Table 31) is estimated to be 10.31 million tonnes of CO₂ by 2020. The cumulative mitigation potential during the period 2012-2020 is estimated to be 49.34 MtCO₂ and about 169.92 MtCO₂ for the period 2012 to 2030.

Table 31: Annual incremental and cumulative mitigation potential (tCO₂-e) of proposed activities under different Greening India sub-missions

Options	Area (ha)	Incremental annual mitigation potential (MtCO ₂)	Incremental cumulative mitigation potential (MtCO ₂)	
		2020	2012-2020	2012-2030
Moderately dense forests	20,000	1.55	7.40	25.57
Degraded/open forests	100,000	1.57	7.47	25.84
Grassland ecosystems	20,000	0.18	0.86	2.97
Urban forest and institutional lands	10,000	0.06	0.30	1.02
Agroforestry	1,000,000	6.22	29.63	102.44
Community and panchayat lands	100,000	0.62	2.96	10.24
Corridors	10,000	0.11	0.72	1.84
Total	1,260,000	10.31	49.34	169.92

Adaptation to Climate Change

The status and quality of forests is critical beyond the sector, impacting water supply, animal husbandry and livelihoods of forest dependent communities. The analysis of impacts of climate change showed that the currently forested districts as well as other districts where afforestation programmes may be implemented in Haryana are vulnerable to climate change. Thus, it is necessary to reduce the vulnerability of forests and the forest dependent communities. Forests have long gestation periods going up to centuries in responding to climate change impacts. There is a lag in the forest response to changing climate. However, the impacts are likely to be irreversible, for example, loss of biodiversity (IPCC, 2007⁵⁷). Given a large dependence on forests for fuelwood, fodder, non timber forest products and livelihoods, it becomes important to consider adaptation to climate change in planning and implementation of all forest developmental programmes.

Proposed Adaptation Projects by State Forest Department

- Anticipatory planting of species across the state
 - o By the big manufacturing corporate houses such as Maruti Udyog Ltd, Hero Honda, Indian Oil refinery, Infrastructure developers such as NTPC, DLF, Unitech Ltd, Omex, BPTP, Parshwanath Developers etc, who are chief polluters and destruction of forest resource under the Corporate Social Responsibility (CSR).
 - o Earmarking of waste land under community control for plantation
 - o Aravalli and Shiwalik Hill districts to be fully protected and only sustainable development schemes allowed with 60 % tree cover in tune with the National Forest Policy 1980.
 - o Large scale plantation of agro-forestry species to improve farm productivity.
- Projects to reduce use of wood and wood products
 - o Distribution of fuel efficient cooking stoves for rural house hold.

⁵⁷ IPCC (2007) Climate change 2007: Working Group II Report: Impacts, adaptation and vulnerability. WMO and UNEP, Geneva

- o Identification, development and use of wood substitutes for buildings and furniture.
- o Shifting to electronic system of file management and development of MIS and establishment of Paperless Office to reduce the use of paper made from wood pulp.
- o Development of high yielding variety of trees for wood production.
- o Development and efficient marketing of NTFP.
- o Development and conservation of Medicinal plants and marketing as medicine under naturopathy and Ayurveda.
- Wild Life Preservation
 - o Development of wild life habitat and safety of wild life from poachers.
 - o Establishment of Zoos and breeding centers and modernization of enclosures of animals in Zoo and breeding centre to enable the wild animals to adapt to the changed climate.

Mainstreaming adaptation in forest planning and management

Adaptation is the only way to deal with the inescapable impacts of climate change. Therefore there is a need for dedicated efforts to mainstream adaptation. Once climate change awareness and capacity begins to grow, integration of adaptation into state, district, sectoral and local development plans can be initiated (Murthy et al., 2011⁵⁸). Assessment of impacts of climate change, development of vulnerability profiles and selection of appropriate adaptation practices requires technical capacity in the forest department. It may be necessary to build this capacity. The following approach may be adopted for mainstreaming adaptation in forest planning and management:

- Step 1: Select all the forest conservation and development programmes currently being implemented or planned for the future
- Step 2: Review the methods and procedures adopted in designing and implementation of these programmes and projects
- Step 3: Use the findings of this study on impact of climate change
- Step 4: Review the current silvicultural and forest management practices for their implications to climate impacts and vulnerability
- Step 5: Modify the existing practices or incorporate potential 'win-win' forest management practices to reduce vulnerability to climate change impacts
- Step 6: Organize consultation workshops with planners, administrators and experts to select the appropriate adaptation practices and strategies for implementation
- Step 7: Review the technical capacity of the institutions involved in planning, implementation and monitoring of forest conservation and development programmes for mainstreaming adaptation
- Step 8: Initiate programmes to build capacity in the forest department at all levels
- Step 9: Initiate programmes to create awareness about the potential impacts of climate change in all stakeholders, in particular local communities who are exposed to climate change threats
- Step 10: Initiate long-term research to study the response of forests to changing climate as well as to identify climate resilient species, forest types and management practices.

⁵⁸ Murthy I K, Rakesh Tiwari and N. H. Ravindranath, 2011, Climate change and forests in India: adaptation opportunities and challenges, Mitigation and Adaptation Strategies for Global Change, Volume 16, Number 2

There is no systematic research for developing adaptation strategies and practices to reduce the vulnerability of forest ecosystems and biodiversity. Development of adaptation practices through experimentation in silviculture and forest management would take a long period. Thus potential largely “win-win” adaptation practices are presented here.

Silvicultural practices

- Anticipatory planting of species along latitude and altitude
- Promote assisted natural regeneration and mixed species forestry
- Promote in situ and ex situ conservation of genetic diversity, in particular threatened species
- Developing strategies to confront forest insects, pathogens, and invasive species and apply phyto-sanitary standards
- Undertaking landscape planning to minimise fire and insect damage (e.g. by introduction of multi-species plantings and by reducing logging waste),
- Altering silvicultural practices (i.e. shortened or extended rotation periods)
- Implementing soil conservation practices
- Develop drought and pest resistance in commercial tree species
- Taking account of traditional knowledge

Sustainable Forest Management and Forest Conservation

- Develop and adopt sustainable forest management practices
- Expand Protected Areas and link them wherever possible to promote migration of species
- Conserve forests and reduce forest fragmentation to enable species migration
- Adoption of energy efficient fuelwood cooking devices to reduce pressure on forests

Forest Policies and Strategies

Forest planning and development programmes and policies may have to be altered to address the likely impacts of climate change and appropriately adopt various policy and management practices to minimize the adverse impacts and vulnerability. Examples of policies and strategies include:

- Incorporate adaptation practices in forest planning both for the short and long term
- Promote forest conservation since biodiversity rich forest are less vulnerable due to varying temperature tolerance of plant species
- Halt forest fragmentation to promote migration of species
- Link protected areas and create corridors to promote migration
- Promote community forest management to create long-term stake for communities in conserving forests and biodiversity
- Provide livelihood diversification opportunities to forest dependent communities, especially in the most vulnerable districts
- Build capacity to develop and implement adaptation strategies and practices

There is a need for further studies and at the same time, planning, designing and implementation of adaptation measures to enable forest and forest dependent communities to cope with the climate change impacts, especially since the impacts on forests and biodiversity are likely to be irreversible.

Sustainable Agriculture Mission

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, carbon dioxide, glacial run-off, precipitation and the interaction of these elements. These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. The overall effect of climate change on agriculture will depend on the balance of these effects. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt farming to maximize agricultural production.

The State's strategy of agriculture development is centred on achieving self sufficiency in food grain production and marketing the produce at remunerative prices and generating revenue and employment opportunities. The broad strategy is to provide food security through

- Creation of assured irrigation in settled cultivation areas
- Promotion of scientific planning and cropping pattern to improve the yield per hectare
- Integrated efforts for enhanced productivity
- Integrated crop management
- Continuation of the traditional organic farming to meet market demands for organic products
- Efforts for improving the rice production rate
- Ecologically sustainable and economically viable diversification of agriculture
- Major emphasis on growing off season vegetables and fruits

Some of the research area proposed meeting the above actions include:

- Under action towards Molecular breeding for heat stress tolerance during grain filling period in wheat it is proposed to develop
 - o suitable mapping populations and identify QTLs linked to heat stress tolerance during grain filling period
 - o marker-assisted breeding for wheat lines with improved terminal heat tolerance
- Development of water efficient aerobic rice
 - o Development of aerobic indica rice lines shall pave a way for the sustainable production of premium rice in Haryana and neighbouring states and shall greatly benefit the farmers and agro-industries in these states
 - o It is proposed to develop high-yielding indica aerobic rice lines using both conventional breeding and marker assisted selection strategies. Capacity and requisite experience and facilities for carrying out microsatellite marker (SSR) analysis and molecular breeding in rice with the help of grants from DBT, ICAR and the Rockefeller Foundation (USA).
 - o It is proposed to develop/ select the advanced breeding lines with aerobic and high-yielding/grain quality traits from crosses/backcrosses between promising aerobic (MAS25 and MAS26 developed at UAS Bangalore and/or promising aerobic genotypes identified in All India Coordinated Trials) and indica rice cultivars.
- To improving abiotic (drought and salinity) stress tolerance in Indian mustard

- It is proposed to develop drought and salinity tolerant Indian mustard genotypes using genetic engineering and marker-assisted breeding. Suitable RIL populations are being developed for the identification of QTLs for stress tolerance and their subsequent use in marker-assisted breeding.
- Molecular Breeding of chickpea for drought prone environments
 - research to improve the performance of chickpeas in marginal lands by identifying genotypes that produce higher yields and thrive better under drought. At CCS HAU
 - screening and identification of chickpea germplasm accessions tolerant to drought conditions
 - development of RILs using highly drought tolerant line with high yielding agronomically superior lines, linkage mapping and tagging the genes/QTLs for drought tolerance
 - marker-assisted breeding for drought tolerant, high-yielding chickpea cultivars.
- Soil health: action plans
 - to develop or modify existing research management practices for reducing nitrogen methane and emission in agriculture and integrate these into best management practices
 - to encourage tillage and soil management practices that improve soil carbon storage
 - to enhance bio-sequestration (through forest sinks) opportunities in agriculture and understand the costs and benefits to agriculture due to these actions
 - to study agriculture diversity in relation to technology availability and its economic viability for climatic adaptation
 - Improving fertilizer efficiency through practices like precision farming using GPS tracking to reduce nitrous oxide emissions
 - the use of cover crops and manures (both green and animal), nitrogen-fixing crop rotations and composting
 - adjusting the planting calendar with careful consideration of the possible changes in crop-nutrient management practices.
 - to adopt and develop technology of land and water management which can help minimize negative impacts of climate changes
 - Converting marginal croplands to trees or grass or bioenergy crops can significantly maximize carbon storage on land that is less suitable for crops
 - Improvements in water use efficiency through measures, such as advanced irrigation systems, viz. drip irrigation technologies; center-pivot irrigation systems, etc. coupled with reduction in operating hours, can significantly reduce the amount of water and nitrogen applied to the cropping system.

