Emission Inventory of CO_2 in Jammu and Kashmir A Sectoral Analysis






Government of Jammu & Kashmir

Department of Ecology, Environment & Remote Sensing

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EMISSION INVENTORY OF CO_2 IN JAMMU AND KASHMIR
A SECTORAL ANALYSIS

ASSESSMENT YEAR
2013-14

Emission Inventory of CO_2 in Jammu & Kashmir- A Sectoral Analysis

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J&K CLIMATE CHANGE CENTRE

DEPARTMENT OF ECOLOGY, ENVIRONMENT AND REMOTE SENSING

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FOREWORD

The past few decades have seen an unprecedented accumulation of knowledge concerning people and environment. Unfortunately, the very mass of this "information explosion" has created problems for those concerned with disseminating the material. The state of Jammu & Kashmir being data deficient needs special effort to prepare the analytical inventories. I am pleased to know that Department of Ecology, Environment & Remote Sensing has come up with a report on Emission Inventory of CO_2 in Jammu and Kashmir – A Sectoral Analysis. Until today, there were no official emissions estimates available. The available information was very inadequate.

There is a global scientific consensus with regard to the unequivocal nature of the climate change and its association with increasing concentration of greenhouse gas emissions and is now widely established. The change in climatic condition has manifested through alteration in frequency, intensity and spatial extent of weather and climate extremes. The range of hydro-meteorological events like heat waves, heavy precipitation, drought, windstorms, hailstorms, etc. have emerged as serious threats to both human and natural systems. Emission Inventory of CO_2 in Jammu and Kashmir – A Sectoral Analysis appears at a most apt time. Many questions were being raised about the quantification of GHGs in the State. This report shall definitely provide the basis for future research in this field.

I congratulate our team of scientists who have put this assessment together. I look forward to the results of the other upcoming studies of DEE&RS.

Muhammad Afzal, IAS

Suresh Chugh, IFS
Formerly Director,
Ecology, Environment & Remote Sensing,
Presently, Pr. Chief Conservator of Forests/CWLW,
Government of Jammu & Kashmir

PREAMBLE

I had been impressing upon my staff for long that in order to enable informed decision- making, we should publish updated emission estimates of our State. I am glad that our team of scientists took up this challenge and have prepared this report with emission estimates for the year 2013-14. Emissions inventory information would assists in planning, reduction in emission, so as to meet the air quality goals and tracking progress of control initiatives towards climate change mitigation.

The development of information for an emission inventory can be carried out in one of the two methods. First method is often referred to as the top-down approach. In the case of a top-down approach, generalized factors, such as, total fuel use, total population, total activity data etc. are used as indicators of emission. Emission factors are developed that predict emission per unit of a process or fuel mass or per person as such. The product of the emission factor with the relevant emissions indicator provides an estimate of emissions. These emissions can be disaggregated sector wise. In the second method, known as a bottom-up-approach, the region of interest is divided into sectors of interest and specific information is developed for each sector. This information is then used to estimate the emissions that will occur in each sector. It is with this second type of approach that a study was envisaged with the objective to develop an annual emission inventory of some selected GHGs of J&K and analyze the trends.

The results are very impressive and we have been off loading some of the carbon through our forests and afforestation efforts. But more needs to be done.

I once again appreciate the efforts put in by my team of scientists for this specialized work.

Suresh Chugh, IFS

Om Prakash Sharma, IFS
APCCF/ Director,
Ecology, Environment & Remote Sensing,
Government of Jammu & Kashmir.

PREFACE

I am pleased to introduce the publication – Emission Inventory of CO_2 in Jammu and Kashmir – A Sectoral Analysis. This report, being brought out by the Climate Change Centre, J&K under National Mission for Sustainable Himalayan Ecosystem (NMSHE), provides information on J&K's CO_2 Emissions for the year 2013-14. The warming trend over large areas of earth surface since the beginning of 20th century has brought curiosity and attention of researchers, planners and policy makers around the world. This increase in temperature and its continuing trend along with the associated impacts on natural resources have become a serious concern of the global community irrespective of developed, developing and under developed countries. All the environmental treaties have recognised that anthropogenic activities are behind climate change and that greenhouse gas emissions need to be checked to reduce its impact. Hence it is of utmost importance to mainstream the climate change mitigation and adaptation into the overall development plans of the State since Jammu and Kashmir is also facing a number of issues as a fall out of the climate change. The impacts of climate change for Jammu and Kashmir are large with extreme weather conditions, changing rainfall patterns, droughts, groundwater crisis, glacial melts, posing challenges to sustainability of agriculture and food security, energy security, water security and health security. The Jammu and Kashmir Climate Change Centre seeks to spearhead the message of Emission Inventory of CO_2 in State on different development sectors such as agriculture and food security, ecology and environment, ecosystems and biodiversity, urban planning, forestry, health, energy, water, etc.

I am sure the information will be useful for one and all, especially, stakeholder organizations shortlisted for implementing State Action Plan on Climate Change. An emission of CO_2 from different sectors is a problem that needs immediate attention at different levels. In future also efforts would be made to touch upon some of the environmental issues that are affecting the state and where there is a need for specific intervention. I congratulate J&K Climate Change Centre team and the Coordinator, NMSHE, Mr. Majid Farooq, for this pioneering effort in compiling this report despite limited availability of activity data.

Om Prakash Sharma, IFS

Climate change you must not ignore or the future might be no more.

Think Globally, Act Locally

Acknowledgements

The compilation of the Emission Inventory of CO_2 in Jammu and Kashmir – A Sectoral Analysis has been a memorable experience, which our team owes to the cooperation and support extended by officers from Industries Department, Municipal Corporations, Regional Transport Office (RTO), Indian Oil Corporation Limited (IOCL), Bharat Petroleum Corporation Limited (BPCL), Hindustan Petroleum Corporation Limited (HPCL), J&K Power Development Department, Indian Railways, and the Heads of various stakeholder department of J&K. We wish to thank all the officials involved in providing the data during the course of this assignment. A well-coordinated support from these stakeholders in sharing information was the key to the success of the whole exercise.

With great pleasure, we extend special thanks to Sh. Muhammad Afzal (IAS), Commissioner/Secretary to Govt. Department of Forest, Environment & Ecology for the constant encouragement. Our sincere thanks to Sh. Om Prakash Sharma, IFS, Director, Ecology, Environment and Remote Sensing, J&K for his encouragement, support & numerous helpful ideas. Thanks are also due to Sh. Suresh Chugh, IFS, former Director, DEE&RS for motivating us to take up the assignment.

We would also like to thank our Sr. Scientists, Mr. Humayun Rashid and Dr. Tasneem Keng, for their continuous guidance. We are grateful to The Ministry of Science & Technology, DST, Climate Change Programme (CCP), Govt. of India, New-Delhi for the funding assistance under NMSHE.

Our team appreciates the help extended by one and all who helped us in compiling the report through data collection/analysis, translation, typing, proof reading and many such similar tasks. This is the first attempt of its kind and a preliminary estimate of GHGs in the state. The team shall continuously make an effort to get the improved activity data and emission factors for more accurate and updated estimates of the state.

PROJECT TEAM
Climate Change Centre under NMSHE

It is a heartening and somewhat optimistic development that knowledgeable people throughout the world are now aware that air, water and land pollution in their various forms threaten life and well-being and that something should be done to minimize their dangers. The development of a dynamic equilibrium among population, the amenities, the supply of natural resources and the world economy is as complex as the underactive discussion by intelligent men – and women! – makes me hopeful that reasonable solutions will be found before we have exceeded the limits of the global balance that permits life as we know it. Hope this work would serve the appropriate purpose for which it is intended.

Majid Farooq
Coordinator/Pr. Investigator
Climate Change Centre under NMSHE

DOCUMENT CONTROL SHEET

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Abstract	The Climate Change Centre J&K a research cell working on vulnerability, adaptation, mitigation and impacts of climate change for the Department of Ecology, Environment and Remote Sensing J & K, filed a report on Emission Inventory of CO_2 in Jammu and Kashmir – A Sectoral Analysis in 2013-14. Inventory of Greenhouse Gases was one of the high priority action proposed in the State Action Plan on Climate Change as there is a global scientific consensus with regard to the unequivocal nature of the climate change and its association with increasing concentration of greenhouse gas emissions is widely established. The change in climatic condition has manifested through alteration in frequency, intensity and spatial extent of weather and climate extremes. The range of hydro-meteorological events include heat waves, heavy precipitation, drought, windstorms, hailstorms, etc. which have emerged as serious threats to both human and natural systems. Such climatic variability is likely to lead to extreme condition or impacts. The impacts over economy or sustainable development are severe when the intensity of the event goes beyond a critical threshold in a social, ecological, or physical system, or through interplay with any other event.

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List of Abbreviations

AGB	Above Ground Biomass
Amsl	Above Mean Sea Level
BC	Before Christ
BGB	Below Ground Biomass
CH_4	Methane
CO_2	Carbon dioxide
CPCB	Central Pollution Control Board
DEE&RS	Department Of Ecology, Environment & Remote Sensing, J&K Government
FSI	Forest Survey of India
GDP	Gross Domestic Production
GHG	Greenhouse Gas
GPG	Good Practice Guidelines
GWP	Global Warming Potential
INCCA	Indian Network for Climate Change Assessment
IPCC	Inter-governmental Panel on Climate Change
JMC	Jammu Municipal Committee
LULUF	Land-use, Land-use Change and Forestry
MAI	Mean Annual Increment
MERES	Methane Emission in Rice Ecosystem
MLD	Million Litres Daily
MSW	Municipal Solid Waste
N_2O	Nitrous Oxide
NATCOM	National Communication
NCVs	Net Calorific Values
NEERI	National Environmental Engineering Research Institute
NMSHE	National Mission for Sustainable Himalayan Ecosystem
SFR	State Forest Report
TOF	Trees Outside Forest
US	United States
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organizations

EXECUTIVE SUMMARY

Executive Summary

Energy Sector

The Electricity generation in Jammu and Kashmir is purely hydro driven. The weighted average emission factor describing the average CO_2 per unit of electricity distributed from NEWNE was used in the report which was 6.0 thousand tonnes of CO_2 per MWH for the year 2013-14. Energy sector in Jammu and Kashmir emitted 3869.24 Gg of CO_2 in 2013-14. The transport sector in Jammu and Kashmir has shown an accelerated growth in past few years. The total number of registered vehicles in the state in year 2013-14 was recorded as 10,21,086. The Transport sector contributes heavily to the total greenhouse emissions from the state. Especially, the road transport emits the 43.78% of the total emission from energy sector.

The residential sector including both urban and rural area is the second largest contributor with 30.38% of the total emission from energy sector. Industrial sector is less developed in the state and contributes only 14.66% and followed by agriculture sector (emission due to consumption of energy only) which contributes only 10.19% of total emission from energy sector. The least contribution was from the Electricity sector which is only 0.16% of total emission from energy sector.

Agriculture Sector

The emissions from Agriculture sector are mainly in the form of CH_4 and the major sources are rice paddy cultivation and enteric fermentation. Nonetheless, N_2O emissions from agriculture sector in Jammu and Kashmir are due to use of fertilizers in the agricultural fields. The total emission from agricultural sector has been estimated 6460.20 (000' tons) of CO_2 equivalent.

- **Livestock**: It is estimated that the livestock in Jammu and Kashmir emitted 187.05 (000′ tons) of CH_4 through enteric fermentation, which accounts 3928.069 (000′ tons) CO_2 eq. The Animal wastes/Dung emitted 13.566 (000′tons) of Methane and 1.524 (000′tons) of N_2O, both of these two gases account 757.328 (000′ tons) CO_2 eq.
- **Burning of Crop Residues**: Burning of crop residues in the crop field of Jammu and Kashmir emitted 44.51 (000′tons) of Methane and 1.44 (000′tons) of N_2O, both of these account total of 1399.70 (000′ tons) CO_2 eq. It has also been observed that the emissions didn't change from 2012 to 2013.
- **Agricultural Soils**: In Jammu and Kashmir emission from agricultural soils in 2013-2014 has been estimated as 0.003688 (000′ tons) of N_2O or 1.14 (000′ tons) of CO_2 eq. The agricultural soils are primarily the source of N_2O due to use of Nitrogenous fertilizers in the agricultural fields.
- **Rice Cultivation**: The total area under rice cultivation in Jammu and Kashmir during the year 2013-14 was 261.58 thousand hectares. The emission of Methane from Jammu and Kashmir rice fields for the year 2013-14 was estimated to be 17.808 Gg (1Gg = 10^9 g or thousand tons) or 373.968 (000′) tons CO_2 eq. The emission from the up land or rain-fed cultivation is zero and thus the irrigated land is the only emitter of Methane.

Land Use, Land Use Change and Forestry

The net CO_2 emissions / removal estimate shows that the sector is a net sink as the net sequestration from the sector is 8872.40 thousand tons CO_2. This sector added 1339.2 Gg CO_2 to and removed 10211.209 Gg CO_2 from the atmosphere in Jammu and Kashmir. Emission sources in LULUCF sector include Forest Land, Crop Land and Grass Lands; however, Wetlands are important but not included here because of data scarcity. In this sector major part of CO_2 is removed by Forest Land followed by Crop Land.

The total growing stock in the state of Jammu and Kashmir is 377245 thousand cubic meters. It is estimated that the total biomass production in the state is about 186976 thousand MT. The date also reiterates that the state of Jammu and Kashmir has the carbon stock of 84139 thousand MT which has the potential of sequestering 308791 thousand MT of CO_2 Equivalent

- **Forest Land**: Estimates show that the forest land has sequestered 9240 Gg CO_2 in Jammu and Kashmir. The emission from the forest land is estimated as 1319.40 Gg.
- **Crop Land**: In Jammu and Kashmir Crop Lands sequestered about 971.209 Gg CO_2.
- **Grass lands**: Include Pasture, Range Lands and meadows emit 19.8 Gg CO_2.

Wastes

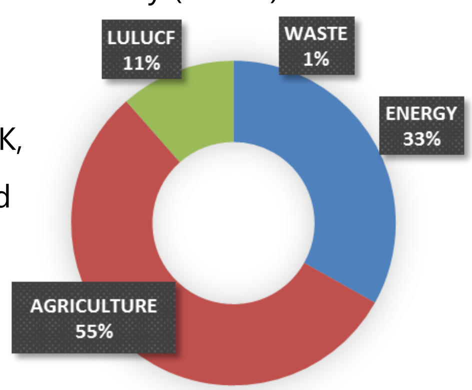
The Municipal solid wastes and waste water generation and deposition in Jammu and Kashmir emitted 0.0509 thousand tons of CH_4 which is equivalent to 1.0689 Gg CO_2 eq.

- **Municipal Solid Waste (MSW):** The generation and disposal of Municipal solid waste in Jammu and Kashmir emit approximately 0.00277 thousand tons of CH_4 or 0.05817 thousand tons CO_2 eq. The MSW is systematically disposed only in two major cities of the State and the disposal under aerobic conditions results in the emission of CH_4.
- **Waste Water**: Emissions from waste water generated from domestic sector is only considered here because of the unavailability of requisite data from industrial sector in the state. It has been estimated that the waste water from domestic sector emit 0.04813 thousand tons of CH_4 or 1.01073 thousand tons of CO_2 eq.

CO_2 Inventory in Jammu and Kashmir

The Climate Change Centre J&K, a research cell working on vulnerability, adaptation, mitigation and impacts of climate change for the Department of Ecology, Environment and Remote Sensing J & K, has prepared this report on Emission Inventory of CO_2 in Jammu and Kashmir – A Sectoral Analysis in 2013-14. Inventory of Greenhouse Gases was one of the high priority action proposed in the State Action Plan on Climate Change as there is a global scientific consensus with regard to the unequivocal nature of the climate change and its association with increasing concentration of greenhouse gas emissions is widely established. The change in climatic condition has manifested through alteration in frequency, intensity and spatial extent of weather and climate extremes. The range of hydro-meteorological events include heat waves, heavy precipitation, drought, windstorms, hailstorms, etc., have emerged as serious threats to both human and natural systems. Such climatic variability is likely to lead to extreme condition or impacts. The impacts over economy or sustainable development are severe when the intensity of the event goes beyond a critical threshold in a social, ecological, or physical system, or through interplay with any other event.

According to the large scale national assessment, Jammu & Kashmir ranking in 2012 with respect to aggregate GHG emissions in the Country was 19th. Keeping in view the scanty data sources quoted in such reports, this report takes into account the best available state level activity data and mainly focuses on emissions from different sectors such as Energy, Industry, Land-use, Land-use Change and Forestry (LULCF) and Waste at State Level.



The net Greenhouse Gas (GHG) emissions from J&K, that is emissions from Energy, Agriculture, Livestock and wastes have been calculated to be 11663.89 thousand tons of CO_2 equivalents (eq) in 2013-14. Out of this, CO_2 emissions were 5141.81 thousand tons; CH_4

emissions were 264.20 thousand tons; and N_2O emissions were 3.1410 thousand tons. The largest percentage of GHG emissions (55.38 %) is from the Agriculture sector followed by Energy, LULUCF and Waste sectors. Within the Agriculture sector, 60.80 % of total CO_2 eq were emitted from Enteric Fermentation while the manure Animal waste/Dung sector contributed to 11.72 % of the total CO_2 eq. The report also points out that for the estimation year 2013-14, LULUCF sector was a net sink. It sequestered 10211.21 thousand tons of CO_2.

Table I: Existing GHG Emissions by Sector (Transport, Buildings, Industry, Waste, Agriculture & Forests) and Sub-sectors in Jammu & Kashmir (000 tonnes)

SECTOR	CO_2 Emissions	CO_2 Removal	CH_4	N_2O	CO_2 Eq.
ENERGY					
Electricity	6.0	-	-	-	6.0
Transport					
Road	1660.4	-	0.088551	0.102944	1694.17
Railways	0.0391		0.00158	0.00032	0.17148
Aviation	32.34	-	-		32.34
Others					
Residential	1173.32	-	0.031111	0.004564	1175.39
Industrial	543.65	-	1.080708	0.002642	567.16
Agriculture	392.86	-	0.015867	0.003173	394.18
AGRICULTURE					
Enteric fermentation	-	-	187.051		3928.069
Manure Animal Waste/Dung	-	-	13.566	1.524	757.328
Rice cultivation	-	-	17.808		373.968
Agriculture Soils	-	-		0.003688	1.14
Burning of crop residue	-	-	44.51	1.5	1399.7
LULUCF					
Forestland	-	9240	-	-	
Cropland	-	971.209	-	-	
Grassland	19.8	-	-	-	19.8
Fuel wood use in forests	1319.4	-	-	-	1319.4
WASTE					
Municipal Solid waste	-	-	0.00277	-	0.05817
Domestic waste water	-	-	0.04813	-	1.01073
GRAND TOTAL	**5147.81**	**10211.21**	**264.20**	**3.1410**	**11669.89**

The Jammu and Kashmir is one of the few States in the country to join the States having conducted inventory of Green House Gases. This is the first report prepared using 2013-14 activity data.