Horticulture

- Extension work and advisory for fruits and vegetables under:
 - Normal Monsoon
 - Delayed onset of monsoon
 - Long dry spell after onset of monsoon
 - Early withdrawal of monsoon
 - For High temperature for long period during summer month

- o Very low temperature and frost during winter

Pests and diseases

- Strengthening of pest monitoring system
- timely pest management decisions: pest monitoring at shorter (7-10 days) intervals for reliable pest forecasts made well in advance and with trained scouts at district/block level for recording pest incidence and quicker compilation and dissemination of pest surveillance information to the end users (i.e. farmers and extension workers) through computer based system.
- Efficient pesticide application: Make available on custom hiring basis, tractors or trolley mounted power sprayers fitted with long delivery hoses and spray guns for quicker application of pesticides
- Growing pest resistant varieties/hybrids: Use of the promising genetically modified material by the growers suitable for their areas is likely to neutralize to a great extent the negative effect of climate change in relation to insect-pest incidence.

Weed management

- to study weeds behavior under altered environment using weed survey conducted for both winter and rainy season crops to assess the level of infestation of weeds and their occurrence along with the information based on soil type, available rainfall, underground water quality and fertility status of soils.

Livestock

Strategies and actions proposed under livestock is given in Table 32.

Table 32: Strategies, Actions, Time lines and Budgets - Livestock and livestock products

Sr. No.	Strategy	Actions
1.	Capacity building of farmers for effective adaptation to climate change.	Strengthen Extension to provide advisory on Adaptation practices vis a vis :-
		i. right shelter for animals to protect them for heat stress,
		ii. right grazing practices that would enable the animals to be protected from heat,
		iii. the practices for identifying disease and mitigating them
		iv. creating feed mixes with proper nutrients for enhancing milk productivity, etc.
2.	Dairy development	i. For enhancing the milk productivity even with increase in temperatures, extensive Artificial Insemination of the indigenous stock is to be undertaken
		ii. Support farmers to augment their cattle sheds vis a vis Water sprinklers to enable them to have evaporative cooling and increase the air circulation in sheds so that cool air is retained, undertaken evaporative cooling;

Sr. No.	Strategy	Actions
		iii. Create special community ponds to allow them to wallow in the ponds
3.	Feed and fodder development	To combat fodder shortage fodder development needs to - have an additional impetus from the government by promoting silage making at farmers level. - Supporting farmer centered fodder banks. - Undertake mineral mapping in different regions to assess mineral status and accordingly supply specific mineral mixture to farmers for growing fodder.
4.	Preventive health measures	- Prepare long term strategies where by 100% population of the livestock get regularly vaccinated (large and small ruminants) against dreadful diseases. - Set up Animal health camps to make people aware of adopting different control measures.
5.	Strengthen disease investigation system	- Develop disease forecasting systems - Establish disease surveillance system - Undertake research studies on - the causes of diseases related to climate and - the nature of emerging diseases due to emergence of new pests and vectors and - developing control measures by involving livestock research institutions.
6.	Risk management	Coverage of livestock under insurance scheme including insurance of disabilities.

Fisheries:

Fish act as a buffer against carbon dioxide in the world's oceans because they secrete calcium carbonate that dissolves easily in water and lowers acidity. The ocean to maintain its optimal pH needs to have lots of healthy, young fish. Old fish are not as good at producing calcium carbonate. They're less active and drink less water. The ocean needs a constant supply of young fish that produce more calcium carbonate (Wilson et al., 2009⁵⁹).

Role of governance in climate change

- Full implementation of code of conduct for responsible fisheries (CCRF).
- Building of institutional and legal frameworks and effective public, private and NGO partnership.

⁵⁹ Wilson RW, Millero FJ, Taylor JR, Walsh PJ, Christensen V, Jennings S and Grosell M (2009) "Contribution of Fish to the Marine Inorganic Carbon Cycle" Science, 323 (5912) 359-362

- Integration in research and management across the sector ensuring regulations and linking disaster management with development planning.
- Adoption environmentally friendly and fuel-efficient fishing and aquaculture practices.
- Eliminate subsidies that promote overfishing and excess fishing capacity.
- Undertake assessments of local vulnerability and risk. Build local-level climate models.
- Strengthen knowledge of the dynamics of biogeochemical cycles in aquatic ecosystems, especially of carbon and nitrogen.
- Encourage sustainable, environmentally friendly biofuel production from algae and seaweed.
- Explore carbon sequestration in aquatic ecosystems.
- Implement comprehensive and integrated ecosystem approaches to managing fisheries and aquaculture; to adapting to climate change; and to reducing risk from natural disasters.

Adaptation measures in fisheries

Strategies and actions proposed under fisheries is given in Table 33.

Table 33: Strategies, Actions, Time lines and Budgets - Fisheries

Climate change element	Impact	Adaptation*
Warming	-Raise above optimal range of tolerance	Better feeds, selective breeding and genetic improvement
	-Increase in growth and higher production	
	-Increased eutrophication and upwelling	
	-Expansion of diseases	
Water stress and drought condition	-Limitations for freshwater abstraction	Improve efficacy of water usage; encourage non-consumptive water use in aquaculture, e.g. culture based fisheries;
	-Change in water-retention period (inland systems reduced, coastal lagoons increased)	
	-Reduced availability and	
	-Period change of wild seed stocks	
	Increase efficacy of water sharing with primary users. Shift to artificially propagated seed; improve seed quality and production efficiency; close the lift cycle of more framed species.	
Extreme weather events	-Destruction of facilities; loss of stock; loss of business;	Encourage uptake of individual/cluster insurance; improve siting and design to minimize damage, loss and mass escapes.
	-Mass scale escape with the potential to impact on Biodiversity	Encourage use of indigenous species to minimize impacts on biodiversity use non-reproducing stock in farming systems
*More faculty members are needed for this specialized work.		

Mitigation measures in fisheries

- Improving fisheries management
- Reducing post harvest losses
- Increasing waste recycling
- Maximizing yield and quality

- Reducing spoilage

Time period and budget requirement for Agriculture and livestock sector

Agriculture and rural sector must be given a high priority in terms of resource allocation and adoption of development policies that are locally relevant and globally consistent. Table 34 gives the summary of timeline and budget for implementation of the actions suggested in the previous paragraphs.

Table 34: Time lines and Budgets –Agriculture and Livestock

Time period for implementation	3 to 5 years
Approximate budget requirement	Rs. 100 crores

It is also proposed that a state center for Climate Change Research units in Agriculture at State Agriculture University be setup. The purpose of the center is to achieve food security through sustainable agriculture development under the changing climatic scenarios. The center will be responsible for research and invent strategies for negating the long-term impacts of climate change, conduct sustained research on increased adaptation of agriculture to climate change, potential technological interventions, improved and reliable monitoring and forecasting mechanism, capacity building, development activities, and change in policies. Specific objective include:

- evaluate possible climate change at regional level.
- undertake the research on effects of climate change on agriculture and animal husbandry.
- identify agri-technology to minimize the adverse effect of climate change.
- develop agro-advisory bulletins based on regional climatic trends and weather forecasting.
- organize awareness programme on climatic trends.

Table 35 gives the summary of timeline and budget for implementation of the actions suggested in the previous paragraphs.

Table 35: Time lines and Budgets –for the proposed Centre on Climate Change Research in Agriculture

	Quantity	Approximate Cost (Rs. Crores)	Time line
Non-recurring			
Automatic Weather station with GPRS facility	70	7.0	5 years
Open Top Climate & Growth Chamber		1.0	
Digital Meteorological data dissemination system		0.4	
Hyper spectral radiometer		0.6	
Computers (Desktop and laptop) with software and accessories; along with global and regional climate models-software		0.2	
Recurring			
Renovation work Laboratory facilities		0.05	
Contingency		0.05	

	Quantity	Approximate Cost (Rs. Crores)	Time line
Travel expenses		0.05	
Contractual services			
Research associates/SRF (Five for each NARP zone)		2.0	
Skilled/unskilled labour		0.15	
	Total	11.5	

Energy Mission

Energy is one of the most important input for any development and directly determines the pace of the state's economic growth. Energy consumption of Haryana has increased manifold in the past decade. The energy consumption has increased from 9290 million units (MUs) in 1999 to 19290 MUs in 2008-09. The per capita consumption has increased from 700 units in 2006-07 to 905 units in 2009-10. The energy within the State has been depending on thermal energy and hydropower from the jointly owned projects. The present generation capacity amounts to about 5761.8 MW⁶⁰ out of which 69 percent is owned by state government. With an average deficit of 15-17%, the state planned to invest \$777m (£480m) as part of a programme designed to ensure that renewable energy makes up 10 per cent of the region's energy mix.⁶¹ Of the 700 MW required, about 130 MW of renewable energy has been installed as of 2010-11.

The Department of Renewable Energy (HAREDA) is responsible to plan, mandate policies and implement programmes related to renewable energy, implementation of energy conservation act and demand side management in order to meet the state energy demands. Energy Conservation is the most-effective method to save energy and reduce costs for any state. Haryana had the target to save at least 500 MW of energy starting 2007-08. Till date, it has been able to 472 MW in the last four years through energy efficiency in agriculture sector, lighting, buildings, industrial sector, publicity and awareness.

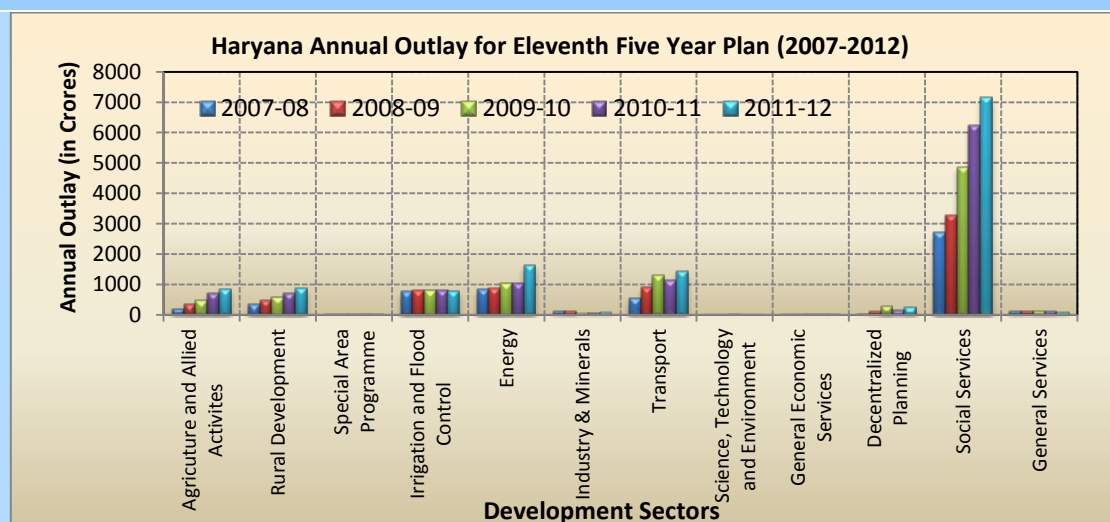
In 2010-11, 32% of the revised outlay of the State Annual Plan (Figure 40) was given to improvement in the basic infrastructure of irrigation, power, transport and SEZs. The highest priority was given to transport (10.32%) followed by energy (9.37%) and irrigation and flood control (7.37%). Of the 1636.80 INR Crore allotted to the Energy Sector, 8.8 INR Crore has been provided to renewable sources.