The annual CO_2 emission of the state for the year 2013-14 is summarized as below:

Table II: Comparison of CO_2 emissions in J & K with India and world

	Annual CO_2 emissions (eq) (in thousands of metric tonnes) Giga Gram	**Percentage of Global total**
India (INCCA, 2007)	**1727706.10**	**<5% of global**
J&K	**11663.89**	**0.68% of India**

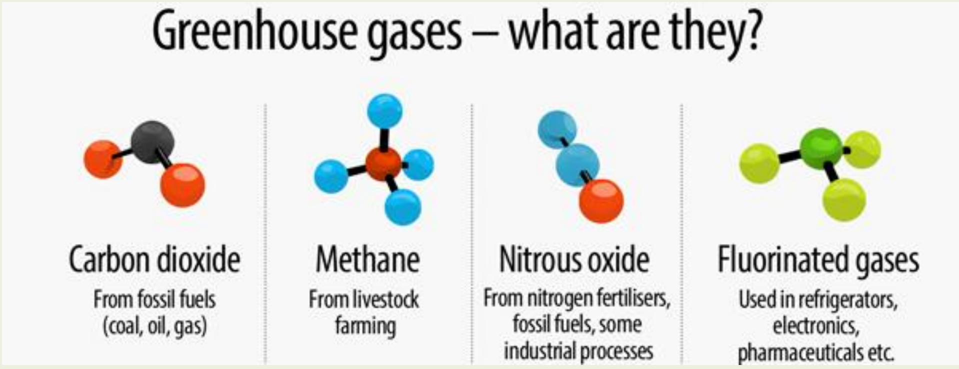
This assessment provides information on Jammu and Kashmir's emissions of Green House Gases viz., Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) emitted from anthropogenic activities at state level from: Energy; Industry; Agriculture; Waste; and Land Use Land Use Change & Forestry (LULUCF). Existing GHG emissions have been analyzed by sector and sub-sectors (viz; Transport, Buildings, Industry, Waste, Agriculture and Forest).

PER CAPITA EMISSIONS

The population in 2011 was 1.22 crore approximately. The per capita GHG emission without LULUCF is estimated to be 0.9 tons of CO_2 equivalent/capita and with LULUCF it is 0.1 tons/capita.

Did you know?

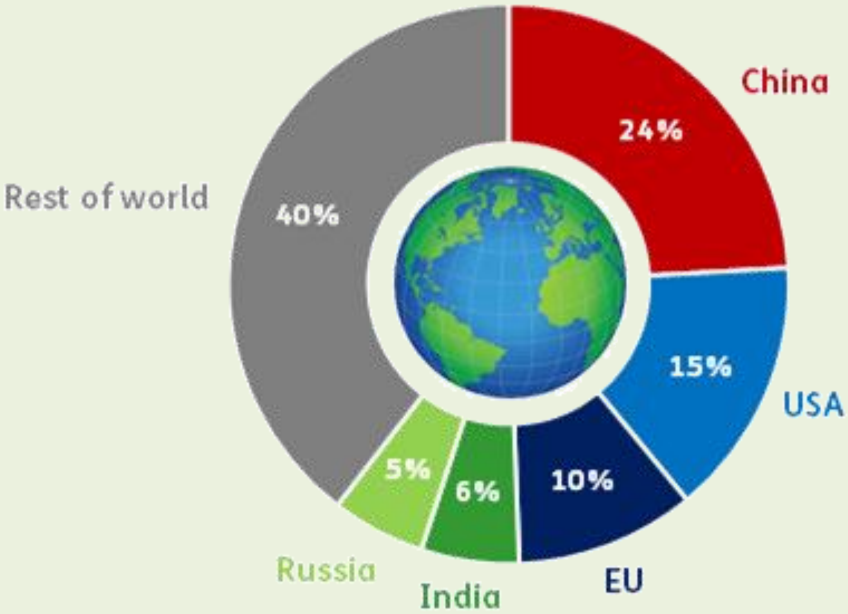
The average annual carbon dioxide emissions per person, in India is 1.6 tons
The average annual carbon dioxide emissions per person, in J&K is 0.9 tons



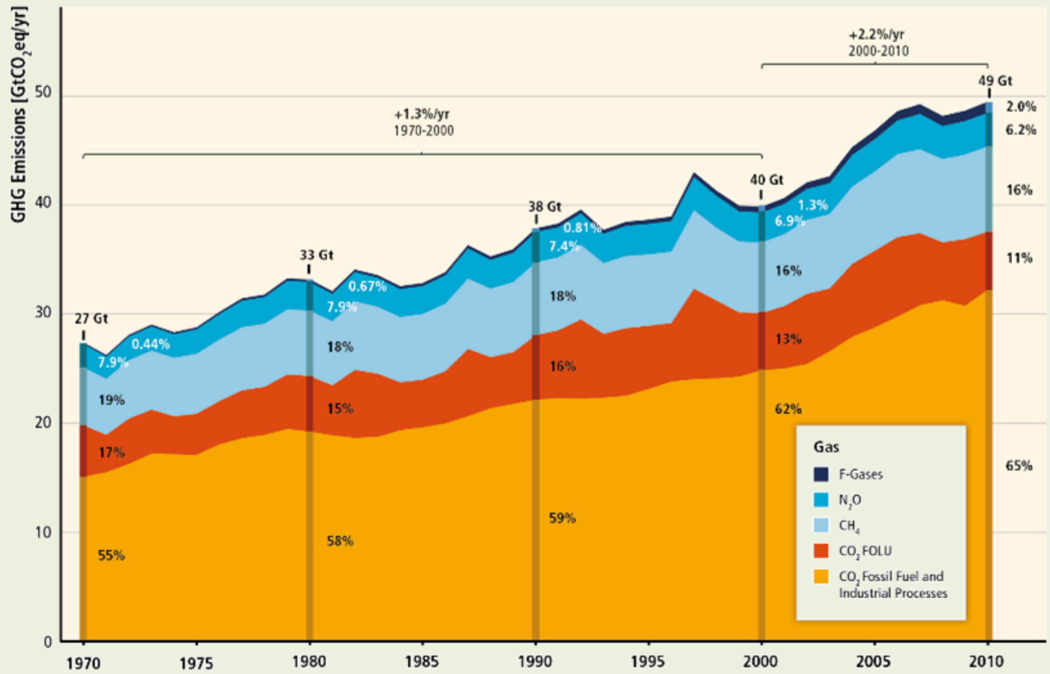
Gases that contribute to the greenhouse effect

GAS	Pre – 1750 Concentration	Current Concentration	Lifetime (years)
CO_2 (ppm)	280	400.16	~ 100-300
CH_4 (ppb)	722	1842	12
N_2O (ppb)	270	327	121
CFC-11 (ppt)	zero	236	45
CFC-12 (ppt)	zero	527	100

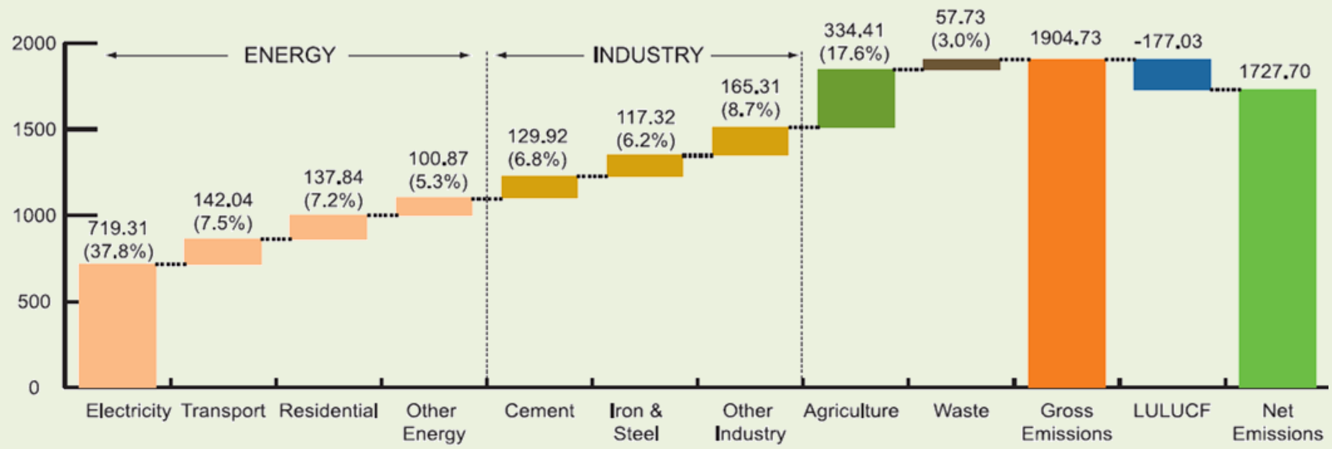
Atmospheric greenhouse gas concentrations



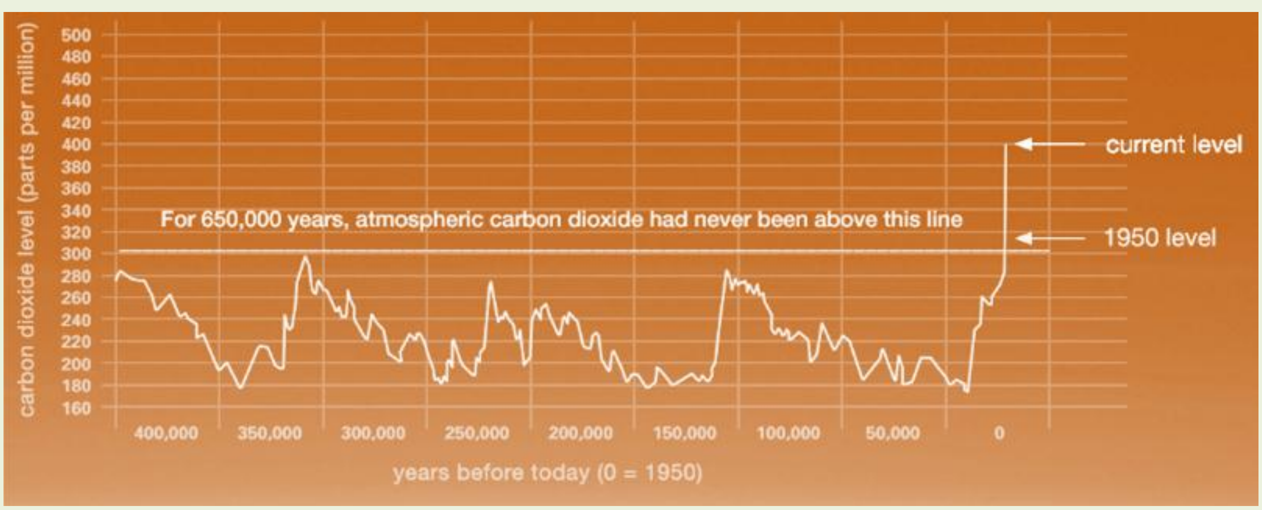
Major contributors of greenhouse gases



Total Annual GHG Emissions by Groups of Gases 1970-2010 (Source (IPCC)



GHG emissions in India by sector in million tons of CO_2 eq (Source:INCCA)



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution.

INTRODUCTION

1. Introduction

1.1 Green House Gases

Greenhouse Gases (GHGs) are gases in the atmosphere that absorb and emit radiation within the thermal infrared range. Earth's most abundant GHGs are Carbon Dioxide, Atmospheric Methane, Nitrous Oxide (NO), Ozone (O_3) and Chloro-Fluro-Carbons (CFCs). Greenhouse effect is a process by which radioactive energy leaving a planetary surface is absorbed by some atmospheric gases called greenhouse gases. The ability of the atmosphere to capture and recycle energy emitted/reflected by earth's surface is the defining characteristic of the greenhouse effect. Global warming is believed to be the result of the strengthening of greenhouse effect mostly due to anthropogenic increase of greenhouse gases in the atmosphere, mainly caused due to economic activities. CO_2 is by far the most important greenhouse gas, and originates mainly from the combustion of fossil fuels and biomass. However, other greenhouse gasses like Methane, Nitrous Oxide and Halocarbons also contribute to climate change. Methane is mainly produced by domesticated animals such as dairy cows, pigs, etc, rice growing, gas flaring and mining activities. Nitrous Oxide mainly originates from agricultural land management, animal manure management, combustion of fossil fuels, and the production of fertilizers and nitric acid.

1.2 Global Warming & Climate Change

The phenomenon of climate change is very complex and is a result of activities that alter the composition of gases in the atmosphere. Undesirable and unwanted over exploitation of our natural resources has made this more complex. The terms 'global warming' and 'climate change' are often used interchangeably, but there is a difference. Global warming is the gradual increase of the Earth's average surface temperature, due to greenhouse gases in the atmosphere, whereas Climate Change is a broader term. The latter refers to long-term changes in climatic conditions, including changes in average temperature and rainfall due to global warming.

Climate change also refers to a statistically significant variation in either the mean state of the climate or in its variability, which is attributed directly or indirectly to anthropogenic activities that alter the composition of the global atmosphere and which are in addition to natural climatic variability observed over comparable time periods. It is the result of changes in our weather patterns because of an increase in the Earth's average temperature. This is caused by increase in greenhouse gases in the Earth's atmosphere. These gases soak up the heat from the sun but instead of the heat leaving the Earth's atmosphere, some of it is trapped, thus making the Earth warmer.

Climate change emerged on the political agenda in the mid-1980s with the increasing scientific evidence of human interference in the global climate system and with growing public concern about the environment. The United Nations Environment Programme (UNEP) and the World Meteorological Organizations (WMO) established the Intergovernmental Panel on Climate Change (IPCC) in 1988 to provide policy makers with authoritative scientific information. In its first report in 1990, IPCC concluded that the growing accumulation of human made greenhouse gases in the atmosphere would "enhance the green-house effect, resulting in an additional warming of the Earth's surface" by the next century, unless measures were adopted to limit emissions.

Climate change is a global problem that requires an internationally co-ordinated solution. 189 countries are Party to the United Nations Framework Convention on Climate Change (UNFCCC). Although the Kyoto Protocol (1997) to the UNFCCC was signed by over 170 countries requiring developed countries to reduce their emissions by 5.2% below 1990 levels in the period 2008-2012 as an essential first step towards stabilizing atmospheric concentrations of greenhouse gases.

The work of the Intergovernmental Panel on Climate Change (IPCC) represents the consensus of the international scientific community on climate change science. The IPCC is the world's most reliable source of information on climate change and its causes. Despite increasing consensus on the science underpinning predictions of global climate change, doubts have been expressed from time to time about the need to mitigate the risks posed by global climate change.

There will always be some uncertainty surrounding the prediction of changes in such a complex system as the world's climate. Nevertheless, the IPCC's conclusion that it is at least 90% certain that temperatures will continue to rise, with average global surface temperature projected to increase by between 1.4 and 5.8°C above 1990 levels by 2100 is a matter of concern. This increase will be accompanied by rising sea levels, more intense precipitation events in some countries, increased risk of drought in others, and adverse effects on agriculture, health and water resources.

Concentrations of greenhouse gases are measured in parts per million (ppm), parts per billion (ppb), or parts per trillion (ppt) by volume. In other words, a concentration of 1 ppb for a given gas means there is one part of that gas in 1 billion parts of a given amount of air. For some greenhouse gases, even changes as small as a few parts per trillion can make a difference in global climate.

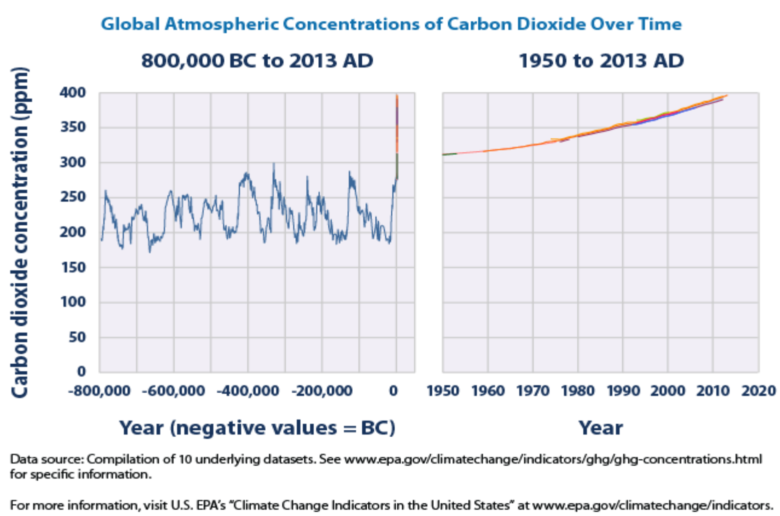


Figure 1.1: Shows concentrations of carbon dioxide in the atmosphere for hundreds of thousands of years ago to 2012. The data generated from a variety of historical ice core studies and recent air monitoring sites around the world. Each line represents a different data source, August 2013

Since the Industrial Revolution began in the late 1700s, the human race has added a significant amount of greenhouse gases into the atmosphere by burning fossil fuels, cutting down forests, and other activities (see the U.S. and Global Greenhouse Gas Emissions indicators). When greenhouse gases are emitted into the atmosphere, many remain there for long time periods ranging from a decade to many millennia. Over time, these gases are removed from the atmosphere by emission sinks, such as oceans, vegetation, or chemical reactions. Emission sinks are the opposite of emission sources, and they absorb and store emissions or cause the gases to break down. However, if these gases enter the atmosphere more quickly than they can be removed, their concentrations increase and this leads to the process of climate change.

1.3 Global– GHG Emissions by Sector

Figure 1.2 presents the estimates of collective emissions of CO_2, CH_4 and N_2O emitted as a result of anthropogenic activities from various sectors of the economy at global level from the year 1990 to 2010 expressed as Carbon Dioxide equivalent (CO_2eq). The sectors included are Energy, Industrial processes, Agriculture, Land Use Land Use Change & Forestry, Waste and international transport. The distribution of anthropogenic greenhouse gas emissions from different sectors at global level shows that the maximum percentage of greenhouse gas is from Energy sector followed by Agriculture, Land use change, Industry and Waste sector

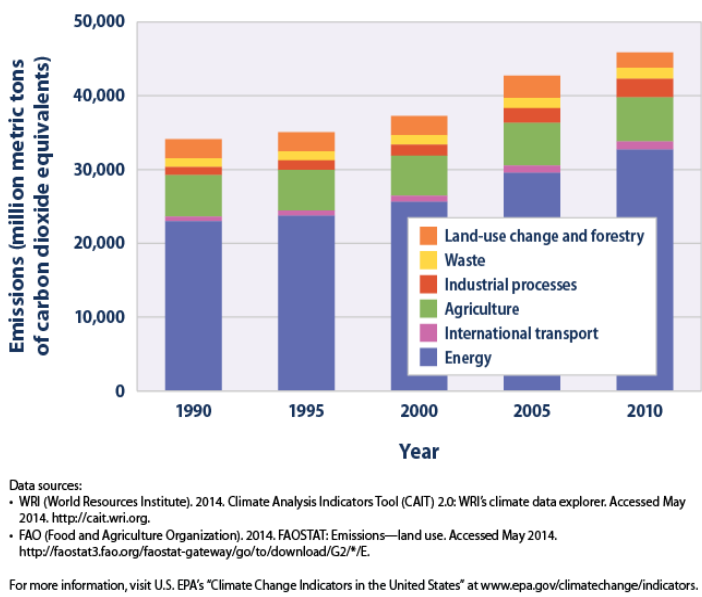


Figure 1. 2: Global Greenhouse Gas Emissions by Sector, 1990-2010

in that order, as evident from the figure 1.2. Furthermore, the emission from Energy sector is significantly increasing which contributes drastically to the total Global Greenhouse emissions.