⁶⁰ Economy Survey of Haryana 2010-11

⁶¹ Indian state maps out \$777m renewables vision

(<http://www.businessgreen.com/bg/news/1806632/indian-maps-usd777m-renewables-vision>)

Figure 40 : Haryana Annual Outlay from 2007-2012



Source: Economic Survey of Haryana 2010-11

Note: 2007-08, 2008-09, 2009-10 is the Actual Expenditure for the respective years
2010-11 is revised outlay while 2011-12 is Approved Outlay.

The state government has been proactive in energy savings through energy conservation programme which are essentially mitigation strategies. As climate change issue cannot be solved by providing only the afore-mentioned programmes, projects are required from adaptation perspective. With generation of electricity through renewable sources of energy is still in pipeline, various solar programmes are being carried out successfully. The state has been leading by examples. Table 36 shows the power plants that will be installed in future to meet the demand of the state in addition to the existing capacity.

Table 36: Summary Of Proposed Power Plants in Haryana

No.	Name of Power Station	Capacity (MW)
Future		
1	Gas based Project, Faridabad	1500
2	Additional super critical Thermal Unit at Yamuna Nagar	660
3	Nuclear Power Plant in district Fatehabad	2800
4	Grid Interactive Solar Power Project, Yamunanagar	6.5

Source: Haryana Power Generation Corporation Ltd. (http://hpgcl.gov.in/personal_18.hp)

Table 37 provides details on strategies applied to conserve energy and the concerned agencies responsible to implement the various projects.

Table 37: Strategies, energy conserved and the agencies/department concerned to carry out the various projects

Sub Sector	Strategy	Energy Conservation		Agencies/Departments concerned
		Target 2012	Target 2017	
Solar power projects	To invite and pre-register the solar power project under Jawaharlal Nehru National	14.08 MU (8.8MW)	16 MU (10 MW)	Uttar Haryana Bijli Vitran Nigam (UHBVN) Dakshin Haryana Bijli Vitran

Sub Sector	Strategy	Energy Conservation		Agencies/Departments concerned
		Target 2012	Target 2017	
	Solar Mission • Signing of power purchase agreement for sale of power to the utilities • Execution of the projects and synchronization with grid			Nigam (DHBVN) Haryana Power Purchase Centre Haryana Electricity Regulatory Commission IPP
Biomass/ Bagasse Cogeneration	• Awareness among the industries specifically rice shellers to adopt this technology • Preparation of feasibility-cum-detailed project report and approval of Ministry of New & Renewable Energy for sanction of CFA • Execution of the project	77 MU (10 MW)	308 MU (40 MW)	Haryana State Federation of Coop. Sugar Mills HAFED District Level Offices for motivating the private industries to adopt this technology
Biomass Power projects	• Awareness among the industries/developers to set up biomass power projects in the State. • Preparation of feasibility-cum-detailed project report and approval of State Govt • Approval of Detailed Project Report • Signing of Power Purchase Agreement with the State Utilities • Execution of the project	77 MU (10 MW)	1470 MU (191 MW)	Statutory approvals from: Haryana Pollution Control Board Ground Water Cell, Agriculture department/ Irrigation department Town and Country Planning department Forest department Haryana Electricity Regulatory Commission Haryana Power Purchase Centre
Off-Grid Roof top and other applications	• CFL based Home Lighting Systems	119292 (5635 units)	596464 (28175 units)	HAREDA, UHBVN, DHBVN
	• SPV Street Lighting Systems	352436 (8778 units)	1192053 (29690 units)	HAREDA UHBVN, DHBVN
	• SPV Power Plant of 10 KW each	109865(7 units)	470850 (30, 300 KW)	HAREDA
	• Solar Pumps 5.00 KW	240000 (50 units)	480000 (100 units)	HAREDA
	Solar power packs (1 KW to 100 KW)	12,25,600 (37 units, 766 KW)	32,00,000 (100, 2000 KW)	HAREDA
Energy Efficiency Mission		835.00 MU	2026.00 MU	HAREDA

Keeping in mind the afore-mentioned information, the state should have a three-pronged approach. It should continue on harnessing energy from renewable sources of energy, while reducing the existing transmission and distribution losses, and concentrating on efficiently improving the demand side management of energy in all the sectors (viz. agriculture, residential, commercial and industrial).

Agriculture sector

Agriculture accounts to more than 40 percent of the consumption mix followed by industrial and domestic categories. The power policy has been pro agriculture to encourage agriculture production. The state government has set the target to double its agriculture production by 2020 that will require the latest technology that is not only energy efficient but also works on renewable source of energy. Apart from this, meter installation is required to get accurate data on electricity consumption, if electricity is provided through grid. Records are required to be updated on the connected load by the utility in order to get the data on the actual consumption for the State.

In order to reduce losses from demand-side management, meter installation for pumpsets, 3-phase feeder separation and mechanization of agricultural equipments is required to be conducted in phases in addition to reducing the aggregate technical and commercial losses. Projects of introducing solar pumpsets and power generation from renewable sources of energy for example biomass in select villages is suggested for coming five years. Financial instruments like state specific crop insurance is required to decrease the farmers' vulnerability to climate change stresses. The food processing industry requires providing necessary infrastructure and linkages for the increase in diversity of agriculture production. Cold storage Godowns need to be built with the latest energy-efficient facilities, preferably getting energy from renewable sources. Table 38 shows the summary of programmes ongoing and proposed with budget for agricultural department.

Fund requirement

Cost of replacing all the existing remaining inefficient pumpsets (nearly 3 lakh) in the state with four or five energy-star (BEE star rating) pump-sets will be around 15000 Crore INR. This also includes the state subsidy provided for installing every pumpset. Around 27000 INR will be required in phases for the proposed additional programmes and projects.

Urban Development

Domestic category accounts for the largest consumer base with consumption share of about 20 percent while industry consumes about 26 percent. Haryana is developing its major cities as manufacturing and IT hubs. Proposals have been approved for setting up SEZs. Initiatives need to be taken to build energy efficient buildings that include using CFLs for lighting, solar energy for streetlights and heating purposes. The major contributors of GHG emissions have been power utilities, industry, various industrial processes and transportation. Power utilities need to take initiatives to improve on their 'zero effluent discharge' in addition to their reduced coal consumption and their lighting applications. Measures need to be taken to reduce the transmission and distribution losses through privatization of distribution systems. More audit is required in the industrial clusters to improve on energy efficiency through ongoing programmes and heat recover. The State requires to extend the Metro cable system into Haryana to improve public transportation and use JNNRUM to encourage CNG infrastructure for buses. Programmes or Urban Transport Policy is required to improve vehicular efficiency and energy saving from freight transportation.

Integrating climate risk and disaster management preparedness for all types of urban planning

The departments require on one hand to study the adverse impacts of climate change on various sector and locations while on the other hand spread awareness on EE technologies in all sectors to conserve energy. The proposed programmes for each of the departments is discussed in Table 38. Some of the programmes that require immediate focus are mentioned below.

Fund requirement

Action 1: Reduce Aggregate Technical and Commercial (AT&C) Losses of the Power Distribution System (PDS) – 200 Crore INR

Action 2: Enhance energy efficiency of municipal water pumping – 50 Crore INR

Action 3: Improvement of Demand Supply Energy Efficient Appliances Standard in residential as well as commercial sector – 100 Crore INR

Action 4: Promoting green buildings – Incremental Cost – 250 Crore INR

Action 5: Waste Management (To Energy as well as Compost) – For Energy – 60 Crore INR

Table 38: Proposed programmes for various departments along with the proposed investment

Departments	Programmes/Projects	Interventions	Status	Budget (INR Cr)
HAREDA				
Solar Mission (and other renewable sources of energy)	(i) Generation of power from solar energy	- To invite and pre-register the solar power project under Jawaharlal Nehru National Solar Mission - Signing of power purchase agreement for sale of power to the utilities. - Execution of the projects and synchronization with grid	2012-2017	179
	(ii) Biomass cogeneration Power Projects	- Awareness among the industries specifically rice sellers to adopt this technology - Preparation of feasibility-cum-detailed project report and approval of Ministry of New & Renewable Energy for sanction of CFA - Execution of the project	2012-2017	180

Departments	Programmes/Projects	Interventions	Status	Budget (INR Cr)
	(iii) Biomass Power Plants	- Awareness among the industries/developers to set up biomass power projects in the State. - Preparation of feasibility-cum-detailed project report and approval of State Govt. - Approval of Detailed Project Report - Signing of Power Purchase Agreement with the State Utilities - Execution of the project	2012-2017	860
	(iv) Off grid roof top and other applications	- CFL based Home Lighting Systems - SPV Street Lighting Systems - SPV Power Plant of 10 KW each - Solar Pumps 5.00 KW - Solar power packs (1 KW to 100 KW)	2012-2017	51.9
Other Programmes	Energy Efficiency Mission			
	(i) Solar Water Heating Projects		2012-2017	25
	(ii) Energy Service Company (ESCO) Projects		Ongoing	
	(iii) Mandatory Use of Compact Fluorescent Lamp (CFL) in Government Buildings/Government Aided Institutions/Boards/Corporations		Ongoing	
	(iv) Scheme on Energy Audit for Industries, commercial buildings, govt. buildings and institutions		Ongoing	
	(v) Enhance EE municipal water pumping		Proposed	50
	(vi) Improvement of Demand Side EE appliances in residential and commercial sectors		Proposed	100
Agriculture Sector				
Agricultural Department	Scheme on energy conservation in agriculture sector i) To conserve Electrical Energy in the Agriculture sector. ii) To encourage and educate the formers to adopt the energy	All the farmers of Haryana who are taking new tubewells connection or opting higher capacity pump sets will be encouraged to install at	Ongoing	