1.4 Greenhouse Emissions - India

The Indian Network for Climate Change Assessment (INCCA), a nation-wide network of 127 research institutions working on science and impacts of climate change for the Ministry of Environment & Forests, Union of India, filed a report on India's Greenhouse Gas Emissions 2007 in May, 2010. The report was released at an INCCA meeting, which made India the first "Non-Annex I" (developing) country to publish such national estimates on global warming and climate change.

According to the report, India's ranking in 2007 w.r.t. aggregate GHG emissions in the world is 5th, behind USA, China, European Union and Russia. The report also points out that the 2007 emissions of USA and China are almost 4 times that of India. What is also highlighted in the report is that the emissions intensity of India's GDP declined by more than 30% during the period 1994-2007, which is largely attributed to the proactive efforts and policies being put in place by the Ministry of Environment & Forests, Union of India from time to time. The report mainly focuses on emissions from different sectors such as Energy, Industry, Land-use, Land-use Change and Forestry (LULUF) and Waste.

The net Greenhouse Gas (GHG) emissions from India, that is emissions with LULUCF, are reported to be 1727.71 million tons of CO_2 equivalents (eq) in 2007. Out of this, CO_2 emissions were 1221.76 million tons; CH_4 emissions were 20.56 million tons; and N_2O emissions were 0.24 million tons. The largest percentage of GHG emissions (58%) is from the Energy sector followed by Industry, Agriculture and Waste sectors in that order. Within the Energy sector, 65.4% of total CO_2 eq were emitted from electricity generation while the transport sector contributed to 12.9 % of the total CO_2 eq. The report also points out that for the estimation year 2007, LULUCF sector was a net sink. It sequestered 177.03 million tons of CO_2.

The report calculates India's per capita CO_2 eq emissions including LULUCF for the assessment year 2007 at 1.5 tons/ capita. The report is also a step further towards incorporating the 3 M's" – Measurement, Modelling and Monitoring in the essence of formulating policies on climate change.

Table 1.1: Existing GHG Emissions by Sector (Transport, Buildings, Industry, Waste, Agriculture & Forests) and Sub-sectors (Source: INCCA, 2007)

SECTORS	CO_2 emissions	CO_2 removal	CH_4	N_2O	CO_2 equivalent
GRAND TOTAL	**1497029.2**	**275358.00**	**20564.20**	**239.31**	**1727706.10**
ENERGY	**992836.30**		**4266.05**	**56.88**	**1100056.89**
Electricity generation	715829.80		8.14	10.66	719305.34
Other energy industries	33787.50		1.72	0.07	33845.32
Transport	138858.00		23.47	8.67	142038.57
Road transport	121211.00		23.00	6.00	123554.00
Railways	6109.00		0.34	2.35	6844.64
Aviation	10122.00		0.10	0.28	10210.90
Navigation	1416.00		0.13	0.04	1431.13
Residential	69427.00		2721.94	36.29	137838.49
Commercial / Institutional	1657.00		0.18	0.04	1673.18
Agriculture/ Fisheries	33277.00		1.20	1.15	33658.70
Fugitive emissions			1509.40		31697.30
INDUSTRY	**405862.90**		**14.77**	**20.56**	**412546.53**
Minerals	**130783.95**		**0.32**	**0.46**	**130933.27**
Cement production	129920.00				129920.00
Glass & ceramic production	277.82		0.32	0.46	427.14
Other uses of soda ash	586.12				586.12
Chemicals	**27888.86**		**11.14**	**17.33**	**33496.42**
Ammonia production	10056.43				10056.43
Nitric acid production				16.05	4975.50
Carbide production	119.58				119.58
Titanium dioxide production	88.04				88.04
Methanol production	266.18		0.91		285.37
Ethylene production	7072.52		9.43		7270.64
EDC & VCM production	198.91				198.91
Ethylene Oxide production	93.64		0.19		97.71
Acrylonitrile production	37.84		0.01		37.98
Carbon Black production	1155.52		0.03		1156.07
Caprolactam				1.08	336.22
Other chemical	8800.21		0.56	0.20	8873.97
Metals	**122371.43**		**0.95**	**1.11**	**122736.91**
Iron & Steel production	116958.37		0.85	1.09	117315.63
Ferroalloys production	2460.70		0.08		2462.29
Aluminum production	2728.87		0.01	0.00	2729.91
Lead production	84.13		0.00	0.01	86.38

Zinc production	76.11		0.00	0.01	77.99
Copper	63.25		0.01	0.00	64.70
Other Industries	**123969.17**		**2.37**	**1.65**	**124530.44**
Pulp and paper	5222.50		0.05	0.08	5248.35
Food processing	27625.53		1.12	0.22	27717.25
Textile and leather	1861.11		0.03	0.02	1867.94
Mining and quarrying	1460.26		0.06	0.01	1464.62
Non-specific industries	87799.77		1.11	1.32	88232.28
Non energy product use	849.49				849.49
Lubricant	776.75				776.75
Paraffin wax	72.75				72.75
AGRICULTURE			**13767.80**	**146.07**	**334405.50**
Enteric fermentation			10099.80		212095.80
Livestock Manure management			115.00	0.07	2436.70
Rice cultivation			3327.00		69867.00
Soils				140.00	43400.00
Burning of crop residue			226.00	6.00	6606.00
LULUCF	**98330.00**	**275358.00**			**-177028.00**
Forestland		67800.00			-67800.00
Cropland		207520.00			-207520.00
Grassland	10490.00				10490.00
Settlement		38.00			-38.00
Wetland	NE				NE
Other land	NO				NO
Fuel wood use in forests	87840.00				87840.00
WASTE			**2515.58**	**15.80**	**57725.18**
Municipal Solid waste			604.51		12694.71
Domestic waste water			861.07	15.80	22980.47
Industrial waste water			1050.00		22050.00
BUNKERS*	**3454**		**0.03**	**0.10**	**3484.45**
Aviation Bunkers	3326		0.02	0.09	3355.31
Marine bunkers	128		0.01	0.003	129.14

JAMMU & KASHMIR PROFILE

2. Jammu & Kashmir - Profile

The State of Jammu and Kashmir is located in the north-western extremity of India, occupying central position in the Asian Continent. Geographical expanse of the State covers an area of 2,22,236 km², which constitutes about 6.74% of the total area of the country. Of the above geographical area of the State, 78114 km² are under illegal occupation of Pakistan and 42735 km² under illegal occupation of China.

2.1 Location

The State lies between 32º 15´ to 37º 45´ N latitude and 72º 30´ to 81º 15´ E longitude. It is the northern most state of India and is bounded by China in the East, Afghanistan in the North West and Pakistan in the West. The State has great geo-political significance. Towards south are situated the states of Punjab and Himachal Pradesh. The state is approachable only from south.

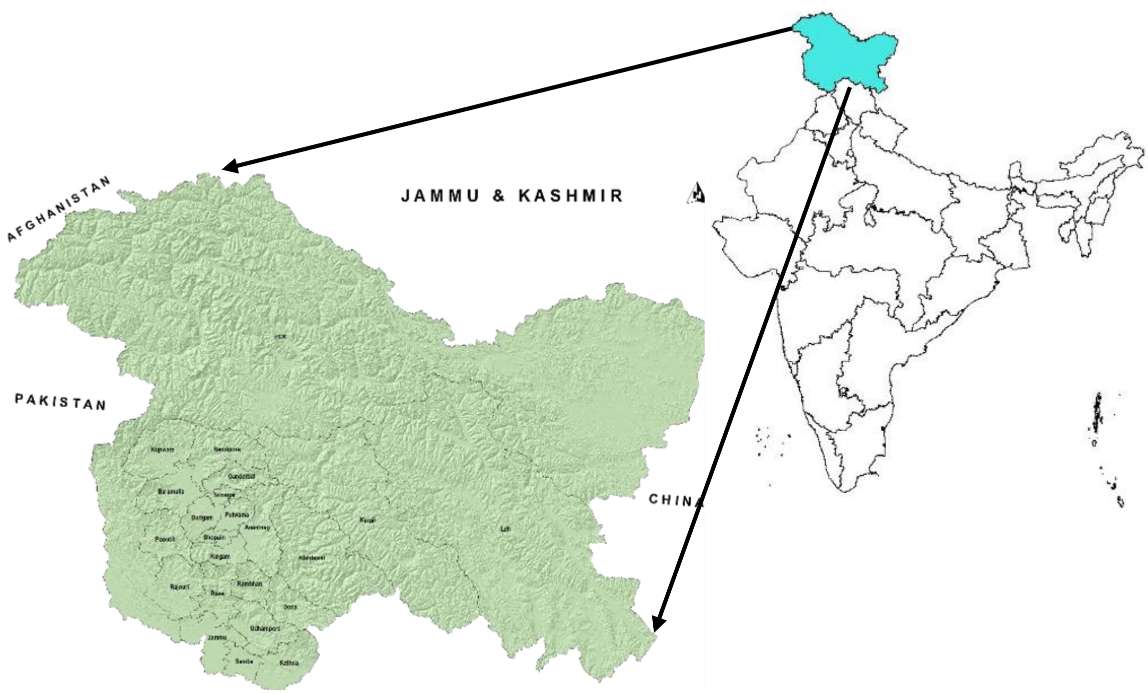


Figure 2.1: Location of Jammu & Kashmir State

2.2 Brief History

In 1846, the State of Jammu & Kashmir was founded by Maharaja Gulab Singh by merging Kashmir, Jammu, Ladakh and Gilgit areas. The recorded history of the State goes as early as 272 B.C. when Kalhana, the author of Raj Tarangni (first recorded history in India) penned down valuable accounts on various geo-political issues. Based on sound scientific evidence and historical records, it is said that Kashmir valley was a large flood basin called by the name Sati-Sar. Geologists believe that the Sati-Sar was drained due to a devastating earthquake that broke open the mountain wall at Baramulla and the water of the Satisar lake flowed out leaving behind lacustrine mud on the margins of the mountains known as Karewas. Thus, the Valley of Kashmir came into existence. Even today, the valley floor has a network of lakes and wetlands which are considered as remnants of the historical Sati-Sar. History bears eloquent testimony to the fact that in view of its strategically important geopolitical status, vast natural resources and beautiful landscape, the state came under the rule of various bonafide and non-bonafide dynasties that left many landmarks assuming the status of invaluable heritage. These monuments belong to Buddhist, Hindu and Muslim period. Whereas, the Buddhist and Hindu temples are built in stone, the Mosques and Khankaha's were built by Muslim rulers in lofty timber structures and bricks of small size. (Srinagar City Master Plan 2000-2021).

2.3 Administrative setup

The state is divided into two provinces viz. Jammu and Kashmir. The Kashmir province includes the districts of Srinagar, Ganderbal, Bandipur, Baramulla, Kupwara, Badgam, Pulwama, Shopian, Kulgam, Anantnag, Leh and Kargil. The Jammu province includes the districts of Jammu, Kathua, Samba, Udhampur, Reasi, Poonch, Rajouri, Doda, Ramban and Kishtwar.

2.4 People

The people of Kashmir valley are a fine race with well built, tall figure and fair complexion. They speak Kashmiri language. They are confined to the valley of Kashmir besides some pockets of Kishtwar, Doda, Karnah and Poonch. The people of Jammu living in the hilly tract extending from the plains of Punjab upto the middle Himalayas are known as Dogras belonging to different religions and sects. They speak Dogri language. Towards the east, in the vast stretch of Ladakh cold desert, lie the Ladakhi people who are a mixture of Mongolian and Aryan races. They are short in stature and speak Ladakhi language.

2.5 Physiography

The State has a unique topography with precipitous hills, plateau lands, plains and valleys. The physiographical divisions of the State are broadly recognized as under:

2.5.1 Outer Plains

It is a small, transverse fringe of level land in the continuation of the Punjab Plains, along the Southern border of the State. The mean height ranges between 200 m to 550 m (above mean sea level). Major part of this division falls in Jammu.

2.5.2 Shiwalik Hills

The region rises, in the form of lowly hilly and broken mounds, gradually from North-western limits of the Outer-Plains with an average height ranging from 700 m to about 1500 m. (above the mean sea level).River Chenab bifurcates the region into two flanks: eastern and western. The division covers lower reaches of Udhampur, Poonch and Rajouri districts and the upper reaches of Jammu and Kathua districts.

2.5.3 Middle Himalayas

The region is constituted of the geo-mass of Panjal-trap .The southern aspect faces of the outer plains and occupies mid and high altitudes of Poonch, Rajouri and Doda districts. The northern aspect comprises the valley of Kashmir and other Himalayan valleys of interior regions. The average height of the region varies from more than 1500m to more than 4700m (above mean sea level). This is the region of great economic importance to the state.

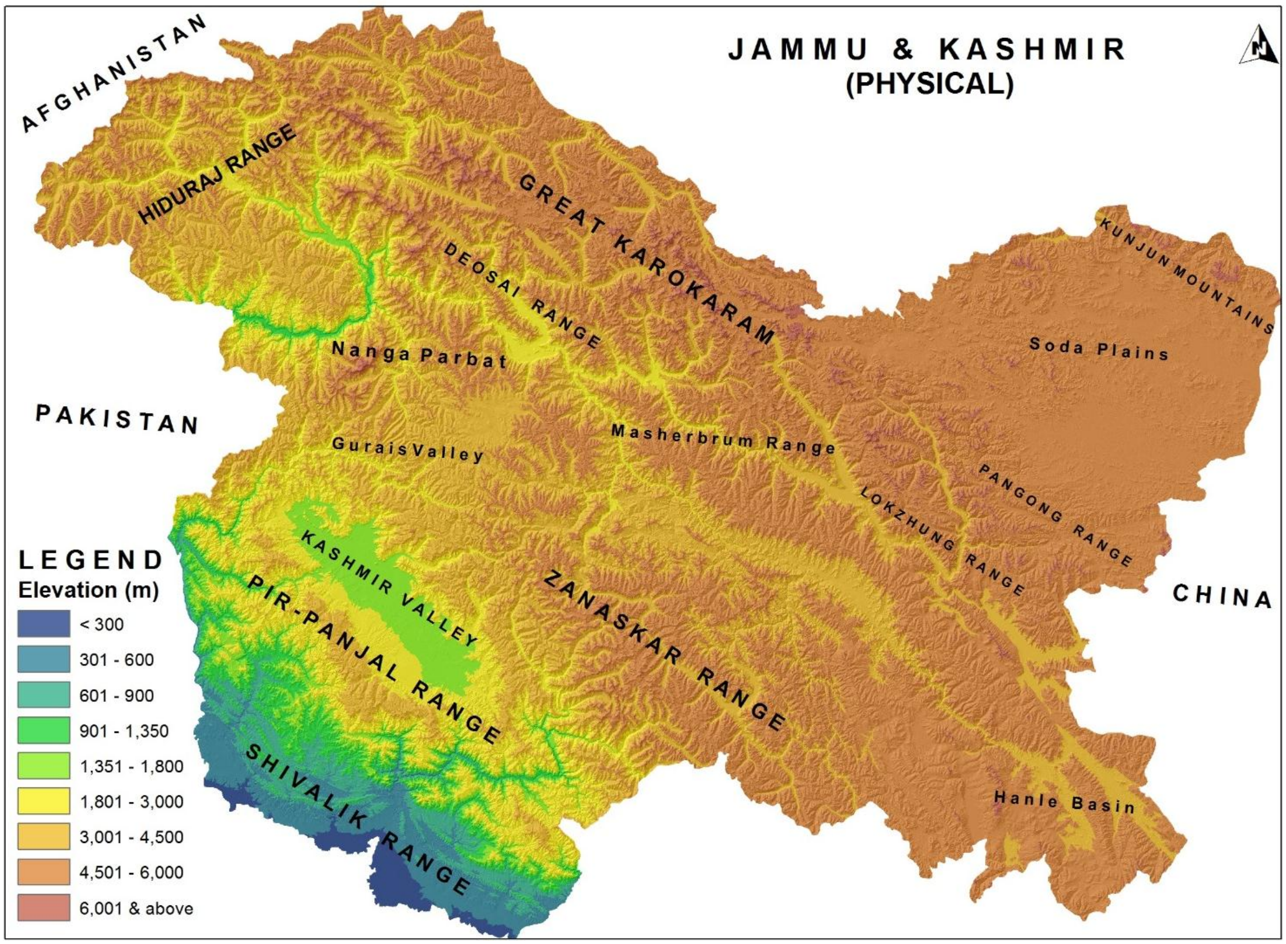
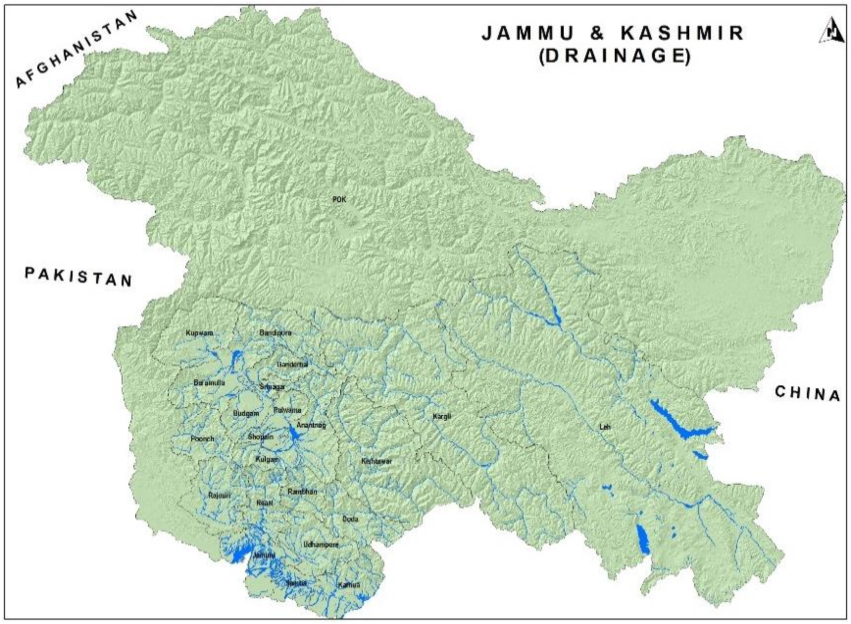


Figure 2.2: Physical map of Jammu & Kashmir State

2.5.4 Greater Himalayas

As the inner valleys of the Middle mountain region narrow down towards the north, a region of lofty elevations starts appearing with average height ranging between more than 5000m to as high as to 8600m (above mean sea level). This physiographic region alone occupies nearly 70% of the total area of the State. The region occupies Ladakh, Kargil and North-western Plateaus of Gilgit.