Departments	Programmes/Projects	Interventions	Status	Budget (INR Cr)
	efficient pump sets in their tubewells. iii To manage electrical energy demand in Agriculture sector.	least 4 star rated (BEE Star rating) pump sets and will be eligible for the state subsidy. Farmers having old non ISI motors and want to replace these with Latest 4 star rated motors will also be eligible under this scheme.		
	Scheme on energy conservation in agriculture sector i) To conserve Electrical Energy in the Agriculture sector. ii) To encourage and educate the formers to adopt the energy efficient pump sets in their tubewells. iii) To manage electrical energy demand in Agriculture sector.	Replacement of ALL/remaining inefficient pump sets with 4/5 star rated (BEE star rating) and the installment of new pump sets in order to double the agricultural production	Proposed	15000
	Demand Side Management Application	Reducing inductive losses on load side appliances to be done in phases	Proposed	500
		Meter Installation for pump sets - to be done in phases	Proposed	1000
		Rural 3-phase feeder separation - to be done in phases	Proposed	20000
		Reducing aggregate technical and commercial losses (AT&C)	Proposed	2500
		More mechanization to increase energy efficiency of agriculture, including off-road vehicles (e.g. tractors, machines etc) - to be done in phases	Proposed	2000
		Solar pump sets	Proposed	200
		Biomass based power generation (using rice straw)	Proposed	160
		Reducing farmers' vulnerability to climate change stresses through introduction of specific crop insurance schemes and packages	Proposed	250
Food Processing Industry	Providing necessary infrastructure (eg Cold storages, Godowns)	Requirement of energy-efficient storage for agricultural products	Proposed	250
		Biomass and solar based cold storages (absorption chiller technology)	Proposed	50
Haryana Power Generation Company Limited (HPGCL)				

Departments	Programmes/Projects	Interventions	Status	Budget (INR Cr)
Generation	Designing power utilities for 'Zero effluent discharge'	DCRTPP Yamuna Nagar	Done	
	Designing power utilities for 'Zero effluent discharge'	Required at all power plants	Proposed	150
	i) Renovation, Modernization and Capacity Addition ii) ISO Certification for HPGCL Power Plants iii) Energy Efficient Buildings iv) Energy Savings by Reducing Consumption v) Energy Audit Tests	i) R&M at Panipat Thermal Power Station (PTPS) ii) ISO Certification for (DCRTPP, Yamunanagar & PTPS, Panipat) iii) Energy Efficient Buildings (DCRTPP, Yamunanagar, PTPS, Panipat & corporate office at Panchkula) iv) Energy Savings by Reducing Consumption (DCRTPP, Yamunanagar & PTPS, Panipat) v) Energy Audit Tests (DCRTPP, Yamunanagar & PTPS, Panipat)	Ongoing/Done	
	i) Renovation, Modernization and Capacity Addition ii) ISO Certification for HPGCL Power Plants iii) Energy Efficient Buildings iv) Energy Savings by Reducing Consumption v) Energy Audit Tests	i) R&M at the remaining thermal power stations ii) ISO Certification for FTPS, RGTPS iii) Energy Efficient Buildings (FTPS, RGTPS, IGSTPP) iv) Energy Savings by Reducing Consumption (FTPS) v) Energy Audit Tests (FTPS, RGTPS)	Proposed	100
	Technical modifications (for ex.: in air & fuel cycle; steam, feed water and condensate cycle; fuel & ash cycle; electrical & lighting system etc.) for energy efficient and cleaner technologies		Proposed	10
	Enhancing renewable power capacity and generation (including solar PV, wind, biomass, hydro)		Proposed	100
Haryana Vidyut Prasaran Nigam Limited (HVPNL) (UHBVNL and DHBVNL)				
Transmission and Distribution	Reducing Aggregate Technical & Commercial Losses (AT&C)	Stations should be automated to improve quality and reduce energy losses	Proposed	200
	Encourage use of Energy-Star Labeled Appliances and BEE Star Labeling		Ongoing	25
	Smart grid applications Research, Development & Demonstration		Proposed	25
	Energy conservation campaign	Bachat lamp Yojna	Ongoing	

Departments	Programmes/Projects	Interventions	Status	Budget (INR Cr)
Town and Country Planning				
Solar Mission (under HAREDA)	Solar Water Heating Projects		Ongoing	
	Energy Service Company (ESCO) Projects		Ongoing	
EE Mission (under HAREDA)	Mandatory use of Compact Fluorescent Lamp (CFL) in Government Buildings/Government Aided Institutions/ Boards/Corporations		Ongoing	
	Scheme on energy audit for industries, commercial buildings, govt. buildings and institutions etc		Ongoing	
Urban Planning	Integrate Climate Risk and Disaster Management Preparedness		Proposed	50
Urban Transport	Promote Public Transport System		Proposed	10
Urban Local Bodies				
Urban Planning	Integrate Climate Risk and Disaster Management Preparedness		Proposed	50
	Promote sustainable cities programme - in phases		Proposed	10
	Promoting green buildings		Proposed	250
	Improving urban infrastructure through rain water harvesting and reuse of waste water		Proposed	100
	Improve land-use planning		Proposed	25
	Improve drainage, sewerage and sewage treatment in all ULBs		Proposed	150
Waste Management	Capacity Building for Waste (Municipal solid waste, domestic sewage, waste water) to Energy. Also waste to compost to be used as fertilizer.		Proposed	60
Urban Transport	Promote Public Transport System and parking infrastructure in large ULBs		Proposed	30
	Increasing efficiency of city buses, including phasing out old stock with new and efficient stocks		Proposed	60
	Adequate infrastructure facilities for pedestrians, cyclists and non-motorists transport		Proposed	10
	Metro rail in over 5 lakh population cities as well		Proposed	100
	BRTS in more cities		Proposed	50
	Hybrid and electric vehicle projects		Proposed	10
Public Works Dept. (B&R)				
Bharat Nirman	Integrate Climate Risk and Disaster Management Preparedness		Proposed	50
Urban Planning	Improvement and widening of congested roads		Proposed	300
Dept. of Science and Technology				

Departments	Programmes/Projects	Interventions	Status	Budget (INR Cr)
Research and Development	Identify, study and disseminate latest EE technologies required to increase agricultural production		Proposed	15
	Identify, study and disseminate latest EE technologies in commercial and industrial sectors		Proposed	10
	Research to study adverse impacts of climate change on various sectors and locations in Haryana state		Proposed	20

Summary

All the aforementioned policies and programmes in each of the department will be continued in accordance with HAREDA mission statements for the twelfth five year plan. Demonstration projects like LED Village and Town Street Lighting projects, litter based power generation projects, combined solar-wind projects need to be scaled up. State-specific energy efficiency projects are required to be implemented in other industrial sectors as planned and scaled up eventually through interactive workshops. For future planning, the highlights will on construction of energy efficient buildings by using energy efficient material and design. Further research and development is required like impact study due to increase in electricity demand because of rise in temperatures, vulnerability study of urban and rural areas in case of natural disasters and eventually local preparedness in terms of disaster management.

Strategies to address concerns in Water Sector

In the present day context when climate change has added to the complexity of managing the water resources it is imperative to bring in the concepts of IWRM (Integrated Water Resources Management) in an effective manner so as to address the desired sustainability issues. Therefore it is important to ensure that information on water resources is managed in a manner that it is integrated across all the departments dealing with this resource irrespective of the scale of their action. This shall require formulation and deployment of framework implemented using databases and GIS technologies.

On one end we have big projects such as storage and diversion based irrigation projects and on the other hand there are projects that are at the local scale for programmes that are run by the central/state government departments directly or by involving agencies that are either NGOs of Gram Panchayats. It is important to understand that all these projects use the common water resource and therefore require a common information base for proper planning, implementation and management of these projects.

Research initiative is required to create infrastructure that shall be able to encapsulate the majority of issues related to water resources and also act as a facilitator to provide a framework for integration, planning, monitoring and assessment. A typical framework, incorporating the Integrated Water Resources Management shall include the following methodologies:

- i. Hydrological assessment of all water uses and users within a catchment

- ii. Catchment Stress Assessment to determine to what extent the catchment is approaching 'closure', or not meeting ecosystem requirements
- iii. Strategic Environmental Assessment to identify the economic returns and employment opportunities that arise or potentially could arise from water use in the catchment
- iv. Methodologies for contextual analysis (forest and water narratives, beliefs underlying policy)
- v. Web and GIS based dissemination tools, incorporating Blue and Green water integrating methodologies and encompassing the social accounting matrix
- vi. Environment impact assessment methodologies, primarily in relation to biodiversity and water quality
- vii. Monitoring and evaluation. The impact assessment methodologies outlined above will also provide the basis for monitoring and evaluating the socio-economic, poverty and water resource outcomes of manmade interventions
- viii. Such a framework should be able to effect convergence of scales to encompass the interventions being made at various levels. The effective adaptation measures to climate change impacts shall only be possible through reliable simulation of the future conditions which such a common framework offers.

The activities proposed and the fund requirements are given in Table 39.

Table 39: Summary Of Climate Change Action Plan for Water Sector

S. no	Strategy	Activity	Implication	Department/ Organization	Duration	Cost in ` Crores
1	Comprehensive water database and assessment of climate change on water resources	a. Development of Hydrological Information System on Real time	Modernization of existing water data collection and management system	Haryana Irrigation Department	3-4 years and ongoing	18.5
		b. Modelling and analysis of the data for climate change impacts on water resources	Procurement and development of appropriate modelling tools for all aspects of water resources management	Haryana Irrigation Department	4-5 years and ongoing	15
		Development of modern real time water quality monitoring system	Better water quality monitoring and effective measures to combat pollution of water resources	Env't. Deptt., HSPCB and Haryana Irrigation Department	3-4 years and ongoing	10
2	Efficient management of water resources	Better management practices	Comprehensive review of the existing management practices	Haryana Irrigation Department	1-2 years and ongoing	0.5
		Establish State Water Regulatory Authority	Reassessment of water allowance	Haryana Irrigation Department	1 year and ongoing	3
		Promote	Plan and execute an	HID and CADA	2-3 years	Not

S. no	Strategy	Activity	Implication	Department/ Organization	Duration	Cost in ` Crores
		Participatory Irrigation Management	extensive PIM programme		and ongoing	estimated yet
		Rehabilitation, Remodelling of irrigation infrastructure	Conservation of water by checking leakages, seepages, etc. for probable climate change impacts	Haryana Irrigation Department	2 years and ongoing	1000
		Flood Control Works and Rehabilitation of flood protection works.	Conservation of water by checking leakages, seepages.	Haryana Irrigation Department	2 years and ongoing	2500
3	Groundwater management	Groundwater legislation	Better groundwater management	Agriculture Department	1 year and ongoing	Not estimated yet
4	Rainwater harvesting and judicious recharging of groundwater	Expeditious implementation of programme for conservation of water through recharge of ground water including rainwater harvesting and artificial recharge in areas/situations sensitive to climate change	Arrest groundwater depletion and conservation of water	HID, AD, HUDA, TCP, etc.	Ongoing	Not estimated yet
5	Waterlogging and salinity control	Set up a Task Force to suggest effective measures to combat Waterlogging and soil salinity	Implementation Plan for checking Waterlogging and Soil salinity	HID and AD	1 year	Not estimated yet
		Measures to control Waterlogging	Action as per the implementation plan	HID and AD	2-3 years and ongoing	Not estimated yet
6	Construction of dams in catchments of rivers	Take up the issue of construction of dams in the catchments of rivers		HID	5-10 year and ongoing	Not estimated yet
7	Crop diversification	Set up a Task Force to suggest Crop		AD and HID	1 year and onwards	Not estimated yet

S. no	Strategy	Activity	Implication	Department/ Organization	Duration	Cost in ` Crores
		Diversification Plan				
8	Promote water saving technologies.	Sprinkler Irrigation System	Provide subsidy to farmers for installing sprinkler sets to cover 4 lac hectares area.	Agriculture Department	2-5 years	300
		Drip Irrigation System	Provide assistance to farmers to set up drip irrigation system to cover 40000 hectares area.	Agriculture Department	2-5 years	400
		Underground Pipeline System	Laying of underground pipeline system in 2.00 lac hectare area for efficiency in water conveyance and bringing more area under irrigation.	Agriculture Department	2-5 years	250
9	Legislation, Policies and Guidelines to handle climate change impact	Frame policies, law for climate change situation on water sector		HID, CADA, AD	2-3 years	Not estimated yet
10	Research and development by partnering with academic institutions	Set up RandD cell in HID for research in water sector and climate change		HID	1 year and onwards	Not estimated yet
11	Capacity building	Implementation Plan for Extensive Capacity Building and Training		HID and HIRMI	1 Year and ongoing	Not estimated yet

Rural Development: Proposed activities under IWMP are as under:-

Farm based-

- Organic farming, Agro forestry, Pasture Development (Promotion of fodder),
- Horticulture (High Density Horticulture), Raising of vegetables, medicinal plants, seed multiplication, seed banks, vermin compost units, raising of nurseries, organic farming etc.