2.6 Drainage



The main drainage is southerly. The principal rivers are the Ravi, Ujh, Besanter and Tawi taking their source from the southerly slopes of the outer Himalayas, cut or flow along the Siwalik down to the plains below. Chenab and its tributaries, Anji and Marwa separate the outer Himalayas from PirPanjal range. Jehlum takes its source from the northerly slope of Pir Panjal and then through the entire length of Kashmir Valley enters the Wular lake and emerges out on a westerly course and separates the Pir Panjal range from the inner Himalayan ranges and finally flows down to Pakistan. The Indus drains the Ladakh District. Almost all the rivers except the Indus are harnessed for irrigation and production of hydroelectric power to some extent.

2.7 Ecology of Jammu & Kashmir

Within the Indian region, Jammu and Kashmir is, phytogeographically, one amongst most diverse. The flora has evolved through various stages during the geo-morphological evolution of this region. This region has been colonized at different times by humid tropical Malayan forms, tropical African forms, temperate and alpine north Asiatic-European forms, sclerophyllous Mediterranean forms, temperate East Asian and semi-arid Central Asian forms. The rigorous environment has further acted upon this mosaic of geographical forms leading to the extinction of species, breaking up of distribution ranges, or induction of genetic variation with or without speciation. The flora of the surrounding regions has enriched the flora of Jammu and Kashmir. Floristically, the state of Jammu and Kashmir can be divided into three regions:

Alpine desert vegetation of Ladakh is almost a treeless expanse. Due to the scarcity of precipitation the plants are generally found growing along moist river margins, or moist rock crevices. There are three main elements in the flora of Ladakh, viz. alpine, deserted and oasitic. A large proportion of the plant diversity also exists in the cultivated areas. This includes crops like barley, wheat, gram, peas, lentil, onion, potato, etc.

Temperate vegetation of Kashmir, which is the significant land cover of the valleys, is comprised of major conifers like Deodar, Blue and Chir pine, Fir and Spruce associated with temperate broadleaved system. Though the vegetation of the Kashmir valley is disturbed due to extensive cultivation of grain crops like paddy and maize, one can see extremely rich vegetation in the beds and banks of the streams and canals. The Kashmir valley abounds in lakes and swampy lagoons with distinctive hydro-phytic formations. The other Pir Panjal forests form a compact and linear strip-like area running from south-east to north-west and constitute the southern boundary of the Kashmir valley. Sub-tropical vegetation of Jammu is another category which has significant the vegetation of the Jammu region is of a dry, mixed deciduous type. During the rainy season the low-lying areas become turn into wetlands supporting a number of aquatic flora & fauna.

2.8 Climate

In view of the unique geographic position of the State of Jammu & Kashmir, it experiences a varied type of climate. There are records of weather for the last one century which reveals appreciable differences both in respect of maximum and minimum temperatures and rainfall. General prevailing weather and climate conditions of the State have micro-level variations. The factors responsible for the climate of the State are mainly latitude, altitude, terrain, distance from sea and winds. Broadly, the state of Jammu and Kashmir comprises three distinct climatic regions: cold arid desert areas of Ladakh, temperate Kashmir Valley, and the humid sub-tropical region of Jammu. In this context, Lawrence's quotation boldly stands out:

"Every hundred feet of elevation brings some new phase of climate and the vegetation, and in a short ride of thirty miles one can pass from overpowering heat to climate delightfully cool". (Lawrence, 1895)

The climate of the State is described in terms of temperature and rainfall as under:-

2.8.1 Temperature

In the outer plains and onto the lower fringes of the outer aspect of the Middle-Mountain region, the mean annual temperature average to 24.2ºC. On the basis of thermal index two broad rhymes can be differentiated in this region: Hot to very hot rhyme with mean maximum and minimum temperatures averaging to 34.5ºC and 24.3ºC, lasts for seven months from April through October. A mild to cold rhythm lasts for five months from November through March with mean maximum temperature averaging to 22ºC and mean minimum to 11.5ºC.

The mean annual temperature in the interior of the Middle Himalayas and its adjoining valleys, averages to 13.3ºC. Four temperature rhythms can be distinguished in the region on the basis of thermal index. Hot to very hot rhythm lasts for four months from June to September, with mean maximum and mean minimum temperatures averaging to 30ºC and 14.7ºC.

A very-cold rhythms lasts for three months (December through February) with mean maximum and mean minimum temperatures averaging to 6.9ºC and -2.1ºC. There are two transitional rhythms; one passing from mild to cold (October and November) and the other from cold to mild (March through May).The mean maximum and mean minimum temperatures of the former rhythm average to 20ºC to 2.5ºC and the latter rhythm to 19ºC to 2.5ºC. The temperature rhythms of the region comprising the mid and high altitude ranges of the outer aspect of the Middle-mountain region are approximately midway between those of the above two regions.

The Inner-mountain region is the coldest area of the State having mean annual temperature of 5.8ºC. On the basis of thermal index, four temperature rhythms can be differentiated: A mild rhythm with mean maximum and mean minimum temperatures averaging to 23ºC and 8ºC, lasts for four months (June through September). Severe cold persists for five months from November through March, when mean maximum and mean minimum temperatures average 3.2ºC and -9.7ºC. October, with mean maximum and mean minimum temperature 14.6ºC-0.7ºC, marks the beginning of severe cold rhythm, while April and May with mean maximum and minimum temperatures averaging to 15.3ºC and 0.95ºC marks the transition from severe-cold rhythm to mild rhythm.

In between the Middle and Inner-mountain regions lies an irregular area with mean annual temperature of 16.8ºC.The hot to very-hot rhythm in this region lasts for five months, from May through September, with mean maximum and minimum temperatures averaging to 32.5ºC and 19ºC. Cold to very cold rhythm lasts for another five months when mean maximum and minimum temperatures average to 12ºC and 3ºC. April and October constitute mild rhythms one at the beginning of hot rhythm and other at the beginning of cold rhythm.

2.8.2 Rainfall

The outer-plains region (and onto the lower reaches of Middle-Mountain region) is summer monsoon region of the State with mean annual rainfall of 1,069mm. Four rainfall seasons can be delineated, in relation to agriculture and moisture balance as (i) monsoon Season (July through September); Post-monsoon season (October through December) pre-summer season (April through June). More than 66% of mean annual rainfall is received during monsoon season. Both post-monsoon and pre-monsoon seasons receive inadequate precipitation and only pre-summer season receives a balanced quantity of rainfall. The precipitation variability index varies from 0.61 to 0.09 with average at 0.35, suggesting the occurrence of critical periods of drought throughout the region; under certain extremes crops may fail altogether or seeding may not be possible.

The mid and high altitude ranges of the outer aspect of Middle-mountain region is essentially a summer monsoon region, but the overall hydric regime is modified by winter precipitation, which comes in part as snow at higher elevations. The typical mean annual rainfall is 1,467 mm which is nearly 37% higher than the adjacent outer plains region. Post monsoon season is dry, receiving less than required amount of precipitation. A second run-off period occurs in pre-summer season, when more than 35% of precipitation can be estimated as run-off. The pre-monsoon regime is less dry than in the outer-plains. Precipitation Variability Index varies between 0.20 and 0.13 with average at 0.16, indicating less critically of drought over major areas.

The inner aspect of the Middle Himalayas is a zone of winter and spring precipitation, with mean annual rainfall of 660 mm, over most part of the area. Two seasons of rainfall distribution can be delineated. One extending from December through May, is Wet and humid, receiving more than 64% mean annual rainfall, of which an appreciable portion is received as snow. Due to low temperature regime 65% of precipitation received during this period can be regarded as surplus. However, unlike warm regions of the State, most of the surplus precipitation is stored as perpetual snow in high ranges. The remaining 35% of mean annual rainfall comes from May through November, which is a period of moisture deficiency. Precipitation variability index varies from 0.45 to 0.15, with average at 0.3, which suggests that droughts can be highly critical (Kawosa, 1988).

In the Greater Himalayas, the total rainfall is inconsequential. Of the mean annual rainfall of 83.0 mm, about 36% is received during cold rhythm from December through March, and another 32.5% is received during the mild rhythm of July and August. The remaining precipitation is distributed over seven months and is effective for crop production, except, perhaps, for the grasslands which can make efficient use of even very small quantities of moisture.

Snowfall in higher reaches is important in this region as it helps in maintaining the moisture supplies during the active season when there is very scanty rainfall. Of special importance are the cumulative snow beds at high ranges. Perpetual snow beds ranging from 2.1 meters to 5.5 meters have been reported at altitudes between 1800 meters and 3000 meters. The snow melts feed the rivers and streams and agriculture thrives in the river and stream valleys.

The Thermal Index is calculated as below

$$TI = (Tmax + Tmin)/2$$

Precipitation variability index was estimated as standardized rainfall departure

$$\sigma_i = \left[\left(N \sum_{i=1}^{N} P_i^2 - \left(\sum_{i=1}^{N} P_i \right)^2 \right) \Big/ N(N-1) \right]^{1/2}$$

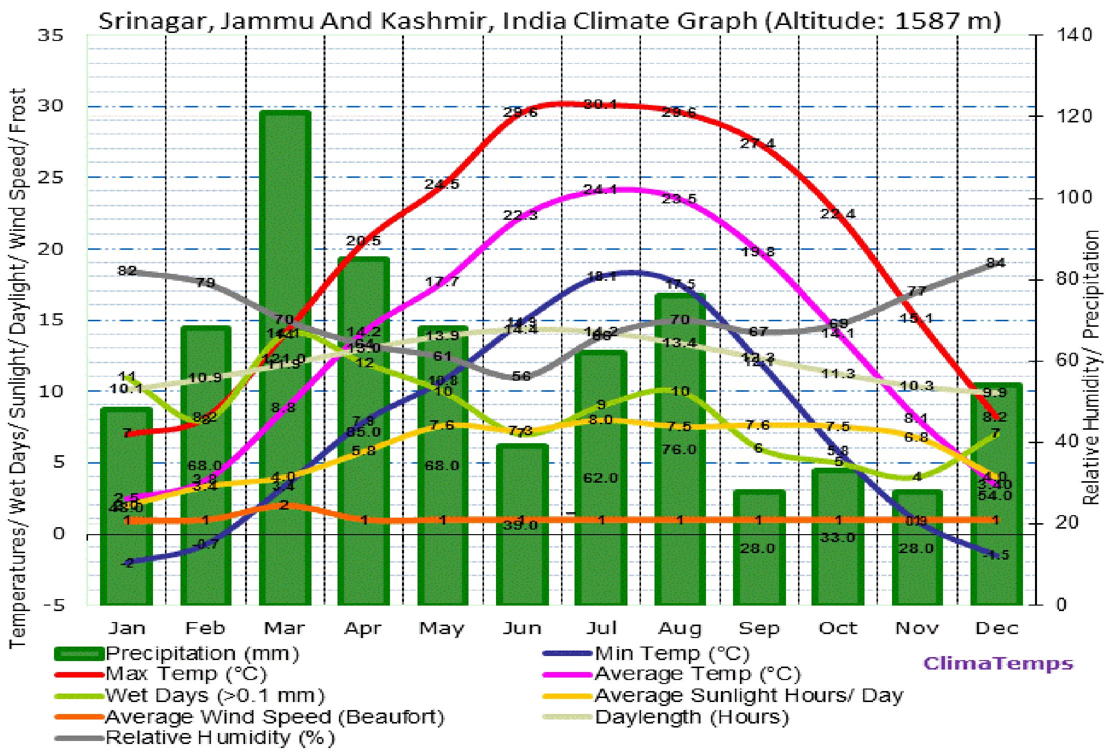


Figure 2.4: Graphical representation of different climatic parameters in Srinagar, J& K

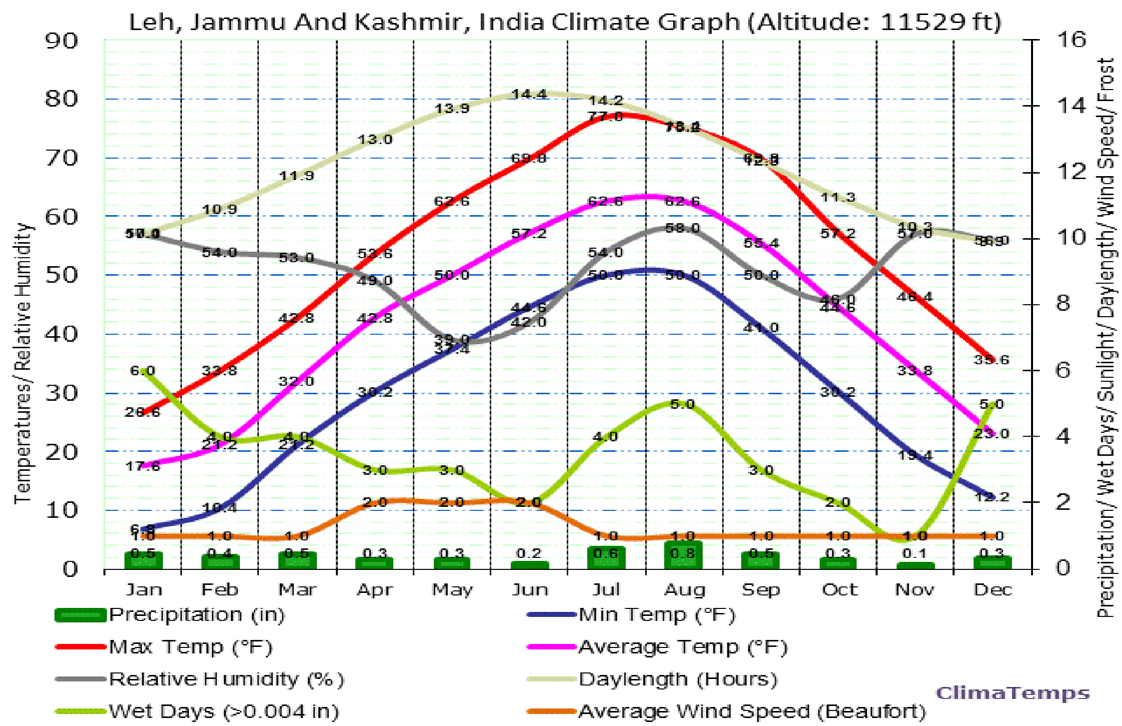


Figure 2.5: Graphical representation of different climatic parameters in Leh, J & K

2.9 Population

As per census of 2011, the population of Jammu & Kashmir has touched 1,25,48,926. According to available figures, the population of various districts is as:

Table 2.1: Provisional Population figures as per 2011 Census

S.No	Region	District	Area in 000'Sq Km	Population(2011)	Headquarters
JAMMU REGION					
1		Kathua	2,651	615711	Kathua
2		Jammu	3,079	1526406	Jammu
3		Samba	910	318611	Samba
4		Udhampur	4,550	555357	Udhampur
5		Reasi	1,700	314714	Reasi
6		Rajouri	2,630	619266	Rajouri
7		Punch	1,674	476820	Poonch
8		Doda	11,691	409576	Doda
9		Ramban	1,527	283313	Ramban
10		Kishtwar	7,737	231037	Kishtwar
KASHMIR VALLEY REGION					
11		Anantnag	3,984	1070144	Anantnag
12		Kulgam	1,067	422786	Kulgam
13		Pulwama	1,398	570060	Pulwama
14		Shupiyan	312	265960	Shupiyan
15		Badgam	1,371	735753	Badgam
16		Srinagar	2,228	1269751	Srinagar
17		Ganderbal	1,045	297003	Ganderbal
18		Bandipore	398	385099	Bandipore
19		Baramula	4,588	1015503	Baramula
20		Kupwara	2,379	875564	Kupwara
LADAKH REGION					
21		Kargil	14,036	143388	Kargil
22		Leh	82,665	147104	Leh

METHODOLOGY

Methodology Adopted For Estimation of GHGs Emission

The estimates presented here have been calculated using standard methodologies prescribed in the Recent 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC 2006), and the IPCC Good Practice Guidance for Land Use, Land-Use Change, and Forestry (IPCC 2006).

The simplest representation of the methodology used for estimating particular GHG emission from each source category is when activity data for a source category is multiplied by respective emission factor to obtain emissions from that source category for a specific gas. To calculate the total emissions of a gas from all its source categories, the emissions are summed over all source categories (Eq. No 3.1).

$$Emission_{gas} = \sum_{category} A \times EF \qquad 3.1$$

Where,

Emission $_{gas}$ is the emission of a given gas from all the categories.
A is the amount of individual source category utilized that generate emissions.
EF is the emission factor of a given gas as per type of source category.

3.1 Activity Data:

The source of activity data taken for data taken for deriving calculations is primarily taken from the published documents of different organizations in the state and studies carried out in the state by different organizations in the state and studies carried out in the state by different organizations such as J&K State Roads &Transport Corporation, Department of Economic and Statistics, J&K Power Development Corporation, Department of Forests and Department of Agriculture etc. The emission factors used in calculations have also been drawn from the INCCA Country specific references available in IPCC publications.

Following sectors have been considered in the state contributing for GHGs emissions: Energy, Industry, Agriculture, Land Use, Land Use change Forest (LULUCF) and wastes.

3.2 Emission factors:

The emission factors used in this report are a mix of default emission factors available in IPCC publications (1997, 2000, 2003 and 2006) and country specific emission factors.

3.3 Global warming potential:

Global warming potential (GWP) is an index defined as cumulative radiative forcing between the present and some chosen later time "horizon" caused by a unit mass of gas emitted now. It is used to compare the effectiveness of each GHG to trap heat in the atmosphere relative to some standard gas, by convention CO_2. The GWP for CH_4 (based on a 100-year time horizon) is 28, while that for N_2O, it is 265 when GWP value for CO_2 is taken as 1. The GWP of different treatments were calculated using the following equation (Watson *et al.*, 1996). However, GWP values were taken from IPCC Fifth Assessment Report, 2014 (AR5)

$$GWP = CO_2\,emission + CH_4\,emission \times 28 + N_2O\,emission \times 265 \qquad 3.2$$

Methodology Tiers:

Tier 1: Approach employs activity data that are relatively coarse, such as nationally or globally available estimates of deforestation rates; agricultural production statistics and global map land cover maps.

Tier 2: Use that same methodological approach as Tier 1 but applies emission factors and activity data which are defined by the country.

Tier 3: Approaches uses higher order methods are used including models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by disaggregated levels

ENERGY

4. ENERGY

Energy sector in India emits more than 1100 million tons (CO_2 eq) of GHGs yearly. Electricity generation emit approximately 65 % of the total GHG emissions from the energy sector. The transport sector contributes about 13% of the total CO_2 equivalent GHGs. Spread both in rural and urban areas the residential sector consumes both fossil fuel as well as biomass which together emit nearly 13% of the total GHG emitted from the energy sector. The other sectors like commercial and residential sector, agriculture and fisheries, the fugitive emissions from coal mining, and from extraction, transport and storage of oil and natural gas emit the rest 9 % of the total emission.

In Jammu & Kashmir, the GHG emissions from various types of fuel used in energy sector were estimated by following the IPCC revised guidelines (IPCC, 2006), and the general equation for calculating emission is given below as equation 4.1. The emission factors for calculating emission from different types of fuels are given in Table 4.1 .The emission factors given in table below are country specific derived on the basis of Net Calorific Values (NCVs) of different types of coal produced in the country, e.g. cooking coal, non-cooking and lignite (NATCOM, 2004; Choudhry et al., 2006).

$$Carbon\ Emission = \sum_{Fuel\ Type} \begin{matrix} Fuel\ consumption\ (Units)\ \times Carbon\ Emission\ factor \\ -Carbon\ Stored + fraction\ Oxidised \end{matrix} \qquad 4.1$$

The energy sector in Jammu and Kashmir emitted 3869.24 Gg of CO_2 during the year 2013-14. The transport sector emitted 44.69 % of the total GHGs, and is the largest contributor in the Energy sector. Second largest emitter of CO_2 is residential sector with 30.38 % contribution to total emission from Energy sector. The residential sector is spread both as urban and rural thus uses both fossil fuels and biomass products. About 14.66%

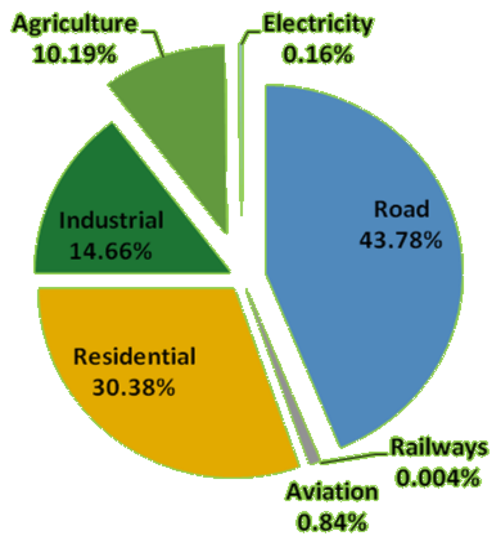


Fig. 4.1: CO_2 Emission from Energy Consumption in J&K

(567.16 Gg) of the total CO_2 equivalent emissions from the Energy sector were due to electricity consumption by Industry, Commercial, Institutions and Tourism. The emission from energy usage in agricultural sector recorded in the year 2013-14 was 10.19 % of total energy sector emission. The Energy consumption in Electricity sector emits least CO_2 among all the other sectors.

Table 4.1: NCV and CO_2 emission factors of different types of fuel used for estimation

NCV	NCV(Tj/kt)	CO_2 EF (t/Tj)
Coking Coal	24.18	93.61
Non-coking Coal	19.63	95.81
Lignite	9.69	106.15
Diesel	43	74.1
Petrol	44.3	69.3
Kerosene	43.8	71.9
Fuel Oil	40.4	77.4
Light distillates	43	74.1
LPG	47.3	63.1
Lubricants	40.2	73.3
ATF	44.1	71.5

Source: IPCC, 2006

The Electricity generation in Jammu and Kashmir is purely hydro driven. The weighted average emission factor describing the average CO_2 per unit of electricity distributed from NEWNE was used in the report which was 6.0 thousand tonnes of CO_2 per MWH for the year 2013-14. The category wise consumption of energy in Jammu and Kashmir is given in Table 4.2. Moreover, the transport sector emits 1726.51 Gg of CO_2, which is 44.69 % of the total emissions from the Energy sector out of which the contribution of road transport sub-sector was 43.78 %, rest of 0.84% was contributed from aviation. The transport sector in Jammu and Kashmir has shown an accelerated growth in past few years. The total number of registered vehicles in the state in year 2014 was recorded as 10,21,086. It has been estimated as the total emission of Greenhouse gases which include CO_2, CH_4 and N_2O from residential sector in year 2013-14 in Jammu and Kashmir was 1175.39 Gg or approximately 30.38 % of total emission from the energy sector. The industrial sector in Jammu and Kashmir is not a well grown sector, so the contribution of GHG emissions from this sector is less as compared to other sub-sectors (only above agricultural sector). The industrial sector emitted 567.16 Gg of GHG in 2013-14, which is approximately 14.66 % of total emission from the energy sector. The least emission of GHG's has been estimated from the agricultural sub-sector. The consumption of energy in agricultural sector resulted in the emission of 394.18 Gg of GHG's in year 2013-14, which is just 10.19 % of the emissions from the energy sector. Based on activity data the GHGs emission 000' tones (or Giga Gram) from Energy sector in Jammu and Kashmir is as under.

Table 4.2: Consumption Categories	Consumption
Energy Consumed by the State:	9600.85MU
a) Domestic	1431.98MU
b) Non- Domestic/Commercial	333.26MU
c) Industrial	849.53MU
d) Irrigation/Agriculture	140.67MU
e) Public Lighting	35.66MU
f) Public Waterworks	636.14MU
g) State Central Dept.	695.65MU
h) General Purpose Bulk supply	144.1MU
Fuel Consumption	
a) Diesel	589000T
b) Petrol	157000T
c) Kerosene	147000T
Transport (Vehicles registered) + Tourist Taxis.	1021086 Nos
LPG (including DBG) Approx.	150000T

Note: The emissions from Vehicles and coal consumption during winter months by Security Forces present in the state is not included in this report.

Table 4.3: GHG emissions from Energy Sector in Jammu & Kashmir

S.No	Type	GHG emission 000′ tonnes (or Giga Gram)				Percentage
		CO_2	CH_4	N_2O	GWP	
Electricity Consumption	Local Production	0	-	-	-	
	Purchased from NEWNE	6.0	-	-	**6.0**	**0.16**
Transport						
	Road	1660.4	0.088551	0.102944	**1694.17**	**43.78**
	Railways	0.0391	0.00158	0.00032	**0.17148**	**0.004**
	Aviation	32.34	-	-	**32.34**	**0.84**
Others						
	Residential	1173.32	0.031111	0.004564	**1175.39**	**30.38**
	Industrial	543.65	1.080708	0.002642	**567.16**	**14.66**
	Agriculture	392.86	0.015867	0.003173	**394.18**	**10.19**
	Total	**3802.60**	**1.217817**	**0.113643**	**3869. 41**	

AGRICULTURE & ALLIED SECTORS

5. Agriculture and Allied Sectors

Agriculture activities- the cultivation of crops and livestock for food – contribute to emissions in a variety of ways:

- Livestock, especially cattle, produce methane (CH_4) as part of the digestion process. This is called enteric fermentation and it accounts for almost one third of the emissions from the agriculture sector.
- The way in which manure from livestock is managed also contributes to CH_4 and N_2O emissions. Manure storage methods and the amount of exposure to oxygen and moisture can affect how these greenhouse gases are produced. Manure management accounts for about 15% of the total greenhouse gas emissions from the Agriculture sector in the United States.
- Smaller sources of emissions include rice cultivation, which produces CH_4 and N_2O.
- Various management practices for agricultural soils can lead to production and emission of nitrous oxide (N_2O). Different activities that can contribute to N_2O emissions from agriculture lands range from fertilizer

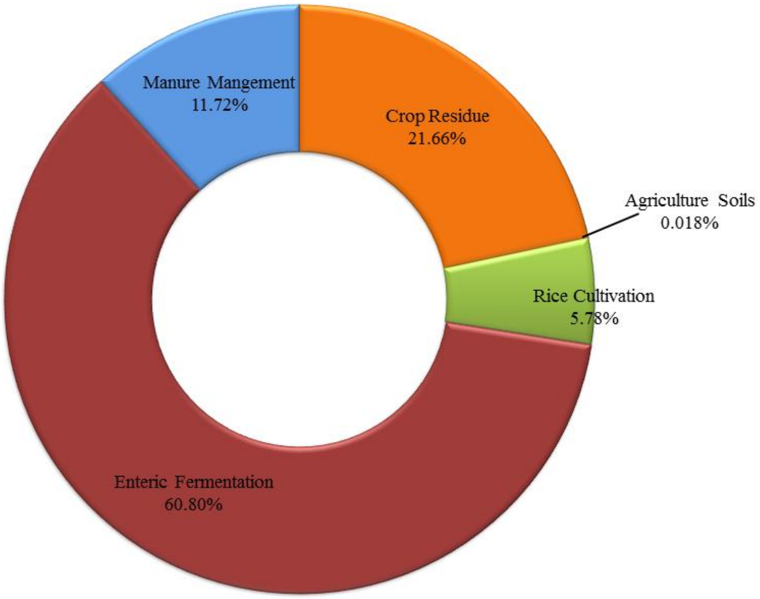


Figure 5.1: CH_4 Emissions from Agriculture Sector in J & K

application to the methods of irrigation and tillage.

- Agricultural soils contribute towards the emission of methane and nitrous oxide, the two important greenhouse gases causing global warming. Due to the diverse soil, land-use types and climate conditions, there are uncertainties in quantification of greenhouse gas emission from agriculture soils in India. For methane emission, specific emission coefficients have been used for all major rice ecosystems. In case of nitrous oxide, both direct and indirect emissions from agricultural soils have been calculated using the specified emission coefficients.

During year 2013-2014, Agriculture sector of Jammu and Kashmir emitted 6460.20 (000´ tons) of CO_2 equivalents, of which 262.93 (000´ tons) were CH_4 and 3.027 (000′ tons) were N_2O.The majority of emissions i.e., about 60.80 % were from enteric fermentation. Burning of crop residue emitted 21.67 % of the total CO_2 equivalent emissions from this sector, where as 11.72 % of the emissions were due to Livestock manure management. However, rice cultivation emitted 5.79 % of the total CO_2 equivalent emission from Agriculture and 0.018 % of the emissions were from Crop soils.

The emissions from Agriculture sector are mainly in the form of CH_4 from enteric fermentation and due to burning of crop residue. However, the N_2O emissions are due to use of fertilizers in the agricultural fields. The sources included for calculations in Jammu and Kashmir are livestock; enteric fermentation, animal manure, rice cultivation; irrigated and rain-fed, agriculture soils; direct emissions and indirect emissions, and field burning of agriculture crop residue etc.

5.1 Enteric Fermentation

In Jammu and Kashmir livestock rearing is an important activity and forms part of agricultural system. Livestock includes cattle buffaloes, sheep, goat, horses, ponies, mules, donkeys, pigs, yaks and other livestock are the major sources of methane emissions (CH_4) through their enteric fermentations. The cattle and buffaloes provide economic stability to farmers. They are main milk producing animals in the state and constitute about 42% of total livestock population. Sheep rearing is prevalent in many areas because they are easy to raise and manage, providing year-round gainful employment to the small and marginal farmers. The livestock census is carried out every 5 years. The latest census data is available for 2012. In order to estimate CH_4 emission from livestock, the cattle population has been divided into diary and non-diary categories. The emission factors provided in the report (IPCC, 2006) have been used to calculate emissions. It is estimated that the Jammu and Kashmir livestock emitted 326.5(000 tons) of CH_4 in 2013-14.

5.2 Animal waste /Dung

In Jammu and Kashmir the animal waste is mainly converted into manure. The dung management practices vary in different districts depending upon the need of fuel and manure. The dung is collected on heaps near the animal shed for converting cattle and buffalo dung in to manure. The manure thus prepared is generally taken to fields and orchards at the time of soil preparations after the rainy season or at the time of need.

A small proportion is used as dung cake for energy purposes in the rural areas. Part of the dung of cattle and buffaloes goes directly to the soil is deposited on the soil during the course of grazing. In J&K large forest areas and natural pastures are available for grazing and animals not only survive on grazing in such areas but also are allowed to graze on road side, canal bunds, fallow lands and harvested fields. The excreta of grazing animals dry up quickly due to mixing with soil during the trampling by animals and does not produce methane gas as suggested by IPCC (2006).

Table 5.1: Emissions from Enteric Fermentation and Manure Animal Waste

		Enteric Fermentation		Manure Animal waste /dung			
Livestock Category	**Population**	**CH_4**	**GWP**	**CH_4**	**N_2O**	**GWP**	**Total GWP**
Cattle	3443115	92.964	**1952.246**	6.886	0.126	183.671	**2135.91**
Buffalo	1050340	57.769	**1213.143**	5.252	0.363	222.816	**1435.95**
Yak	61910	1.672	**35.103**	0.124	0.004	3.840	**38.943**
Sheep	4127149	20.636	**433.351**	0.619	0.181	69.111	**502.462**
Goat	2068273	10.341	**217.169**	0.352	0.623	200.514	**417.683**
Horse	104982	1.890	**39.683**	0.172	0.212	69.336	**109.019**
Ponies	61935	1.115	**23.411**	0.102	0.006	3.993	**27.40**
Mules	42387	0.424	**8.901**	0.038	0.007	2.971	**11.87**
Donkey	24105	0.241	**5.062**	0.022	0.002	1.076	**6.13**
Total	**10984196**	**187.051**	**3928.069**	**13.566**	**1.524**	**757.328**	**4685.39**

Estimation of emissions from enteric fermentation and manure management are presented in table 5.1. The perusal of above data shows that enteric fermentation from livestock population in J&K emits 187.051(000´tons) of CH_4 having Global Warming Potential of 3928.069 (000′ tons). In addition manure animal waste generate 13.566(000´tons) of CH_4 and 1.524(000′tons) of N_2O. While comparing among different livestock categories, Cattle population has maximum global warming potential 2135.91(000′tons) followed by Buffalo 1435.95(000′tons) and minimum was estimated as 6.13(000′tons) for Donkeys.

The emissions from Agriculture sector are mainly in the form of CH_4 from enteric fermentation and due to burning of crop residue. However, the N_2O emissions are due to use of fertilizers in the agricultural fields. The sources included for calculations in Jammu and Kashmir are livestock; enteric fermentation, animal manure, rice cultivation; irrigated and rain-fed, agriculture soils; direct emissions and indirect emissions, and field burning of agriculture crop residue etc.

The dung of goat and sheep goes directly to the soil and farmers value this source of nitrogen (N), phosphorous (P), and potassium (K) for their soil. Normally in winters (from November to February) farmers in many parts of state invite the nomadic shepherds along with their flock after harvesting is over so that the flock can remain on the harvested field and consume the stubble and provide the nutrients from their dung and urine in the field. Traditionally shepherds are obliged with food and shelter till their flock sits on the field. The dung of other species such donkey, horses directly goes to the soil due to their daily mobility.

5.3 Rice Cultivation & Emissions from rice fields

Rice crop plays a significant role in livelihood of people of Jammu and Kashmir State. Although area under rice is very small of about 0.27 m ha, it plays an important role in the state economy. Rice productivity in the state is high (2.2 t/ha) compared to the national average productivity of about 1.9 t/ha. The total annual rice production in the state is about more than 0.59 mt. In Jammu region, the cultivation of rice extends from Jammu plains with an elevation of 200 m to the mid and high hills extending upto 2300 m altitude. In Kashmir valley the cultivation of rice extends from the area having altitude 1600m above the mean sea level to high hills 2300 m amsl. In Ladakh there is no cultivation of rice.

Rice is grown only once in a year because of extreme climatic conditions. Further, the diversity in agro-climate, coupled with farmers' preferences, give rise to wide range of grain preference from bold, coarse grains in temperate region to fine, aromatic and basmati in sub-tropical areas. Jammu region represents almost all the zones ranging from sub-tropical one to mid hills extending to high hills (high altitudes) thus constituting temperate zone. Basmati rice in sub-tropical zone of Jammu region is grown on more than 32,000 hectares of area. Basmati of Jammu region, particularly of R. S. Pura belt is world famous for its high aroma. The business from basmati rice annually fetches more than 45 crores of rupees. Thus, the cultivation of rice in this region offers a great potential for its improvement.

The CH_4 emissions from rice cultivation have been estimated by multiplying the seasonal emission factors by the annual harvested areas. The annual amount of CH_4 emitted from a given area of rice is a function of the crop duration, water regimes, and organic soil amendments. The total annual emissions are equal to the sum of the emissions from each sub-unit of harvested area using the following equation.

$$CH_{4\ Rice} = \sum \{EF_{i,j,k} \times A_{i,j,k} \times 10^{-6}\} \qquad 5.1$$

Where;

CH_4 Rice = Annual methane emissions from rice cultivation, Gg CH_4/ yr;

EF_{ijk} = A seasonal integrated emission factor for i, j and k conditions, kg CH_4/yr;

A_{ijk} = Annual harvested area of rice for i,j and k conditions, ha/yr;

I, j and k = Represent different ecosystems, water regimes and type and amount of organic amendments under which CH_4 emission from rice may vary.

Separate calculations were undertaken for each rice ecosystems (i.e., irrigated, rain-fed upland rice production).

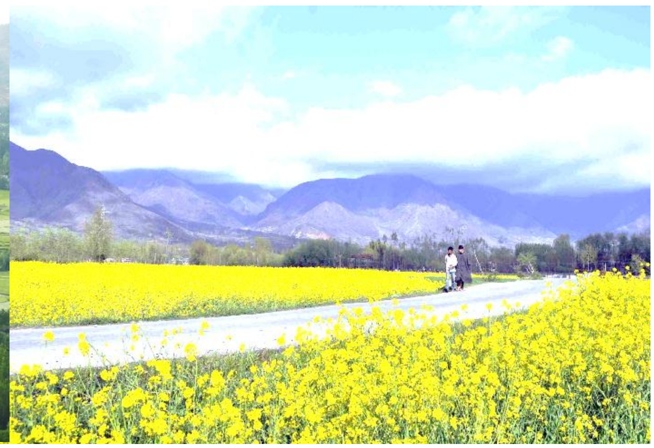
The upland rice area is 151.72 (000'ha) and is a net sink of CH_4, as no anaerobic conditions are generated at these heights.

The total harvested area of rice in India has increased from 86 Mha in 1935 to 144 Mha in 1985, which means an annual average increase of 1.05 per cent. The average annual increase was 1.23 per cent between 1959 and 1985. However, in the last few years, the rate of expansion of the total rice acreage has decreased (Minami, 1994). Metthew *et al.,* (2000a, b) developed MERES (Methane Emission in Rice Ecosystem) model for simulating CH_4 emissions from rice fields. The area under rice cultivation in the State of Jammu and Kashmir is about 261.58 (000 hectare). The rain-fed area is around 58% and irrigated area is 42% of the total cropped area. The emissions from the sector are:

Table 5.2: Emission from Rice Cultivations

Ecosystem	Rice cultivation area (000' ha)	Methane (CH_4) {000'tons}	GWP {000'tons}
Rain fed (upland only)	151.72	-	-
Irrigated	109.86	17.808	373.968

The emission of methane from Jammu and Kashmir rice fields for the Year 2013-14 was estimated to be 17.808 Gg (1Gg = 10^9g or thousand tons). The total area under rice cultivation during the year 2012-13 was 261.58 thousand hectares. Among the various rice ecosystems, the largest cultivated area of 151.72 thousand hectare was under rain-fed (upland only). The rice cultivation under irrigated area was 109.86 thousand hectare and contributed to 17.808 thousand tons of methane emission (Table 5.2). In India, rice is cultivated under various water management systems, depending on the availability of water across the geographic regions of the state. In the mountainous regions, rice is grown in terraces created along the side of the mountains.



5.4 Agriculture Soils

N_2O emissions are estimated using details of human-induced net N additions to soils [e.g., synthetic or organic fertilizers, deposited manure, crop residues, sewage sludge], or of mineralization of N in soil organic matter following drainage/ management of organic soils, or cultivation/ land-use change on mineral soils [e.g., Forest land/ Grassland/Settlements converted to Cropland]. Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification. Nitrification is the aerobic microbial oxidation of ammonium to nitrate, and denitrification is the anaerobic microbial reduction of nitrate to nitrogen gas {N_2}. Nitrous oxide is a gaseous intermediate in the reaction sequence of denitrification and a by-product of nitrification that leaks from microbial cells into the soil and ultimately into the atmosphere. One of the main controlling factors in this reaction is the availability of inorganic Nitrogen {N} in the soil.