Off farm based -

- Forest based activities: - Gum and resin collection, cultivation and ornament making and basket making, bee keeping.
- Agriculture based activities: Spices processing, jaggery and jaggery production, apiculture, medicinal and aromatic plants cultivation, floriculture etc.

- Poultry bases activities: - Backyard poultry, small poultry farms.
- Dairy bases activities,
- Fishery based activities:- Pisciculture,
- Piggery based activities:- Pig farming,
- Goatery bases activities:- Goat farming,
- Horticulture bases activities:- Flower and vegetable Vending, Fruit pulp processing, pickle making, processing of spices like making of saunth for ginger promoting scientific practices of live stock learning.

Summary of the proposed actions, time period and the fund requirement is given in Table 40.

Table 40: Summary of Climate Change Action Plan for IWMP by Rural Development department

Sl no	Item			Details	
				No	Area in ha
1	Micro-watersheds not covered till date			1521	1066103
2	Plan for covering balance micro-watersheds	11 th Plan	2011-12	311	179531
		12 th Plan		414	303508
		13 th Plan		423	310059
		14 th Plan		373	273005
		Total		1521	1066103
3	No. of projects (clusters) proposed for 2011-12			47	
	No. of micro projects proposed for 2011-12			311	
	Estimated project cost (Rs. in crores)			222.42	
	Central share (Rs. in crores)			199.28	
	State share (Rs. in crores)			23.14	
	Amount of 1st instalment of Central Share (20 %) (Rs. in crores)	6%		11.95	
		14%		27.9	
		Total		35.85	

Health Sector Climate Change Strategy and Action Plan

Some of the action plans and projects for a sustainable development and adaptation to Climate Change is given in Table 41. The period of implementation can be in the next 10 years.

Table 41: Projects proposed and Funding Requirement for Health Sector

Sl. no	Area of Issues on Climate Change by Health sector	Actions proposed to be expected	Timeline years	Remarks	Funds (INR Crore)
1	Addressing enhanced diseases burden	With reference to Climate Change- • An assessment needs to be carried out to understand the extent of disease burden that may occur due to climate change and population	5		4.0

Sl. no	Area of Issues on Climate Change by Health sector	Actions proposed to be expected	Timeline years	Remarks	Funds (INR Crore)
		projections, • Identification of vulnerable areas for each disease, and • Identification of vulnerable communities along with identification of windows of opportunity of new diseases that might occur due to change in climate determinants, • An assessment of number of additional health centres and health personnel required. IDSP to continue to monitor disease prevalence and outbreak IDSP to include private, public as well as all village level health care centres for surveillance Putting in place additional health care centres and medical personnel	10 10 10		Funding to continue from present source -do- To be funded from existing programmes if they continue
2.	Reduction targets for Vector Borne diseases	Reduction in Malaria incidence by at least 50%. To bring API below 1 in all the Districts of the State. Enhanced use of ITBNs (especially in High Risk Areas) by 50% among Below Poverty Line (BPL) Population. Enhanced use of larvivorous fish in 75% villages of high-risk areas 50% villages of all areas. 50% reduction in use of Indoor Residual Spraying by spraying only high-risk areas. Entomological study on prevalence and vector densities for Malaria, JE, Dengue, CCHF (Chimean-Congo Haemorrhagic Fever) in the state.		@ Rs.0.05 Cr per districts and Rs.0.2 Cr for State Hq. Includes also training cost, monitoring, field work and lab.	To be funded from current NVBDCP -do- -do- 1.25

Sl. no	Area of Issues on Climate Change by Health sector	Actions proposed to be expected	Timeline years	Remarks	Funds (INR Crore)
				Test etc.	
3	Control of TB	Under RNTCP the aim is in terms of Universal Access is 100% case detection. At present in Haryana is 57% total TB Cases and 56% NSP cases in the year 2010 Expansion of DOTS Plus services Extend services in private hospitals with OPD patient intake of 100-150 per hospital	5 5	To be funded from the RNTCP -do-	-
4.	To control NCD	To control NCDs main emphasis will be given on IEC activities to reach out target communities, continuous monitoring and independent evaluation of the program and research, Promotion of public private partnerships, Mainstreaming AYUSH – revitalizing local health traditions	10	To be funded from NPCDCS and NRHM	-
5	Ecological study on air pollutants- from industry, transport and domestic cooking, pollen and molds (as triggers of Asthma and Resp. diseases) and how they are affected by CC	Pilot study is proposed for all districts Hospitals, *To screen and study patients suffering from Bronchial Asthma and other Resp. Diseases	5	@ 0.1 Cr rupees per district *Required Med. Specialist and Chest Specialist are available.	2.1
6.	Enhanced provision of Primary, Secondary and Tertiary health care facilities and implementation of public health measures, including vector control, sanitation and clean drinking water supply	i) Primary level:- Awareness and sensitization to all sectors on Climate change. ii) Secondary level:- Early diagnosis and treatment i.e. Testing kits and drugs. lii) Tertiary level:- Testing kits and treatment with drugs		Primary level: Rs.0.05 Cr per districts and Rs.1.8 Cr for State Hq Secondary and tertiary level each: Rs.1 Cr @ of Rs.0.05 Cr per districts and Rs.2 Cr for State Hq.	2.5
7.	Providing high resolution weather and climate data to study the regional pattern of diseases. Development of a high resolution health impact model at the state level	Through IDSP (Integrated Disease Surveillance Project) which is a project by GOI on Disease Surveillance and is engaged in Outbreak/ Epidemic forecasting and investigation/management. Assistance of department. Of Science and Technology, Remote Sensing section will be taken for real time high resolution weather and climate data.		Fund will be needed for engaging Remote Sensing department for high resolution data transfer.	1.0
8.	GIS mapping of access routes to health facilities	Both State Remote Sensing Health departments, under NVBDCP will be utilized for GIS mapping.			-
9	Development of a disaster Risk reduction	In association with the National Disaster Management Authority			

Sl. no	Area of Issues on Climate Change by Health sector	Actions proposed to be expected	Timeline years	Remarks	Funds (INR Crore)
	plan	develop plans for risk reduction of diseases escalation and outbreaks due to climate change			
10.	Climate change coordination committee	A committee needs to be formulated with members from all disease control programmes who will ensure integration of climate change concerns in planning and implementing diseases control measures for existing and new and emerging diseases			
	Total budget proposed				10.85

Strategic Knowledge Mission

Successful climate change management calls for a new development paradigm that integrates climate change into strategies and plans, and that links policy setting with the financing of solutions. Climate change Strategy and Action Plans under Strategic Knowledge Mission proposes:

- Framing the State Action Plan on Climate Change
- Actions under the State Strategic Knowledge Mission

Some of the focus area include:

- Prioritize areas for research. Research also helps to address what measures will be needed to adapt to these impacts and how we can mitigate against the effects.
- Promote research in multi disciplinary aspects of environmental pollution as well as waste utilization.
- Prepare and upgrade environmental status reports with special emphasis on climate change.
- Conduct Environmental Impact Assessment of development projects critical to climate change i.e. power, housing, cement. Create climate change related databases and identify responses to climate change.
- Research into identification of alternative means of livelihood.
- Research into low and alternative energy options.
- Preparing communication strategies.
- Constitution of Task Force for monitoring the progress of implementation of Corporate Responsibility for Environmental Protection (CREP, MoEF) recommendations/ action points.
- A scheme for Research Promotion for development of effective and low cost technology for prevention and control of pollution in small industry sector etc.
- Preparation and publication of the State of Environment Report.
- Documentation carried out on Industry best practices.

Awareness of Climate Change

Activities proposed under creating awareness for Climate Change are:

- Provide a one stop window to access and share information on climate change learning
- Dissemination of Climate Change Information.
- Massive awareness campaign on climate change vis-a-vis of its impact.
- Communicate climate change issues to growers, policy makers and all stake holders.
- Train school and college teachers on climate change, impacts, adaptation and mitigation.
- Organize seminars, conferences and workshops on Climate Change.
- Create Climate Change awareness centers at National Parks, Sanctuaries, Zoos and other public places.
- Publicity through print and electronic media.
- Environmental education, Training and awareness programme under which celebration of World Environment day, International Bio Diversity day, International Ozone Layer Conservation day, Organization of Environmental Training programs and awareness programme.
- Awareness for Optimum use of water.
- Identification of technical experts for creation of awareness for different target groups.
- Promotion of eco-tourism.

Capacity Development

Activities proposed under capacity development are:

- Research and Development Priorities identified by the state.
- Providing training and Capacity building among town planning professionals so that they can use latest technique for preparation of master Plan.
- Training the Officials of State Development Departments on the steps and approaches to handle the climate change impacts on various sectors and to build scientifically the adaptations options to be considered by the policy makers and the society.
- Establish Centers of Excellence in Colleges/ Universities/ Institutions.
- Sensitize the importance of Climate Change and its inter-linkages with development options.
- Importance of “Adaptation” in policy making, planning and programming. The adaptation programming is to improve the adaptive capacity and reduce the vulnerability of human populations and the natural and economic systems on which they depend, to climate change and its impacts, and therefore contribute to the realization of the Adaptation.
- Learn about systematic steps aiming at defining concrete adaptation options at national, sector, local and project level, and accord support of necessary institutional capacities to facilitate carry out a change process.
- Learn about relevant climate information.
- Communicate scientifically based information on observed climate trends.
- Skill Development both at formal and informal level.
- Creation of a Centre for Knowledge Management & Skill Development on climate change. The centre will also create, maintain and update a portal on the subject.
- Identification of State Govt. Departments having the capability to execute the recommendations finalized in the SAPCC.