The emissions of N_2O that result from anthropogenic N inputs or N mineralization occur through both a direct pathway and through two indirect pathways: (i) following volatizations of NH_3 and NO_x from managed soils and from fossil fuel combustion and biomass burning, and the subsequent re-deposition of these gases and their products NH_4^+ and NO_3^- to soils and waters; and (ii) after leaching and runoff of N, mainly as NO_3^- from managed soils. Therefore, total N_2O emitted from soils can be represented as:

$$N_2O - N_{Total} = N_2O - N_{Direct} + N_2O - N_{Indirect} \quad 5.2$$

Table 5.3: Emissions from Agriculture Soils

Type	GHG emissions 000, tones (or Giga Gram)		
	Methane(CH_4)	N_2O	GWP (CO_2 eq)
Agriculture Soils	-	0.003688	1.14

Using the methodology given above, during the year 2013-14 the total N_2O emissions from agriculture soils of Jammu and Kashmir are estimated to be 0.003688 (000' tons) or 1.14 (000' tons) CO_2 eq. The emission factor used for rice is 0.76 kg ha^{-1} N_2O-N for urea application.

Table 5.4:Distribution of fertilizers (in nutrients) N,P & K in Jammu & Kashmir during year 2013-14

Fertilizer	Metric tonnes
Nitrogen	65020.99
Phosphorus	29925.75
Potassium	15126.65
Total	**110073.40**

Source: Department of Agriculture, J & K Govt, 2014

The perusal of the data presented in table 5.4 shows that the 65020.99 metric tonnes of Nitrogen is distributed during the year 2013-14 for enriching the soil wealth. The emissions of N_2O that resulted from this anthropogenic Nitrogen inputs also contribute to some extent to global warming.

5.5 Burning of Crop Residues

Crop residues are burnt in the fields as per prevailing practices in many districts of the state such Anantnag, Barmulla, Kupwara, Ganderbal, Poonch, Rajouri, Kuthua producing CO, CH_4, N_2O, NO_X and SO_2 and many other gases. We have calculated only the CH_4 and N_2O emissions by using the equation given below.

$$EBCR = A \times B \times C \times D \times E \times F \quad (5.3)$$

Where,

EBCR= Emissions from residue burning
A = crop production
B = residue to crop ratio
C = Dry matter fraction
D = fraction burnt
E = fraction actually oxidised
F = emission factor

The estimation of emission of targeted species was arrived at by first estimating the amount of biomass actually burnt in the field using the IPCC revised inventory preparation guidelines (IPCC, 1996). Currently wastes from three crops viz rice, wheat and maize are subjected to burning. The state crop production figures for 2012 have been used as the basic activity data.

The dry matter fraction of crop residue is taken as 0.8 (Bhattacharya and Mitra 1998), 0.25 as fraction burned (IPCC, 1997) in field and 0.9 as fraction actually oxidised (IPCC, 1997). Crop specific values of crop fraction were as per IPCC default values. The default N/C ratios were taken from (IPCC 2006). Further the emission ratio was calculated using emission factors given by Andrea and Marlet (2001) which are default factors mentioned in (IPCC 2006) national inventory preparation guidelines.

Using this methodology, it is assumed that in J&K 44.51(000tons) of CH_4 and 1.5 (000, tons) of N_2O was emitted from burning of crop residues in the fields and no change has been observed between years 2013-14.

Table 5.5: Emissions from Crop Residues

Type	GHG emissions 000, tones (or Giga Gram)		
	Methane(CH_4)	N_2O	GWP (CO_2 eq)
Crop residues	44.51	1.5	1399.7

LAND USE, LAND USE CHANGE & FORESTRY

6. Land Use, Land Use Change & Forestry (LULUCF)

Land Use, Land Use Change and Forestry (LULUCF) are one of the key components of the Greenhouse Gas Emissions. It involves estimation of carbon stock changes, CO_2 emissions and removals and non-CO_2 GHG emissions. For estimating GHG emissions from this sector, the GHG inventory guidelines followed at National level i.e. IPCC – 2003 GPG approach were adopted.

6.1 Methodology

IPCC GPG 2003, adopted six land categories to ensure consistent and complete representation of all land categories, covering the total geographic area of a country or a State. The GPG 2003 adopted three major advances over IPCC 1996 guidelines, such as:

- Introduction of three hierarchical tiers of method that range from default data and simple equations to use country specific data.
- Land use category based approach for organizing the methodologies.
- Provides guidelines for all the 5 carbon pools.

Methods adopted in Good Practice Guidelines (GPG, 2003) are as under:

- Land category based approach covering forest land, cropland, grassland, wetland, settlement and others.
- These land categories are further sub divided into; - land remaining in the same use category differently - other land converted to this land category.
- Methods given for all carbon pools; AGB, BGB, dead organic matter and soil carbon and all non-CO_2 gases.
- Key source/sink category analysis provided for selecting significant land categories; - sub-land categories- C-pools - CO_2 and non-CO_2 gases.
- Three tier structures presented for choice of methods, Activity Data and Emission Factors.
- Biomass and soil carbon pools linked particularly in Tier 2 and Tier 3.

6.2 Estimating Carbon Stock Changes

Carbon stock change is the sum of changes in stocks of all the carbon pools in a given area over a period of time, which could be averaged to annual stock changes. A generic equation for estimating the changes in carbon stock for a given land use category is as follows:

$$\Delta C_{LUi} = \Delta C_{AB} + \Delta C_{BB} + \Delta C_{DW} + \Delta C_{Li} + \Delta C_{SC} \qquad 6.1$$

Where:

ΔC_{LUi} is the carbon stock change for a land use category, **AB** is above ground biomass, **BB** is below ground biomass, **DW** is dead wood, **Li** is litter and **SC** is the soil carbon. For the purpose of this equation the stock change has been estimated for each pool by using following method:

$$\Delta C = \frac{C_{t2} - C_{t1}}{(t_2 - t_1)} \qquad 6.2$$

ΔC is the annual carbon stock change in the pool, $\mathbf{C_{t1}}$ is Carbon Stock at time $\mathbf{t_1}$ and $\mathbf{C_{t2}}$ is the same at time $\mathbf{t_2}$ in the same pool.

6.3. Inventory Estimation

In Jammu and Kashmir GHG inventory has been prepared by taking the activity data available at National and State levels. Land use change matrix has been prepared using land use data for 2005 and 2012. The area under forest has been obtained from Forest Survey of India Report, 2013 and area under other land categories has been sourced from Directorate of Economics and Statistics, J&K Government, for the year 2013.

6.4. Land Use Change Matrix

GHG inventory is estimated for the land use category remaining in the same category as well as land use category subjected to land use change. Table below provides the land use change matrix for the inventory year 2013, based on data from Forest Survey of India (FSI, 2013). It can be observed that forest area has marginally decreased, whereas the net sown (cropped) area has increased. The grassland area has also decreased.

Table6.1: Land use pattern of Jammu & Kashmir in 2013

Land Use	Sub-Category	Area 2013 (Mha)
Forest	Very Dense Forest	0.41
	Moderately Dense Forest	0.88
	Open Forest	0.97
	Sub total	**2.26**
Cropland	Net Sown Area	0.74
	Fallow Land	0.12
	Sub total	**0.86**
Grass Land	Grazing Land and Pastures	0.1
	Scrub	0.21
	Sub total	0.31
Other Land	Other Land	18.79
GRAND TOTAL		22.22

Figure below shows the land use map of Jammu & Kashmir generated from Resourcesat Satellites for the years 2004-2005 and 2011-2012.

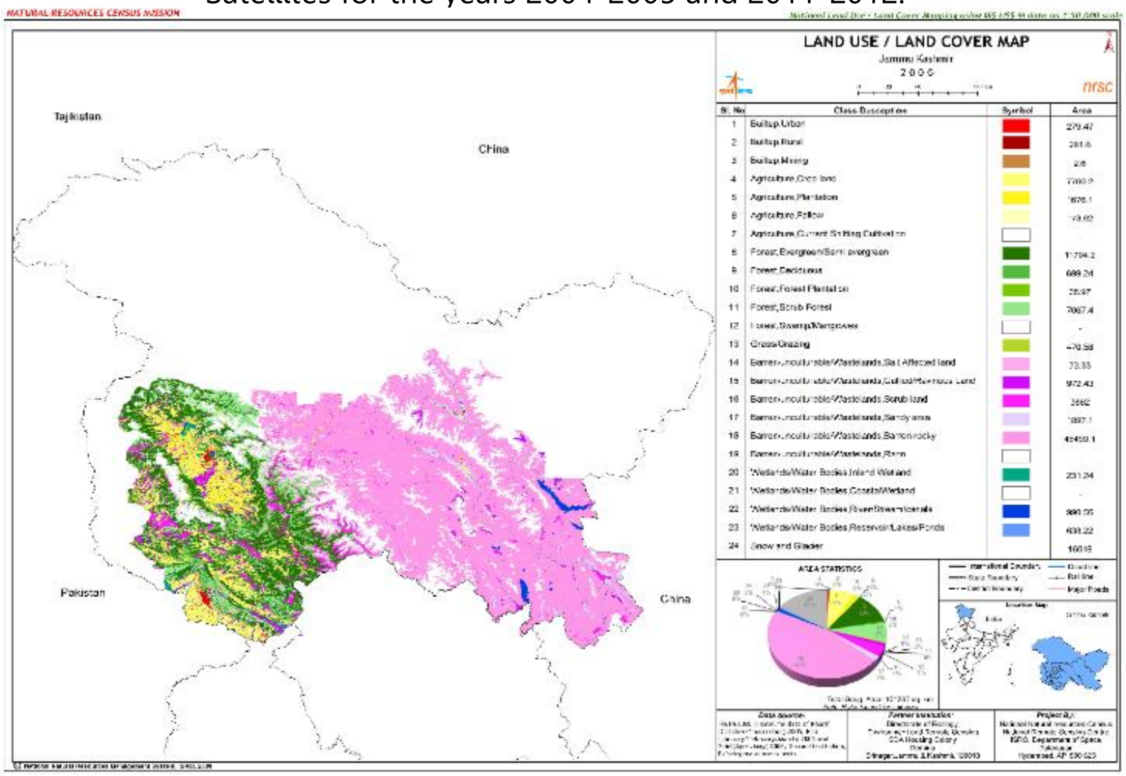


Figure 6.1: Land Use of J&K for the year 2005

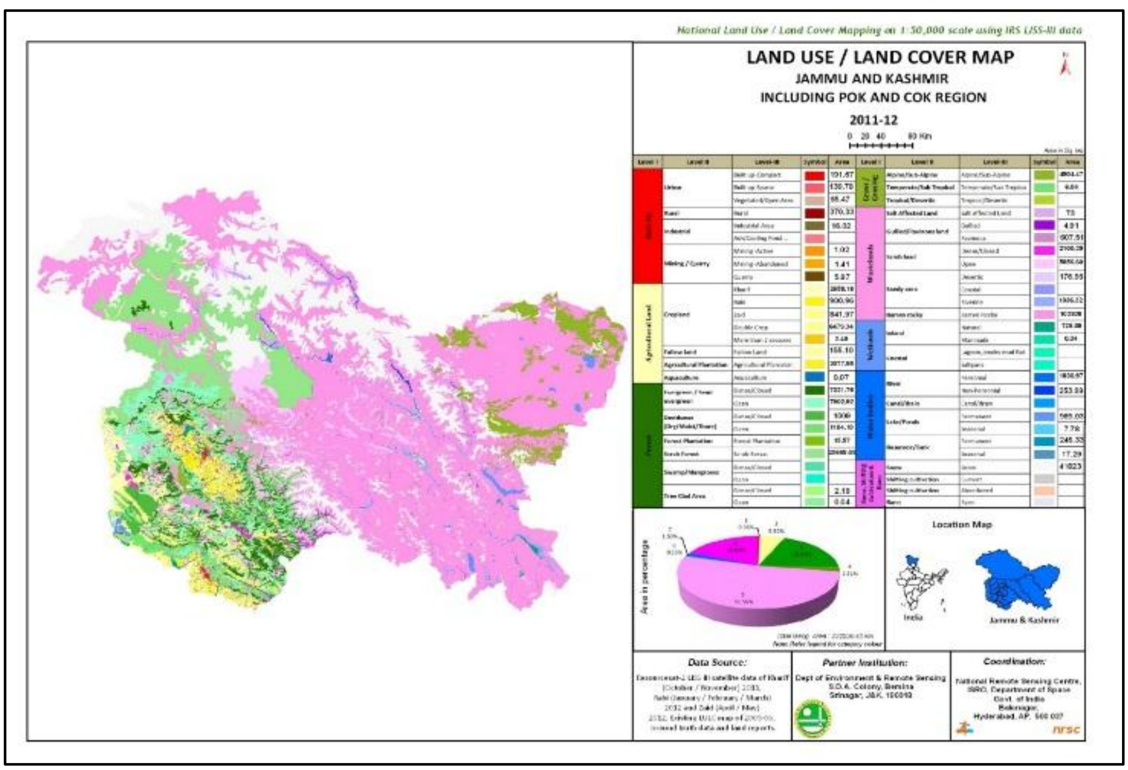


Figure 6.2: Land Use of J&K for the year 2012

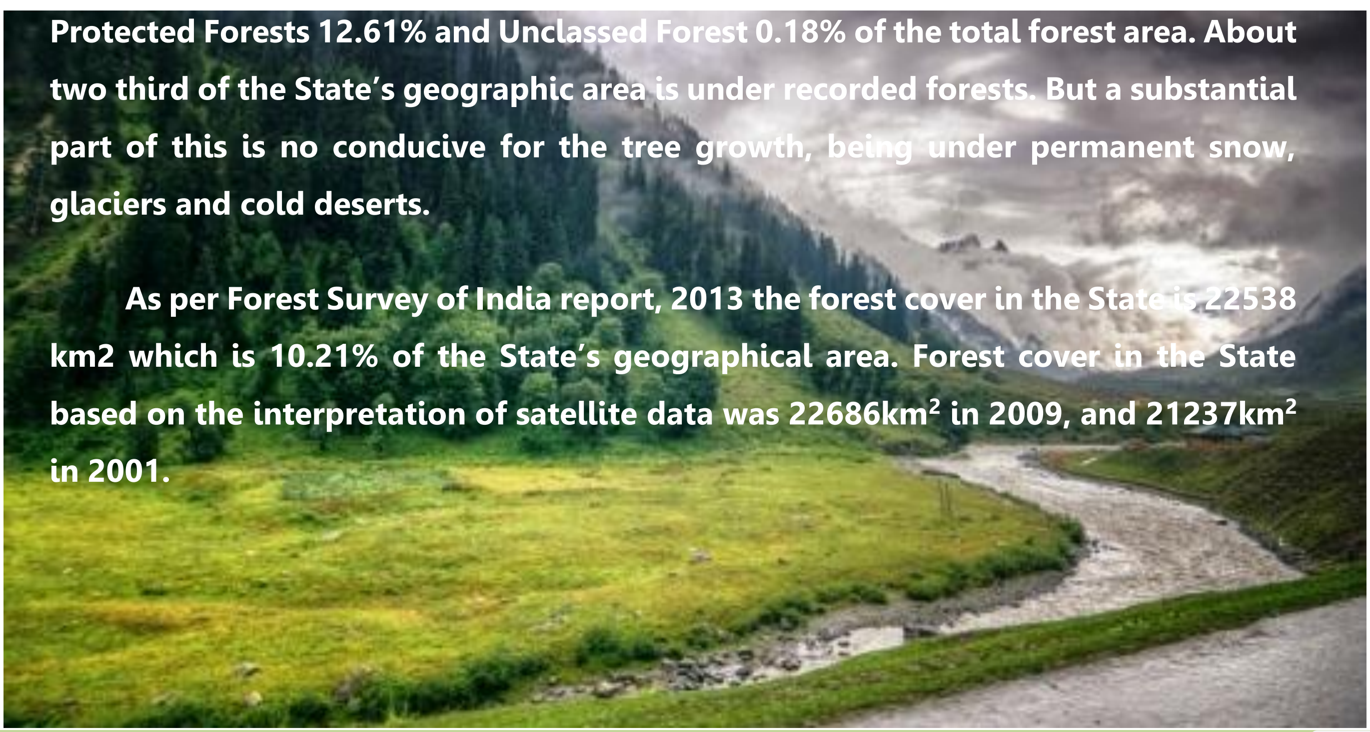
Table 6.2: Land-use change matrix for 2013 (Area in ha)

Land Use	Sub-Category	Area (ha) 2005	Area (ha) 2013	Change in area
Forest	Very Dense Forest	429800	414000	-15800
	Moderately Dense Forest	897700	876000	-21700
	Open Forest	941400	963800	22400
	Sub total	**2268900**	**2253800**	
Cropland	Net Sown Area	734000	744989	10989
	Fallow Land	98000	125556	27556
	Sub total	**832000**	**870545**	
Grass Land	Grazing Land and Pastures	127000	114239	-12761
	Scrub	204200	210500	6300
	Sub total	**331200**	**324739**	
Other Land	Other Land	18791500	18779300	-12200
GRAND TOTAL		**22.22 (Mha)**	**22.22 Mha)**	

6.5. Forests Cover

Forests are one of the most important resources of Jammu and Kashmir. The recorded forest area of the State is 20230 km^2. Reserved Forests constitute 87.21%, **Protected Forests 12.61% and Unclassed Forest 0.18% of the total forest area. About two third of the State's geographic area is under recorded forests. But a substantial part of this is no conducive for the tree growth, being under permanent snow, glaciers and cold deserts.**

As per Forest Survey of India report, 2013 the forest cover in the State is 22538 km2 which is 10.21% of the State's geographical area. Forest cover in the State based on the interpretation of satellite data was 22686km^2 in 2009, and 21237km^2 in 2001.



6.6 Forest Types

The vegetation type map prepared under Biodiversity Characterization Project, clearly showed that 36.7% of the geographical area is under vegetation/forest cover. This includes vegetation prevalent as alpine pasture, scrub and temperate/sub-tropical scrub covers, which are expressions of vegetal cover comprising of diversity. Snow and Barren land which represent extremes of land use situation, showed area extents of 13.4% and 41.2% respectively. At coarser level observations, Cold desertic/alpine vegetation occupied maximum area (20.4%) well above the extents by Phenological/mixed formations (6.9%) or gregarious vegetation (4.9%)

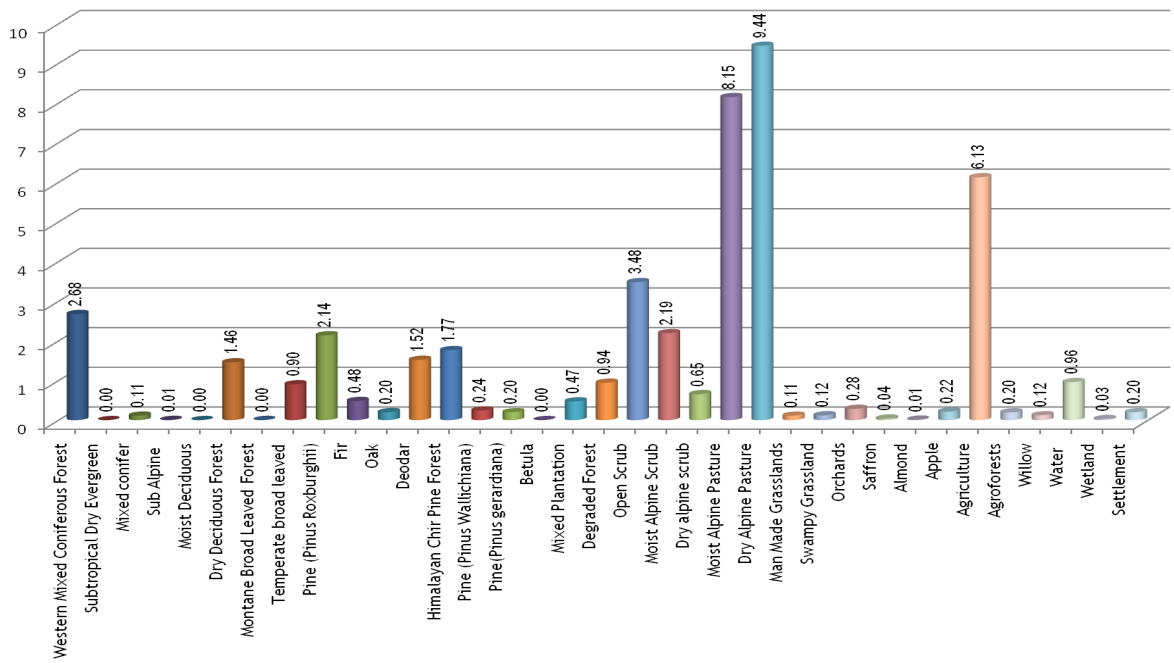


Figure 6.3: Distribution of % Vegetation and land cover in Jammu & Kashmir

Degraded system contributes 4.4% of total geographic area, whereas plantations which represent intentional efforts of cultivation cover 1.1% of the study area. Cultivated area by seasonal crops accounted for 6.5% of the area. Settlements accounted for 0.2% whereas every one square kilometer in 100 is covered by water surface. Vegetated areas show prominence of dry alpine pasture, moist alpine pasture, agriculture, and open scrub with 9.44%, 8.15%, 6.13%, 4.32%and 3.48% coverage. Western mixed coniferous forest, Himalayan Chirpine forest (mixed with broadleaved) and deodar, representative temperate forest cover of key region of valley and adjacent Jammu area showed 2.68%, 1.77% and 1.52% cover respectively.

Degraded forest covered an area of 0.94% of the total state, which corresponds to relatively open up forest canopy in otherwise continuous portions. Dry alpine scrub, characteristic of upslope and distant habitats with respect to moister regimes were found prevailing on 0.65% of the total geographic area. Moist alpine scrub covered an area of 2.19% of the total geographic area, which is the mesic counterpart of the drier type. In gregarious formation category, Blue pine stands occupied 2.14% of the total geographic area, followed by Deodar (1.52%) and Fir (0.5%), Oak (0.2%) and Chilgoza (*P. gerardiana*, 0.2%). Cover types like Sub-alpine forests, Betula stands, Moist deciduous and sub-tropical dry evergreen forests occupied less than 10 sq km area.

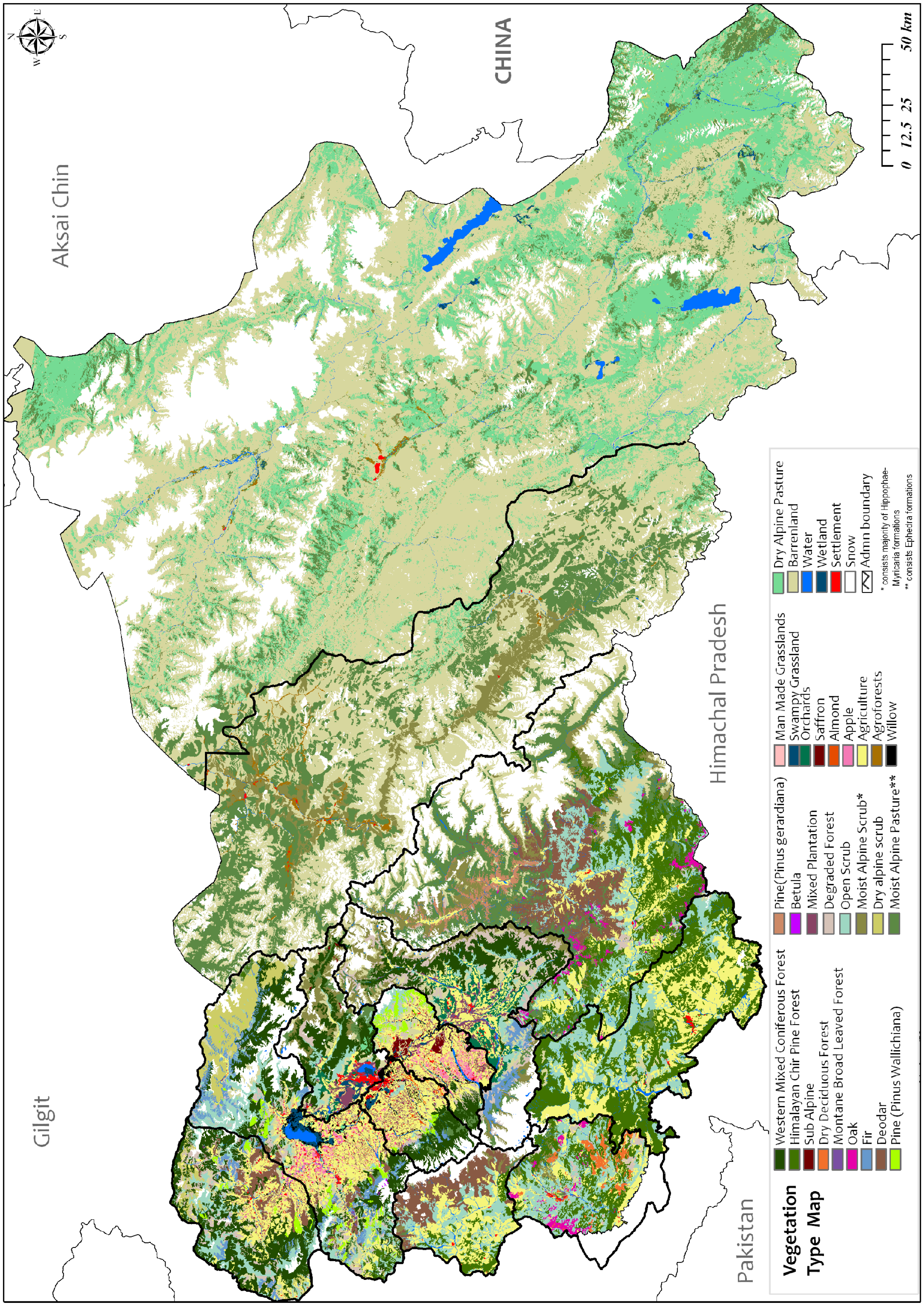


Figure 6.4: Vegetation type map of Jammu & Kashmir

6.7. Assessment of Carbon Stock from Forests

The rate of growth or change for different carbon pools for different land categories and land use change categories is obtained from literature and field measurements. The carbon stocks and rates of change values on an annual basis are likely to vary for different regions, management practices and land use systems. Very limited data is available for rates of change in different carbon pools for different land use categories. Some of the references used for this work are Puri 1950; Sekhar and Rawat, 1960; Pant, 1981; Dhand *et al.*, 2003 and Gupta *et al.*, 2003. Inventory is estimated largely using tier 2 approach using nationally available data.

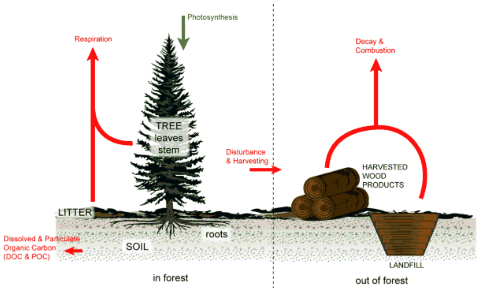


Table 6.3: Carbon stock under Forest sector (2013)

Forest Cover (km^2)	22538
Growing Stock (000m^3)	377245
Biomass (000 tons)	186976
Carbon (000tons)	84139

The carbon stock estimates combined in terms of;

- Above ground biomass
- Below ground bio mass and
- Soil Carbon.

An assessment of Growing stock, Biomass and Carbon stock of Indian forests strata wise have been made by FSI based on SFR, 2011 data base. The estimated emissions from forest sector in J&K during 2014, based on 2010 and 2013 based on stock changes is given below.

Table 6.4: Component wise carbon stock in Jammu & Kashmir				
Carbon Pools	**C Stock in Million tons 2011**	**C Stock in Million tons 2013**	**Change in C stock in million tons (2011-2013)**	**CO_2 removal in million tons during 2013**
	A	**B**	**C=(A-B)/2**	**D=C x 44/12**
Above Ground Biomass	95.08	96.09	0.505	1.85
Below Ground Biomass	25.24	26.25	0.505	1.85
Soil Carbon	112.48	115.50	1.51	5.54
Total	**232.8**	**237.84**	**2.52**	**9.24**

Net change in carbon stock of 5.04 Mt during 2011 and 2013 is divided by two years to get 2.52 Mt for the year 2013, which is further multiplied by 44/12 to convert to CO_2

The emissions and removals for biomass and soil carbon for land categories with land remaining in the same categories based on National Mean Annual Increments are:

Table 6.5: Land use categories &net carbon sequestration							
Land Use categories	**MAI in perennial aboveground biomass (t/ha/y)**	**MAI in perennial belowground biomass (t/ha/y)**	**MAI in total perennial biomass (t/ha/y)**	**MAI in soil carbon (t/ha/y)**	**MAI in total Carbon (t/ha/y)**	**Net DC (Mt C)**	**Net Change in CO_2 (Mt)**
	A	**B**	**A+B**	**C**	**D=(A+B)/2 +C**	**E= D x Area**	**F= E x 3.6666**
Crop Land	0.130	0.046	0.176	0.220	0.308	0.26488	+0.9712
Grass Land	0.003	0.001	0.004	-0.056	-0.054	-0.0054	-0.0198

Removal (-) Emission (+)
Below ground biomass was calculated as a fraction (0.26) of the total biomass: IPCC default conversion factor
MAI: Mean Annual Increment

The net CO_2 emission/ removal for LULUCF sector is given below. This includes CO_2 net emissions and removals from land categories. The net CO_2 emissions include gain and loss of CO_2. The loss of CO_2 is largely due to extraction and use of fuel wood from felling of trees which is not very significant. The net CO_2 emissions / removal estimate shows that the sector is a net sink of 8872.40 (000' tons) CO_2. The sector is a net sink due to uptake of CO_2 by forest land followed by cropland. This is a preliminary estimate and may change with improved activity data and emission factor estimates.

Table 6.6: CO_2 Emissions or Removals from different ecosystems			
Land use categories	**CO_2 emissions/ removals ($GgCO_2$)**	**CO_2 loss due to fuel wood use ($GgCO_2$)**	**Net CO_2 removal ($GgCO_2$)**
Forestland	-9240	+1319.40	-8872.409
Cropland	-971.209		
Grassland	+19.8		
TOTAL	**(-)10191.409**	**+1319.40**	**-8872.409**

Removal (-) Emission (+)

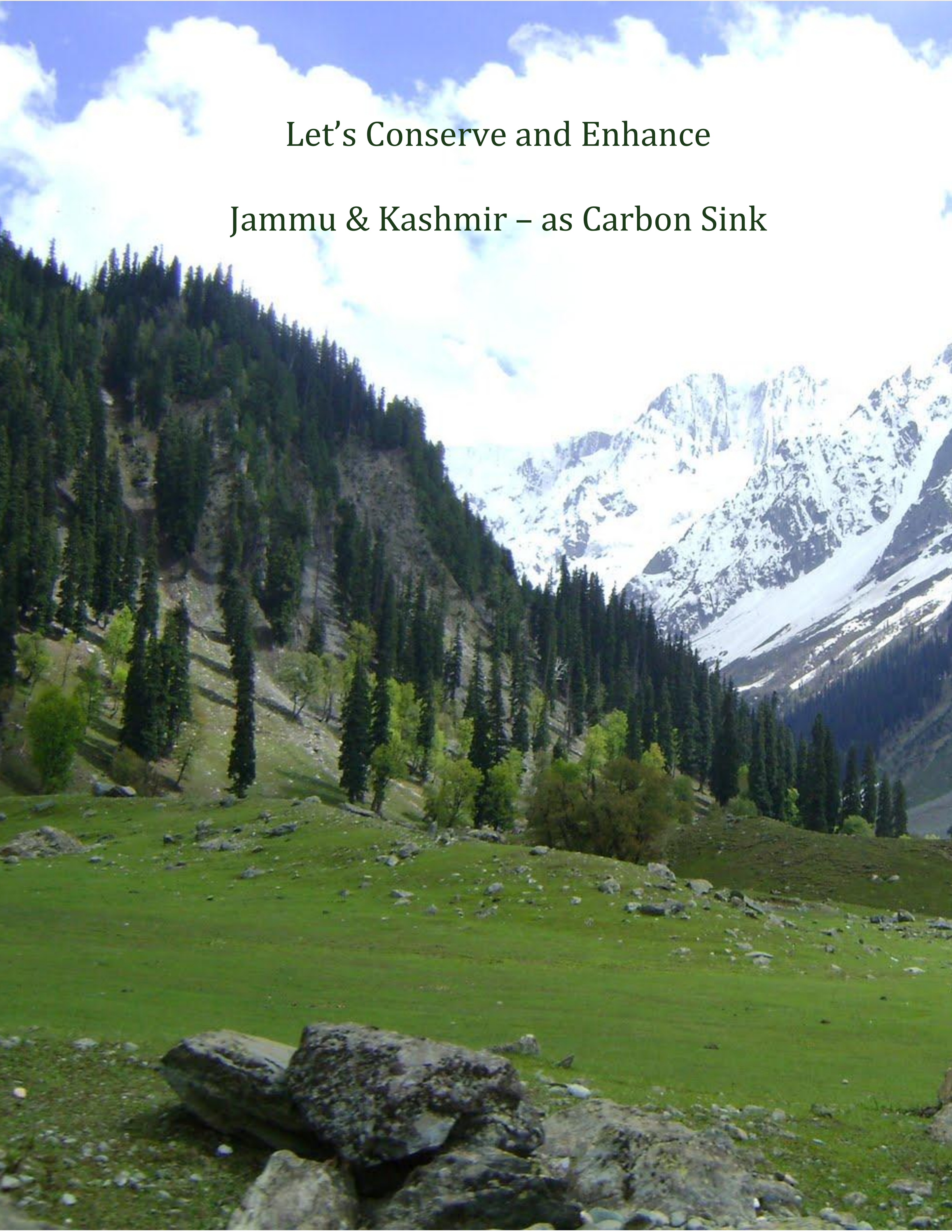
Green felling of trees is completely banned in J&K; exact source and quantification of fuel wood is also not known or researched, so it is assumed to come from all land categories. About 2-3% of the fuel wood consumption is estimated to come from felling of trees leading to net CO_2 emission.

Table 6.7: Species wise Growing stock and CO_2 sequestration potential in J & K Forests					
	Species	**Growing Stock (000'cubic meters)**	**Biomass (000'MT)**	**Carbon Stock (000'MT)**	**CO_2 Sequestration potential (000'MT)**
In Forest	Deodar	18580.0	10776.4	4849.4	17797.2
	Kail	25988.0	17412.0	7835.4	28755.9
	Fir	73766.0	37620.7	16929.3	62130.5
	Chir	14591.0	6566.0	2954.7	10843.7
	others	99256.0	56575.9	25459.2	93435.1
TOF		145064.0	58025.6	26111.5	95829.3
Total		377245.0	186976.5	84139.4	308791.7

The perusal of the data presented in above table shows the total growing stock in the state of Jammu and Kashmir is 377245 thousand cubic meters. It is estimated that the total biomass production in the state is about 186976 thousand MT. The date also reiterates that the state of Jammu and Kashmir has the carbon stock of 84139 thousand MT which has the potential of sequestering 308791 thousand MT of CO_2 Equivalent.