Brief monitoring and evaluation framework

- Creating a database: In order to benefit from the experience of development agencies in monitoring and evaluating their activities, there is a need to organize a data source and convert into database.
- Integrate conventional data sources with modern data sources to develop GIS database.
- Constant monitoring of climate change signals/climate variability and creating meteorological database/forecasting for decision support system in all the districts and providing competitive incentives to the better performing districts.
- A high power committee for supervision and review of policies.
- Constitution of Climate Change Authority in State may be considered aiming, at coordination among various departments.

It is felt that at least 1% of the total funding for the State need to be provided for Capacity building.

Consolidated abstract of budget requirement for Haryana

Summary of the funding required for various activities under different missions are consolidated in Table 42.

Table 42: State funding requirement for all Sectors for climate change vulnerability reduction measures

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
Forest Sector							
Sub Mission 1: Enhancing quality of forest cover and improving ecosystem services	Moderately dense forest cover, but showing degradation	80	Short (2020) to Long (2030)		20000	40000	
	Eco- restoration of degraded open forests	650			100000	65000	
	Restoration of grasslands	80			20000	40000	
Sub-mission 3: Enhancing tree cover in Urban and Peri-urban areas	Avenue, city forests, municipal parks, gardens, households, institutional lands, etc.	50			10000	50000	
Sub Mission 4: Agro-forestry and Social Forestry (increasing biomass & creating carbon sink)	Agroforestry	5000			1000000	50000	
	Community and Panchayat land are under tree cover	100			100000	10000	
	Corridor	100			10000	100000	
Total Forest		6060			1260000	355000	
Water Sector							
Comprehensive water database and assessment of climate change on water resources	Development of Hydrological Information System on Real time	18.5	3-4 years & ongoing	Haryana Irrigation Department			Modernization of existing water data collection & management system
	Modelling & analysis of the data for climate change impacts on water resources	15	4-5 years & ongoing	Haryana Irrigation Department			Procurement & development of appropriate modelling tools for all aspects of water resources management

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	Development of modern real time water quality monitoring system	10	3-4 years & ongoing	Env't. Deptt., HSPCB & Haryana Irrigation Department			Better water quality monitoring & effective measures to combat pollution of water resources
Efficient management of water resources	Better management practices	0.5	1-2 years and ongoing	Haryana Irrigation Department			Comprehensive review of the existing management practices
	Establish State Water Tariff Authority	3	1 year and ongoing	Haryana Irrigation Department			Reassessment of water tariff, water allowance & allocation priorities
	Promote Participatory Irrigation Management		2-3 years & ongoing	Haryana Irrigation Department & CADA			Plan & execute an extensive PIM programme
	Rehabilitation, Remodelling of irrigation infrastructure	1000	2 years and ongoing	Haryana Irrigation Department			Conservation of water by checking leakages, seepages, etc.
	Flood Control Works and Rehabilitation of flood protection works.	2500	2 years and ongoing	Haryana Irrigation Department			Conservation of water by checking leakages, seepages.
Groundwater management	Groundwater legislation		1 year & ongoing	Agriculture Department			Better groundwater management

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
Rainwater harvesting & judicious recharging of groundwater	Expeditious implementation of programme for conservation of water through recharge of ground water including rainwater harvesting and artificial recharge in areas/situations sensitive to climate change		Ongoing	HID, AD, HUDA, TCP, etc.			Arrest groundwater depletion & conservation of water
Waterlogging & salinity control	Set up a Task Force to suggest effective measures to combat Waterlogging & soil salinity		1 year	HID and AD			Implementation Plan for checking Waterlogging & Soil salinity
	Measures to control Waterlogging & soil salinity		2-3 years & ongoing	HID and AD			Action as per the implementation plan
Construction of dams in catchments of rivers	Take up the issue of construction of dams in the catchments of rivers		5-10 year & ongoing	HID			
Crop diversification	Set up a Task Force to suggest Crop Diversification Plan		1 year & onwards	AD and HID			
Promote water saving technologies	Sprinkler Irrigation System	300	2-5 years	Agriculture Department			Provide subsidy to farmers for installing sprinkler sets to cover 4 lac hectares area.
	Drip Irrigation System	400	2-5 years	Agriculture Department			Provide assistance to farmers to set up drip irrigation system to cover 40000 hectares area.
	Underground Pipeline System	250	2-5 years	Agriculture Department			Laying of underground

Programme/Mission	Action Plan	Prposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
							pipeline system in 2.00 lac hectare area for efficiency in water conveyance and bringing more area under irrigation.
Legislation, Policies & Guidelines to handle climate change impact	Frame policies, law for climate change situation on water sector		2-3 years	HID, CADA, AD			
Research & development by partnering with academic institutions	Set up R&D cell in HID for research in water sector & climate change		1 year & onwards	HID			
Capacity building	Implementation Plan for Extensive Capacity Building & Training		1 year & ongoing	HID and HIRMI			
Total Water Sector		4497					
Energy Sector							
Solar Mission (and other renewable sources of energy)							
Generation of power from solar energy	To invite and pre-register the solar power project under Jawaharlal Nehru National Solar Mission	179	2012-2017	HAREDA			
	Signing of power purchase agreement for sale of power to the utilities.						
	Execution of the projects and synchronization with grid						
Biomass cogeneration Power Projects	Awareness among the industries specifically rice sellers to adopt this technology	180	2012-2017				
	Preparation of feasibility-cum-detailed project report and approval of Ministry of New & Renewable Energy for sanction of						

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
Biomass Power Plants	CFA						
	Execution of the project						
	Awareness among the industries/developers to set up biomass power projects in the State.	860	2012-2017				
	Preparation of feasibility-cum-detailed project report and approval of State Govt.						
	Approval of Detailed Project Report						
	Signing of Power Purchase Agreement with the State Utilities						
	Execution of the project						
Off grid roof top and other applications	CFL based Home Lighting Systems	51.9	2012-2017				
	SPV Street Lighting Systems						
	SPV Power Plant of 10 KW each						
	Solar Pumps 5.00 KW						
	Solar power packs (1 KW to 100 KW)						
Other Programmes	Energy Efficiency Mission	25	2012-2017				
	Solar Water Heating Projects		Ongoing				
	Energy Service Company (ESCO) Projects		Ongoing				
	Mandatory Use of Compact Fluorescent Lamp (CFL) in Government Buildings/Government Aided Institutions/Boards/Corporations		Ongoing				
	Scheme on Energy Audit for Industries, commercial buildings, govt. buildings and institutions		Ongoing				

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	Enhance EE municipal water pumping	50					
	Improvement of Demand Side EE appliances in residential and commercial sectors	100	Proposed				
Scheme on energy conservation in agriculture sector							
To conserve Electrical Energy in the Agriculture sector.	All the farmers of Haryana who are taking new tubewells connection or opting higher capacity pump sets will be encouraged to install at least 4 star rated (BEE Star rating) pump sets and will be eligible for the state subsidy. Farmers having old non ISI motors and want to replace these with Latest 4 star rated motors will also be eligible under this scheme.		Ongoing	Agriculture Sector			
To encourage and educate the formers to adopt the energy efficient pump sets in their tubewells.							
To manage electrical energy demand in Agriculture sector.							
Scheme on energy conservation in agriculture sector	Replacement of ALL/remaining inefficient pump sets with 4/5 star rated (BEE star rating) and the installment of new pump sets in order to double the agricultural production	15000	Proposed				
To conserve Electrical Energy in the Agriculture sector.							
To encourage and educate the formers to adopt the energy efficient pump sets in their tubewells.							
To manage electrical energy demand in Agriculture sector.							
Demand Side Management Application	Reducing inductive losses on load side appliances to be done in phases	500	Proposed				
	Meter Installation for pump sets - to be done in phases	1000	Proposed				
	Rural 3-phase feeder separation -	20000	Proposed				

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	to be done in phases						
	Reducing aggregate technical and commercial losses (AT&C)	2500	Proposed				
	More mechanization to increase energy efficiency of agriculture, including off-road vehicles (e.g. tractors, machines etc) - to be done in phases	2000	Proposed				
	Solar pump sets	200	Proposed				
	Biomass based power generation (using rice straw)	160	Proposed				
	Reducing farmers' vulnerability to climate change stresses through introduction of specific crop insurance schemes and packages	250	Proposed				
	Drip irrigation systems for increasing water-energy efficiency of irrigation systems		Proposed/Water Resources				
Food Processing Industry	Providing necessary infrastructure (eg Cold storages, Godowns)	250	Proposed				
	Requirement of energy-efficient storage for agricultural products						
	Biomass and solar based cold storages (absorption chiller technology)	50	Proposed				
Designing power utilities for 'Zero effluent discharge'	DCRTPP Yamuna Nagar		Done	Haryana Power Generation Company Limited (HPGCL)			
Designing power utilities for 'Zero effluent discharge'	Required at all power plants	150	Proposed				
• Renovation, Modernization and Capacity Addition	• R&M at Panipat Thermal Power Station (PTPS)		Ongoing/Done				
• ISO Certification for HPGCL Power Plants	• ISO Certification for (DCRTPP, Yamunanagar &						

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	PTPS, Panipat)						
• Energy Efficient Buildings	• Energy Efficient Buildings (DCRTPP, Yamunanagar, PTPS, Panipat & corporate office at Panchkula)						
• Energy Savings by Reducing Consumption	• Energy Savings by Reducing Consumption (DCRTPP, Yamunanagar & PTPS, Panipat)						
• Energy Audit Tests	• Energy Audit Tests (DCRTPP, Yamunanagar & PTPS, Panipat)						
• Renovation, Modernization and Capacity Addition	• R&M at the remaining thermal power stations	100	Proposed				
• ISO Certification for HPGCL Power Plants	• ISO Certification for FTPS, RGTPS						
• Energy Efficient Buildings	• Energy Efficient Buildings (FTPS, RGTPS, IGSTPP)						
• Energy Savings by Reducing Consumption	• Energy Savings by Reducing Consumption (FTPS)						
• Energy Audit Tests	• Energy Audit Tests (FTPS, RGTPS)						
Technical modifications (for ex.: in air & fuel cycle; steam, feed water and condensate cycle; fuel & ash cycle; electrical & lighting system etc.) for energy efficient and cleaner technologies		10	Proposed				
Enhancing renewable power capacity and generation (including solar PV, wind, biomass, hydro)		100	Proposed				
Reducing Aggregate Technical & Commercial Losses (AT&C)	Stations should be automated to improve quality and reduce energy losses	200	Proposed	Haryana Vidyut Prasaran Nigam Limited (HVPNL)			
Encourage use of Energy-Star Labeled		25	Ongoing				

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
Appliances and BEE Star Labeling				(UHBVNL and DHBVNL)			
Smart grid applications Research, Development & Demonstration		25	Proposed				
Energy conservation campaign			Ongoing				
Urban Planning	Integrate Climate Risk and Disaster Management Preparedness in urban plans	100	Proposed	Town and Country Planning and Urban Local Bodies			
	Promote sustainable cities programme - in phases	10	Proposed				
	Promoting green buildings	250	Proposed				
	Improving urban infrastructure through rain water harvesting and reuse of waste water	100	Proposed				
	Improve land-use planning	25	Proposed				
	Improve drainage, sewerage and sewage treatment in all ULBs	150	Proposed				
Urban Transport	Promote and plan Public Transport System and parking infrastructure in large ULBs	40	Proposed				
	Increasing efficiency of city buses, including phasing out old stock with new and efficient stocks	60	Proposed				
	Adequate infrastructure facilities for pedestrians, cyclists and non-motorists transport	10	Proposed				
	Metro rail in over 5 lakh population cities as well	100	Proposed				
	BRTS in more cities	50	Proposed				
	Hybrid and electric vehicle proportion projects	10	Proposed				
Waste Management	Capacity Building for Waste (Municipal solid waste, domestic	60	Proposed				

Programme/Mission	Action Plan	Prposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	sewage, waste water) to Energy. Also waste to compost to be used as fertilizer.						
Bharat Nirman	Integrate Climate Risk and Disaster Management Preparedness in flagship programmes (Rural Housing, Rural Roads)	50	Proposed	Public Works Dept. (B&R)			
Urban Planning	Improvement and widening of congested roads	300	Proposed				
Research and Development	Identify, study and disseminate latest EE technologies required to increase agricultural production	15	Proposed	Dept. of Science and Technology			
	Identify, study and disseminate latest EE technologies in commercial and industrial sectors	10	Proposed				
	Research to study adverse impacts of climate change on various sectors and locations in Haryana state	20	Proposed				
Total Energy Sector		45325.9					
Health Sector							
Addressing enhanced diseases burden With reference to Climate Change	An assessment needs to be carried out to understand the extent of disease burden that may occur due to climate change and population projections,	4					Funding to continue from present source
	Identification of vulnerable areas for each disease, and						
	Identification of vulnerable communities along with identification of windows of opportunity of new diseases that						

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	might occur due to change in climate determinants,						
	An assessment of number of additional health centres and health personnel required.		5				
	IDSP to continue to monitor disease prevalence and outbreak		10				
	IDSP to include private, public as well as all village level health care centres for surveillance		10				Funding to continue from present source
	Putting in place additional health care centres and medical personnel		10				Funding to continue from present source
Reduction targets for Vector Borne diseases	Reduction in Malaria incidence by at least 50%.						To be funded from current NVBDCP
	To bring API below 1 in all the Districts of the State.						
	Enhanced use of ITBNs (especially in High Risk Areas) by 50% among Below Poverty Line (BPL) Population.						
	Enhanced use of larvivorous fish in 75% villages of high-risk areas 50% villages of all areas.						
	50% reduction in use of Indoor Residual Spraying by spraying only high-risk areas.						
	Entomological study on prevalence and vector densities for Malaria, JE, Dengue, CCHF (Chimean-Congo Haemorrhagic Fever) in the state.	1.25					@ Rs.0.05 Cr per districts and Rs.0.2 Cr for State Hq. Includes also training cost,

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
							monitoring, field work and lab. Test etc.
Control of TB	Under RNTCP the aim is in terms of Universal Access is 100% case detection. At present in Haryana is 57% total TB Cases and 56% NSP cases in the year 2010		5				To be funded from the RNTCP
	Expansion of DOTS Plus services						
	Extend services in private hospitals with OPD patient intake of 100-150 per hospital		5				To be funded from the RNTCP
To control NCD	To control NCDs main emphasis will be given on IEC activities to reach out target communities, continuous monitoring and independent evaluation of the program and research, Promotion of public private partnerships, Mainstreaming AYUSH – revitalizing local health traditions		10				To be funded from NPCDCS and NRHM
Ecological study on air pollutants- from industry, transport and domestic cooking, pollen and molds (as triggers of Asthma and Resp. diseases) and how they are affected by CC	Pilot study is proposed for all districts Hospitals, *To screen and study patients suffering from Bronchial Asthma and other Resp. Diseases	2.1	5				@ 0.1 Cr rupees per district *Required Med. Specialist and Chest Specialist are available.
Enhanced provision of Primary, Secondary and Tertiary health care facilities and implementation of public health measures, including vector control, sanitation and clean drinking water supply	i) Primary level:- Awareness and sensitization to all sectors on Climate change ii) Secondary level:- Early diagnosis and treatment i.e. Testing kits and drugs. Iii) Tertiary level:- Testing kits and	2.5					Primary level: Rs.0.05 Cr per districts and Rs.1.8 Cr for State Hq Secondary and tertiary level

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	treatment with drugs						each: Rs.1 Cr @ of Rs.0.05 Cr per districts and Rs.2 Cr for State Hq.
Providing high resolution weather and climate data to study the regional pattern of diseases.	Through IDSP (Integrated Disease Surveillance Project) which is a project by GOI on Disease Surveillance and is engaged in Outbreak/ Epidemic forecasting and investigation/management.						Fund will be needed for engaging Remote Sensing department for high resolution data transfer.
Development of a high resolution health impact model at the state level	Assistance of department. Of Science and Technology, Remote Sensing section will be taken for real time high resolution weather and climate data.	1					
GIS mapping of access routes to health facilities	Both State Remote Sensing Health departments, under NVBDCP will be utilized for GIS mapping.						
Development of a disaster Risk reduction plan	In association with the National Disaster Management Authority develop plans for risk reduction of diseases escalation and outbreaks due to climate change						
Climate change coordination committee	A committee needs to be formulated with members from all disease control programmes who will ensure integration of climate change concerns in planning and implementing diseases control measures for existing and new and emerging diseases						

Programme/Mission	Action Plan	Prposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
Total Health Sector		10.85					
Agriculture, Livestock and Fisheries							
Agricuture	Reserach in:, Creation of assured irrigation in settled cultivation areas, Promotion of scientific planning and cropping pattern to improve the yield per hectare, Integrated efforts for enhanced productivity , Integrated crop management, Continuation of the traditional organic farming to meet market demands for organic products, Efforts for improving the rice production rate , Ecologically sustainable and economically viable diversification of agriculture, Major emphasis on growing off season vegetables and fruits	100	3 to 5 years				
Horticulture	Extension work and advisory for fruits and vegetables , pest and diseases and weed management						
Livestock	Enhancement of livestock production by introduction of CC adaptive measures, dairy development, Feed and fodder development, Preventive health measures, Strengthen disease investigation system and risk management						
Fisheries	Better feeds, selective breeding and genetic improvement; Improve efficacy of water usage; encourage non-consumptive water use in aquaculture, e.g.						

Programme/Mission	Action Plan	Proposed investment (Rs. in crores)	Duration	Department/ Organization	Area (ha)	Unit Cost/ha (Rs)	Remarks/Others
	culture based fisheries;Encourage uptake of individual/cluster insurance; improve siting and design to minimize damage, loss and mass escapes;Encourage use of indigenous species to minimize impacts on biodiversity use non-reproducing stock in farming systems;						
Centre on Climate Change Research in Agriculture	Automatic Weather station with GPRS facility, Open Top Climate & Growth Chamber , Digital Meteorological data dissemination system, Hyper spectral radiometer, Computers (Desktop and laptop) with software and accessories; alon with global and regional climate models-software and Recurring (staff)	11.5					
Total Agriculture/Horticulture/Livestock/Fisheries		111.5					
Total (Rs. Crore)		56005.25					
Strategic Knowledge (Capacity Building (@1%))		560.05					
Grand Total (Rs. Crore)		56565.00					

Sector wise Consolidated abstract of budget requirement

Sector/Mission	Sector	Proposed* investment (in Rs crore)	Duration	Carbon sink enhancement potential
Forest (Greening India Mission)	Forest	6060.0	Short (2020) to Long (2030)	6.32 million tonnes of CO ₂ by 2020
Agriculture (Sustainable Agriculture Mission)	Agriculture	111.5	Short (5 years)	
	Live-stocks			
	Horticulture			
Energy (Enhanced Energy Efficiency Mission Jawaharlal Nehru National Solar Mission)	Energy	45325.9	Short (5 years) to Long (10 years)	
Water (National Water Mission)	Water Resources	4497.0	Short (5 years)	
Rural Development	IWMP	2224.20	13th and 14th plan	
Health Sector		108.5	Short (10 years)	
Total		56005.25		
Strategic Knowledge (Capacity Building (@1%))		560.05		
Grand Total		56565.00		
		Rs. 566.0 billion		

Chapter 7

Cross Cutting Issues and Integrated Approach

Chapter 7 - Cross Cutting Issues and Integrated Approach

Sectoral Policy and Barrier analysis for M & A project design, implementation and Monitoring

The State has already recognized a large number of issues critical to the management of climate change. Some of the critical areas recognised and the areas of research that need to be taken up under the Strategic Knowledge Mission have been identified as below.

Critical Areas:

While dealing with Climate Change challenges some of the critical issues that are spread across the sectors and domains could be:

- Identification of species tolerant to climate change.
- Identification of alternative livelihood options.
- Identification of technology options for handling industrial and domestic sewage.
- Handling of municipal solid wastes.
- Handling of air pollution from industrial, domestic, transportation sources.
- Alternative energy options
- Documenting traditional practices, local knowledge and folk traditions.
- Minimizing time lags in Lab to field transfer of technologies.
- Utilization of CDM benefits.
- Creating data base and identifying trends and Climate responses.
- Strengthening the nodal agencies and creation of human resource.

Areas of research:

Priority areas for research should include:

- Promote research in multi disciplinary aspects of environmental pollution as well as waste utilization.
- Undertake carrying capacity assessments in critical/aquatic stretches and air polluting areas.
- Prepare and upgrade environmental status reports with special emphasis on climate change.
- Develop effective and low cost technology for pollution control.
- Conduct EIA of development projects critical to climate change i.e. power, housing, cement etc.
- Document biodiversity status and traditional and folk knowledge.
- Create climate change related databases and identify responses to climate change.
- Research into identification of alternative means of livelihood.
- Research into low and alternative energy options.
- Preparing communication strategies.

The above intent is not an easy affair and needs a strategic planning and implementation to get the desired results. The major players that influence the policy which in turn influences the various intended systems can be grouped into two categories with respect to the scale at which they operate. The main players from this angle are the organizations/departments involved in planning, implementation and management of the big projects which have widespread influence. Most of these projects be they a major irrigation project, a hydropower project or national highway project, have been in the realm of the government or at the most public sector domain. It is only recently that the private sector started participating, once the government policies were changed to woo private participation.

The second kind of players are those who work at the local scale for programmes that are again run by the central and state government departments but involve agencies that are either NGOs or Gram Panchayats. At this scale there are more inherent problems than the earlier situation where one is concentrating on a single project. In this case, the programmes are invariably widespread. However the policies are made with a view to have minimum variability, in order to get uniformity of implementation. For some sectors such uniformity of implementation might not have any problem but on the contrary there are other sectors that are very sensitive to the environment and need special handling. Water and agriculture are two such sectors and need special understanding and handling. Some of the programmes that have faced problems on account of independent actions are:

- The National Drinking Water Mission which has seen a very large number of hand pumps becoming defunct after installation
- Watershed management programme which has created problems for downstream people in many cases
- The rejuvenation of old tanks programme that has limited success due to over-doing the watershed development activities in the catchment area of the tank.

Need for Integrated approach

As mentioned above, the water resources sector is the core sector to which all the other sectors are connected in a very complex way. If the climate change adaptation has to be adequately and comprehensively addressed then the interconnectivity of other sectors has to be understood with the water resources. For such an intent use of an integrated approach becomes essential. Integrated watershed/water resources management does not merely imply the amalgamation of different activities to be undertaken within a hydrological unit. It also requires the collation of relevant information so as to evaluate the cause and effect of all the proposed actions. The watershed is the smallest unit where the evaluation of man-induced impacts upon natural resources becomes possible with respect to the water balance approach. As the impacts resulting from actions taken at the watershed level will be experienced at a higher level within the drainage basin, the assessment of these impacts will require the availability of a framework which enables the mapping of such units to the higher catchment level in the hierarchy of River Basin at the highest level of drainage system. Such a framework will need regular maintenance and updating to reflect fully the most accurate ground-truthed data of the infrastructure requirements for planning and management of the natural resources collected by the relevant departments. This framework, once available, could be used by all the line departments and updated by the relevant departments which have designated areas of

jurisdiction over the data entry. Such a framework shall also be used to enumerate the freshwater ecosystem services each system is serving and need to be preserved.

The policy, being an intent put together by domain experts and policy makers, is invariably a very good document that addresses all the concerns of a very wide cross-section of stakeholders. The same situation occurs with the National/State Water and Environment policies. These are very good documents in their own right. However there are few issues that are either not adequately addressed or are altogether missing. Some of these issues are briefly discussed below.

- The National Water Policy (NWP) and State Water Policies (SWPs) do emphasize on a river basin approach to manage the water resources effectively. It somehow does not explicitly emphasize that the same drainage area based approach should also be continued for the sub-areas of the basin, namely catchments and watersheds that shall make it possible to address the equity and externality issues effectively under the present and future situations
- There is no provision in the NWP/SWPs for a feedback mechanism on the implications of actions taken in the policy instruments of other sectors such as Environment, Forest, Agriculture, Watershed Development, Energy, etc.
- The NWP/SWPs do not attempt to tackle equity issues and other societal issues connected with water. These only stop at providing rehabilitation to those people uprooted by big projects but no attempt is made to quantify the impact of local level interventions that are potentially capable of creating bigger impacts.
- Even with the National Water Mission (NWM) that has been put together for tackling climate change impacts, many of the above concerns still remain intact. It is very important to take stock of these concerns if the objectives set forth under the NCCAP/SCCAPs are to succeed.

It is not true that our policy makers at the national and state level are not aware of these issues; the present situation is more on account of lack of initiative and also many times due to difficulty in handling the complexity of these issues. To help bridge the apparent gap between the policy and research communities it is important to incorporate advocacy and promotion techniques to connect and disseminate new knowledge of the biophysical and socio-economic outcomes of land and water interventions to policy makers through a number of mechanisms. These would include peer-to-peer networking of policymakers, the use of interactive workshops and the use of innovative media including e-fora and websites.

Data and Information infrastructure, Modelling

Another segment that shall require maximum research and development initiative is to create infrastructure that shall be able to encapsulate the majority of issues described above and which shall act as a facilitator to provide a framework for integration, planning, monitoring and assessment. A typical framework can revolve around water sector by incorporating the Integrated Water Resources Management Cycle and shall include the following methodologies which can be operated in conjunction with support tools. Formulation, implementation and maintenance of such a framework is truly in the realm of research and must be taken up at the earliest at the state level.

Some of the components and functionalities of such a system are:

- Hydrological assessment of all water uses and users within a catchment
- Catchment Stress Assessment to determine to what extent the catchment is not meeting aquatic ecosystem requirements
- Strategic Environmental Assessment to identify the economic returns and employment opportunities that arise or potentially could arise from water use in the catchment
- Methodologies for contextual analysis (forest and water narratives, beliefs underlying policy)
- Web and GIS based dissemination tools, incorporating Blue and Green water integrating methodologies
- An 'Allocation Equity Guide', providing guidelines to support stakeholder negotiations
- Environment impact assessment methodologies, primarily in relation to biodiversity and water quality
- Poverty reduction impact assessment methodologies, addressing the questions: who are the winners and losers of these policies? Will the outcomes of the policy instruments benefit key poor and vulnerable groups?
- Monitoring and evaluation. The impact assessment methodologies outlined above will also provide the basis for monitoring and evaluating the socio-economic, poverty and water resource outcomes of manmade interventions
- Such a framework should be able to effect convergence of scales to encompass the interventions being made at various levels. The effective adaptation measures to climate change impacts shall only be possible through reliable simulation of the future conditions which such a common framework offers.

Linking vulnerability reduction and Carbon sink enhancement

The development of Information Systems is logical response to meet the specific information needs of the various line departments dealing with various sectors. These systems may be domain specific to certain extent for managing the sector specific information but need to have cross linkages to tackle the interdependence of these sectors.

A hydrologic information system consists of a hydrologic database coupled with tools for acquiring data to fill the database and tools for analyzing, visualizing and modeling the data contained within it. The IIT Delhi and INRM has taken an initiative in this direction and formulated a GIS portal (<http://gisserver.civil.iitd.ac.in/natcom>), for the general users, providing Web Mapping Application for accessing Hydrological Information based on the SWAT hydrological modeling and other web based interface applications. This interface also provides the outputs of the NATCOM Phase I and Phase II projects quantifying the climate change impact assessment on the river basins of Indian. This has provided a base framework that can be improved upon to cater to the information needs of the diversified users and sectors. However this serves as an example that has demonstrated that such systems are useful for serving the present needs of integration of information across the sectors and space for comprehensively tackling the issues of mitigation and adaptation.

Institutional arrangements for vulnerability reduction programmes - Forestry

Institutional and operation barriers: The State Forest Department of Haryana has highlighted several technical, institutional and operational barriers.

- No clear cut land use policy regarding the plantation on community land which competes with the agriculture against plantation under forestry needs.
- Lowering of water table needs redesigning of the forestry plantation model in forest areas and farm forestry requiring higher cost norms and enhanced investment and financial budget allocation.
- Plantation on ridges and trench serves the dual purpose of water conservation and fast growth of plants. It requires higher investment and budget is a constraint.
- Diversion of forest land for various development projects.
- Due to developmental activities forest land is transferred for non forestry purpose. Due to increasing traffic on all roads, the roads are widened diverting forest land though it remains legally forest land.
- Very meager provision of budget in the Forestry sector. The financial allocation in 2009-10 was Rs. 90.74 Crore which is very low. 5.13 Crore. Seedlings have been planted out of which 3.13 Crore. plants have been distributed free and 2 Crore. plants have been planted by the Haryana Forest Department.
- Shortage of skilled staffs for protection of forests and implementation of schemes.
- Availability of land for development as forest and growing trees.
- Research and development in identifying new species and field trial of various plantation models for agro forestry and forest land.
- Supply of large scale quality saplings from modern production facilities such as clonal plants in Mist Chamber due to lack of budgetary provisions.
- The forest land is situated along roads in the middle of the human habitation resulting in the frequent fire and damage by cattle and public who depend upon the forest trees for fodder and fuelwood.

According to GIM, a revamped State Forest Development Agency (SFDA) will act as the State Mission Directorate. SFDA will be reconstituted to ensure representation of all key interests as spelt out in the Mission organisation. The revamped SFDA would be chaired by the Chief Minister/ Forest Minister. At the district and village level, the Mission activities will be facilitated through a revamped Forest Development Agency. The planning process will be suitably linked with the District Planning Committee. At the village level, planning and implementation will be vested with the local-level institutions such as the Gram Sabha, i.e., revamped JFMCs, CFM groups, Van Panchayats, Village Council, Biodiversity Management Committees, or any new institution set up by the Gram Sabha for CFR provisions under Forest Rights Act, 2006. The institutions at village level would link to the cluster level, sub-watershed/ sub-landscape level.

Capacity building

Capacity building is a very critical segment for the success of mitigation and adaptation. The capacity building has many segments; enhancing the technical capacity of the concerned departments to handle the climate change impact assessment and adaptation capability, monitoring, awareness creation and financial management. Some of the activities under capacity building are given in the following Table.

Activity	Capacity development needed
Mainstreaming climate change in developmental programmes	• Training the Officials of State Development Departments on the steps and approaches to handle the climate change impacts on various sectors and to build scientifically the adaptations options to be considered by the policy makers and the society • Establish Centers of Excellence in Colleges/ Universities/ Institutions
Integrate climate change agenda with National Green Corps activities and District Plan activities	Train the individuals involved in these activities
Finalize state environmental policy	Strengthen Climate Change Nodal Cell
Monitoring of the mission projects	Select Research institutions and universities and train on methods and approaches on monitoring mitigation and adaptation projections
Awareness	• Train school and college teachers on climate change, impacts, adaptation and mitigation • Organize seminars, conferences and workshops on Climate Change • Create Climate Change awareness centers at National Parks, Sanctuaries, Zoo and other public places • Publicity through print and electronic media
Financing	• Create corpus of fund for climate change • Make Banks, Government Departments to seek funding from national Climate change Missions and international mechanisms on climate change

Institutional arrangements

Constitution of Climate Change Authority in State may be considered aiming, at coordination among various departments. The Authority will act as a facilitator to provide a framework for integration, planning, monitoring and assessment. While the overall programme implementation will be facilitated, supervised and monitored by the designated department. Village Committees and Eco-development Committees will have a greater role in implementation of works at field level with involvement of NGOs and other village level thematic groups like Self Help Groups under linkage with Gram Panchayats. Line departments have identified the activities to be carried out by them with assistance from their strategic partner departments like State Remote Sensing Department, Science and Technology, Krishi Vigyan Kendra.

Monitoring and Evaluation

Monitoring and evaluation (M&E) framework is to measure and assess performance of the identified key strategies. It is proposed to select Research Institutions and universities and train on methods and approaches on monitoring mitigation and adaptation projections. Line departments have their inbuilt monitoring mechanism which may take care of monitoring and evaluation once trained.

Review and Continuous Improvement

This is the first attempt at preparation of SAPCC for the state of Haryana. Limitations in terms of data, knowledge on climate change/gaps in available studies on impact and vulnerability on sensitive

sectors and the nature of arriving at approximate costs of the suggested actions were the learning experience. It is desired that this document be reviewed after 12th Five year Plan based on the monitoring and evaluation of the activities taken up during the 12th Plan and with refined, high resolution regional climate change projections.