Let’s Conserve and Enhance

Jammu & Kashmir – as Carbon Sink

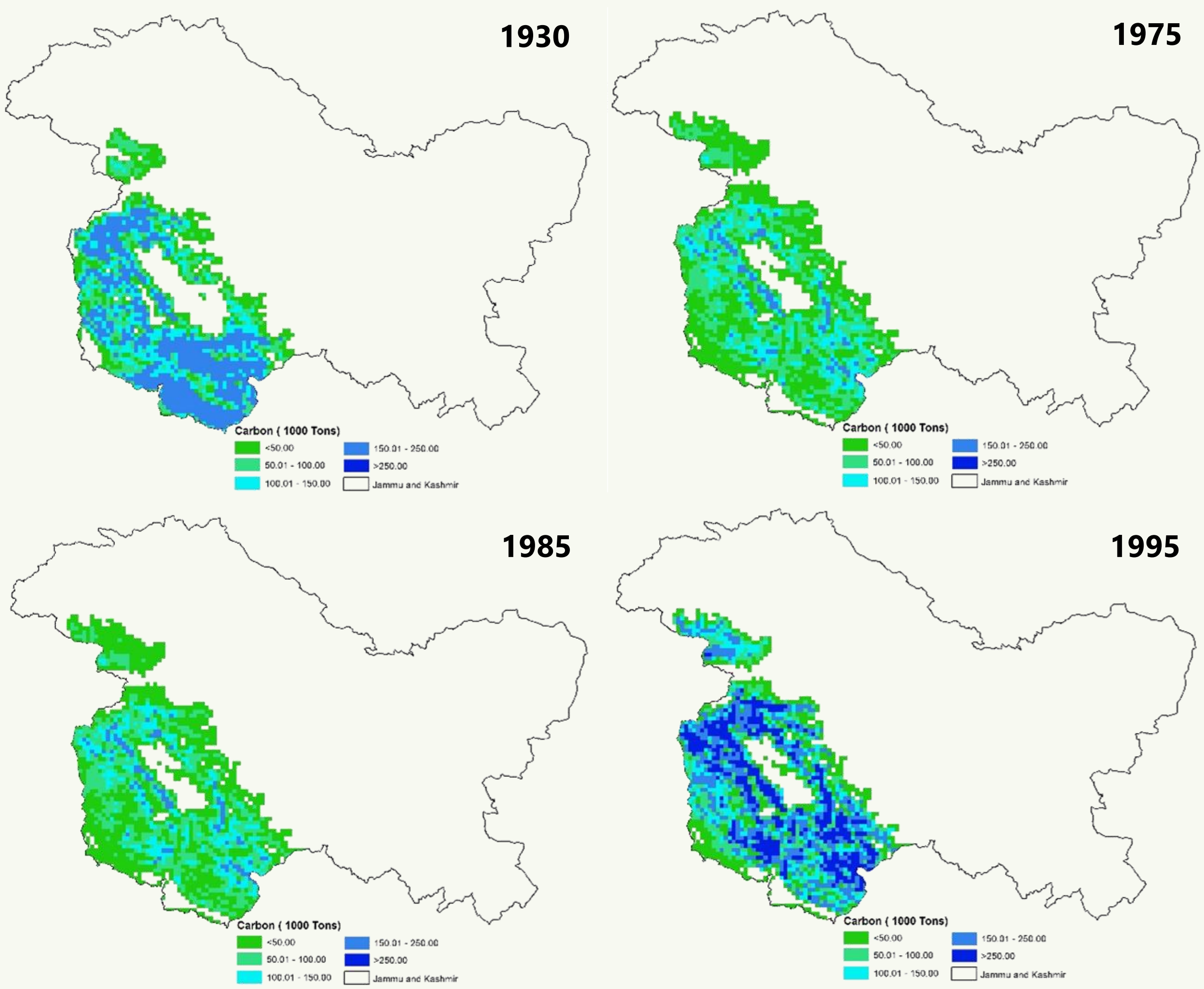


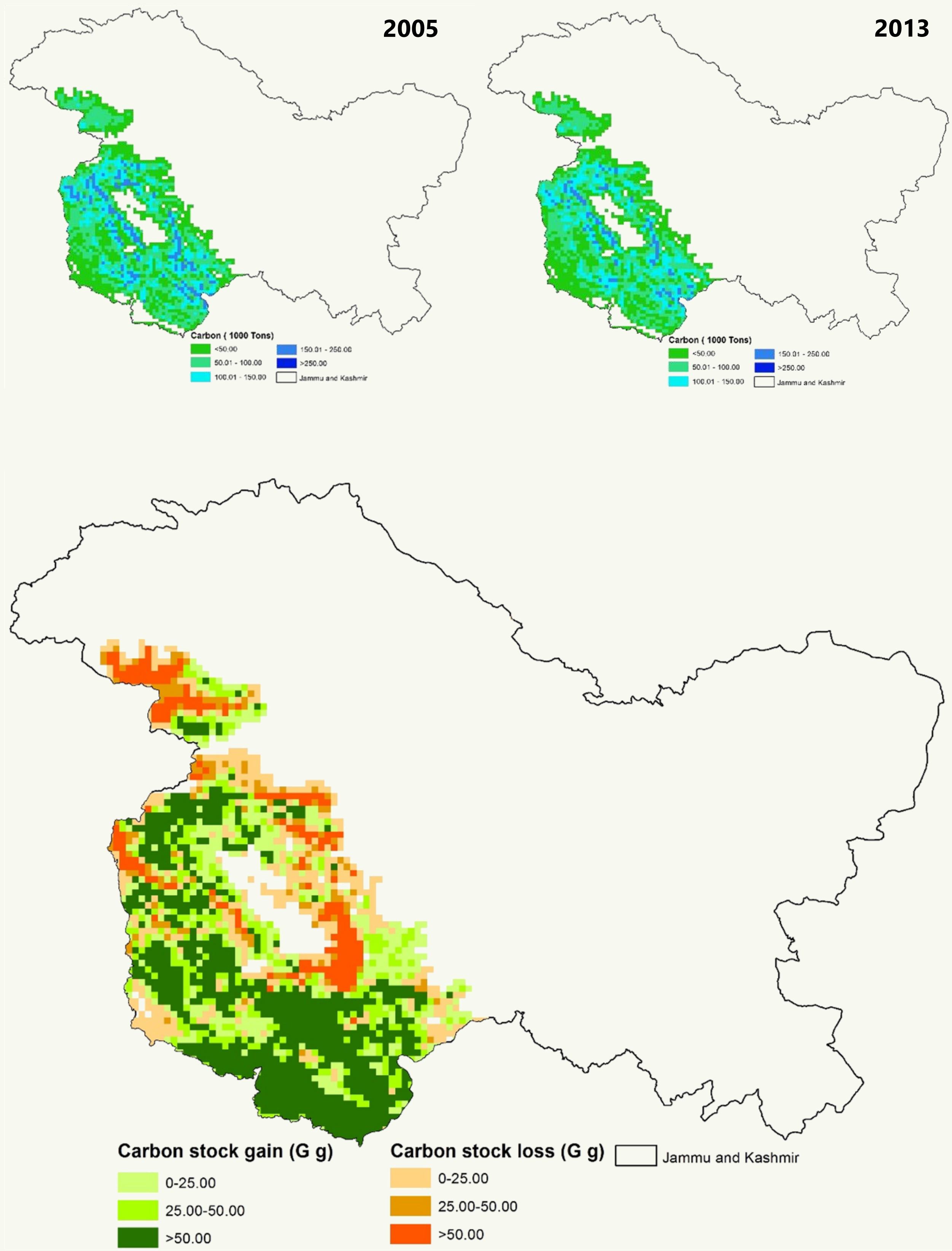
Geospatial assessment of long-term changes in carbon stocks and fluxes in forests of India (1930–2013)

C.S. Reddy et al., 2016
National Remote Sensing Centre, Indian Space Research Organization, Balanagar, Hyderabad 500 037, India

Abstract

The study has estimated spatial distribution of biomass carbon density from satellite remote sensing data, historical archives and collateral data from 1930 to 2013. The spatial forest canopy density datasets for 1930, 1975, 1985, 1995, 2005 and 2013 were analysed to obtain biomass carbon pools at 5 km grid level. The total above ground biomass carbon stock of Jammu and Kashmir Forests was calculated as 134.76 Tg C in 2013. There are 4.39 % of carbon stocks stored in the forests of Jammu & Kashmir when compared at the national level. The spatial characterization of distribution and changes in carbon stocks can provide useful information for planning and strategic management of resources and fulfilling global initiatives to conserve forest biodiversity.





Change in above ground biomass carbon stock in J&K from 1930 to 2013

SOLID WASTE AND WATER WASTE

7. Solid Waste & Waste Water

The state of J&K is part of the complex Himalayan mountain system and is located in the northern part of the Indian sub-continent and sharing international border with Pakistan, Afghanistan and China and has the most strategic location among the states in the country. It falls in the great north-western complex of the Himalayan Ranges with marked relief variation, snow-capped summits, antecedent drainage, and complex geological structure. The mountains of Jammu and Kashmir play a key role on supporting economy, which depend heavily on the water towers for hydropower, water supply, agriculture, and tourism. The State of J&K also holds significant importance in terms of biological (species) richness, biodiversity, socio-cultural diversity, and ecological-wealth. Most of the region's indigenous people consider the mountains sacred and look upon them with reverence. In essence, the mountains of J&K are both pride and necessity of the region. Irrespective of the ethereal beauty, majesty and grandeur, the ecosystem of the state is considered the most fragile on the earth. The lives and livelihood of the state are heavily dependent on the natural resources and climatic conditions. Climate change concerns in the State are multifaceted encompassing floods, droughts, landslides, human health, biodiversity, endangered species, agriculture livelihood, and food security

7.1 Municipal Solid Waste

One of the major problems being faced by cities and towns relate to management of municipal solid waste (MSW). Due to growing population, not only in the urban areas but also in rural areas, the environmental problem arising from unscientific and indiscriminate disposal of municipal garbage is a real menace for the whole society.

Municipal solid waste (MSW), also called Urban Solid Waste, and is a waste type that includes predominantly household waste (domestic waste) with sometimes the addition of commercial wastes, construction and demolition debris, sanitation residue, and waste from streets collected by a municipality within a given area. They are in either solid or semisolid form and generally exclude industrial hazardous wastes.

Enormous generation of solid wastes in developing countries like India particularly in last few decades has become a cause of concern for the civil and government agencies. In India, urban areas generate 55 million tons of MSW and most of it is disposed in landfill areas that results in the production of large quantities of methane gas. In Jammu and Kashmir total solid waste production per day is around 746.24 tons (Chouhan *et al.,* 2015).

7.2 Methodology

In this study, calculation of CH_4 emission from the solid waste is based on the yearly MSW generation data. IPCC 2000 guidelines and the methane emission factors proposed by NEERI (2005) have been used to calculate the emission of methane from the MSW.

Following equation was used to calculate the amount of degradable organic matter (DOm) present in the MSW.

$$\mathrm{DOm} = \mathrm{W} \times \mathrm{DO} \times \mathrm{DO_f} \times \mathrm{MCF} \qquad 7.1$$

Where;

DOm = mass of decomposable Organic matter deposited m Gg

W = mass of waste deposited, Gg

DO = degradable organic carbon in the year of deposition, fraction, Gg C/Gg waste

DO_f = fraction of DO that can decompose (Fraction)

MCF = CH_4 correction factor for aerobic decomposition in the year of deposition (fraction)

Methane generated in a year from the MSW has been calculated using the following equation:

$$CH_4 = DOm \times F \times \frac{16}{12} \quad 7.2$$

Where;

F = Fraction of CH_4 by volume

16/12 = molecular weight ratio, CH_4/C

Methane emitted has been calculated by:

$$CH_4 = \left(\sum CH_4\, generated - RT_y\right) \times \left(1 - OX_y\right) \quad 7.3$$

Where;

RT = recovered CH_4 in year Y, Gg

OX_y = Oxidation factor in year Y, (Fraction)

Default factors used for calculation of GHG emissions from MSW in J&K State (after IPCC)	
Methane correction factor	0.4
Factor for degradable organic carbon that decomposes (DOf)	0.5
Fraction of methane in landfill gas	0.5
Recovered methane	0
Oxidation factor	0
Factor for degradable organic carbon fraction in waste disposed (DO)	0.11

7.3 Srinagar City

Srinagar city with population 1273312, alone generates 407.84 tons of solid waste per day with 271gms per capita per day production (Wani and Ahmad, 2013). The open space Landfill site at Syedapora Achan is 6 kms from the city centre. The area of this dumping site is 34 hectares and is functional since 1987. The waste from city is collected at 519 collection points is being transported to this dumping site through Municipality Transport Vehicles (Table 7.1).

Table 7.1: Type of Collection Points in Srinagar City

S. No	Type of Vehicle	Existing Number
1	Mini Truck.	5
2	Truck-Tipper.	24
3	Hook Trailer (transfer station)	--
4	1. Refuse Collector 2. Refuse Collector Bins.	1 20
5	1. Dumper Placer vehicle. 2. Dumper Bins.	12 110
6	Tricycle	20
7	Hand Carts	500
8	Wheel Barrows	1000
9	Containerized handcarts	--
10	Front-End-Loader	20

11	TATA ACE for door-to-door collection of waste	-
12	Road Sweeping Machines	--
13	Compactors for dumping site.	1
14	Snow clearance Dozer (MiniDozer compatible to clear snow in lanes and by lanes).	--

Source: Khan (2014)

Table 7.2: Waste collections points and capacity holding			
Waste Collection Point Type	**Capacity of Waste Holding**	**Total No.**	**Distribution**
Dumper bins/containers	2 metric tons	112	Such bins can are mainly found along roads around hotels, shopping complexes, main market, old city etc
Garbage sheds	5-7 metric tons	7	Mainly located in city core (CBD)
Open collection points	variable	400	They spread throughout the city along roads, streets and open urban land patches
	Total	**519**	

Source: Wani and Ahmad (2013)

Table 7.3: Estimation of CH_4 emissions from MSW disposal in Srinagar City	
Component	Quantity
Population of Srinagar	1273312
MSW generated per capita/day	271 gms
Waste generation from Srinagar	370 metric tons/day
Quantity of waste to Landfill	220 metric tons/day
DO_m decomposed	1.76 tons
Estimated CH_4	1.17 tons

7.4 Jammu City

Jammu city, the winter capital of Jammu and Kashmir is spread over of 112 km^2 and the population is around 502197. The Jammu Municipal Corporation comprises of 71 wards, 3 zones and 2 divisions for accomplishing various activities. The total MSW generated in the Jammu city is around 368 MT/day(JMC), and the per capita/day generation rate is 450 gms (*Daily Excelisor, 2014*). There are 453 collection points in the Jammu city and around 300 MT/day of waste from the city is collected by a good number of *Safiakaramcharies* who bring the waste to these collection points, where from it is transported by 118 vehicles (owned by JMC) to dumping site at Bhagwati Nagar (Area 0.6 km^2).

Table 7.4:Types of collection points in Jammu city		
Bins	**Specification**	**Existing Numbers**
RC Bins (Blue Bin)	1 cubic meter Capacity	60
Dumper Placer bins (Yellow/Green Bins)	4.5 CMt. Capacity	340
Open Storage Sheds (Collection Points)	Not recommended being unscientific.	53
Total Collection points in the City		**453**

Source: Jammu Municipal Corporation

The CH_4 emission from the MSW generated in Jammu city has been calculated using the methodology adapted from IPCC (2006) report.

Table 7.5: Estimation of CH_4 emissions from MSW disposal in Jammu City	
Component	**Quantity**
Population of Jammu City	502197
MSW generated per capita/day	450gms
Waste generation from Jammu	368 metric tons/day (approx.)
Quantity of waste to Landfill	300 metric tons/day(approx.)
DOm decomposed	2.40 tons
Estimated CH_4	1.60 tons

7.5 Waste Water

Emission of CH_4 from all the sources needs to be quantified to formulate the strategies to reduce the emission rate of CH_4 into the atmosphere. Globally, methane emission from the urban sources is approximately 30-60 Tg (Socolow, 1997)Methane is the primary greenhouse gas emitted from the waste waters and accounts 5% of total global emissions (IPCC, 2007). In India, domestic waste water is the dominant source of CH_4 and account 40% of the total CO_2 equivalent emissions from the waste sector (INCCA, 2010)

7.6 Methodology

CH_4 emissions have been estimated using IPCC tier II approach. In this approach country specific emission factors and country specific activity data have been incorporated. The methane emissions from the domestic waste water have been calculated using the following equation (IPCC, 2007)

$$Td = \{\Sigma(U_i \times T_{ij} \times EF_i)\}(TOW - S) - R \qquad 7.4$$

Where;

Td = CH_4 emissions in inventory year, kg CH_4/yr

TOW = Total organics in wastewater in inventory year, kg BOD/yr

S = organic component removed as sludge in inventory year, kg BOD/yr

U_i = fraction of population in income group i in inventory year

T_{ij} = degree of utilization of treatment/discharge pathway or system, j, for each income group fraction i_{th} in inventory year.

i= income group: rural, urban high income and urban low income

j = each treatment/discharge pathway or system

EF_j = emission factor, kg CH_4 / kg BOD

R = amount of CH_4 recovered in inventory year, kg CH_4/yr

The Jammu and Kashmir have 2 Class I cities with the population of 19,10,060 and 4 class II cities with the population of 2,44,990. The sewage water generated from the Class I cities has been estimated as 213.93 MLD and 27.86 MLD from Class II cities (CPCB, 2010). In present study all the sewage water generated is treated as domestic because of lack of activity data in other sectors like commercial / industrial. The CH_4 emission from domestic waste water in Jammu and Kashmir is 48.13 ton, which 1010.73 of CO_2 equivalent.

7.7 Emissions

The Parameters used in while calculating the methane emission through tier II approach of IPCC are given in Table 1

Table 7.6: Parameters used for calculating methane emissions waste water

Parameter	Value	Reference
CH_4 emissions in inventory year, kg CH_4/yr	48139.5	This report
Total organics in wastewater in inventory year, kg BOD/yr	26744170.5	This report
Fraction of population in income group *i* in inventory year	0.32	Karthik, 2011
Degree of utilization of treatment/discharge pathway or system, j, for each income group fraction *i* in inventory year.	0.02	Karthik, 2011
Emission factor, kg CH_4 / kg BOD	0.3	IPCC
Amount of CH_4 recovered in inventory year, kg CH_4/yr	0	J&K Govt.
BOD per capita per day in grams	34	Doorn and Liles (1999)

Table 7.7: Estimation of CH_4 emissions from waste water

Component	Quantity
Population	2155050
Total waste water generated (MLD)	241.79
Methane emitted in inventory year (tons)	48.13

The Municipal solid wastes and waste water generation and deposition in Jammu and Kashmir emitted 0.0509 (000'tons) of CH_4 which is equivalent to 1.0689 (000'tons) CO_2 eq.

Table 7.8: Total estimated CH_4 emissions and Global warming potential (GWP) from Solid and water waste

Component	Methane (CH_4) {000'tons}	GWP {000'tons}
Municipal Solid waste	0.00277	0.05817
Waste Water	0.04813	1.01073
Total	**0.0509**	**1.0689**

Future Perspective - Towards improvement in the estimates

As suggested by INCCA, some of the activities that can be carried out to make the improvements can be the following:

Energy sector

- Continuous improvement of NCV of coal.
- Sampling of coal at power plant for estimating NCV of different types of coal entering the plants.
- On line measurement of CO_2 emission at each stack of large power plants that constitute 90% of the total emission of CO_2 from this source.
- Estimating GHG emission factor by kilometre travelled by each vehicle type and using the same data in road transport GHG emission models.
- Bridging activity data gaps, especially for ascertaining energy use in commercial, residential, agriculture sectors. Therefore ascertaining the allocation of diesel and biomass consumptions are key data requirements for these sector.

Industry

- Measuring plant specific CO_2 emission in large industrial units.
- Bridging data gaps in various industries, especially non-specific industries amongst others - enhance role of industry associations.
- Determining CO_2 emission factor for industrial production and improving the activity data for the same through sample survey.

Agriculture

- Updating CH_4 emission factor from continuously flooded fields, by ascertaining area of flooding through remote sensing.
- Focusing on measurement of CH_4 emission factor from prominent species of dairy cattle in India.
- Updating N_2O emission factors for crop soils.

Waste

- Updating data for estimating CH_4 emission factors from waste water in industries.
- Measuring CH_4 emission factors from MSW in all the cities and towns of the State.

Land Use / Land Use Change and Forestry

- Continuous categorisation of land use for 20 year previous to the year of estimate.

Recommendations

Energy

- Maximize the use of renewable energy as well as technical options such as co-generation and tri-generation.
- Maximizing solar power usage and encouraging use of Solar Gadgets especially in Industries.
- Renovation and modernization of Hydro power projects.
- Promotion of cities and villages as Solar and carbon neutral through implementation of pilot projects and encourage for green building in the state.
- Support a financial market that provides credit for energy efficiency.
- Further support the energy service industry through benchmarking and peer learning.
- Awareness and implementation for use of Solar, CFL and replacing incandescent lamps.

Agriculture and Allied Sectors

- Development of improved variety of crops, fruit crops with enhanced drought tolerance need to be focused.
- Transform agriculture into climate resilient production system.
- Ensure Food Security and equitable access to food resources through organic farming
- Governments to pursue policies to encourage poorer and risk-averse farmers to adopt measures that would mean spending money upfront. "The provision of microfinance schemes can be effective to support the adoption of new technologies and practices by small-scale farmers,"
- Where the adoption of technologies and practices are costly for farmers in the short or medium term, but provide large mitigation benefits, abatement subsidies should be envisaged.

Land Use, Land Use Change & Forestry

- In order to ensure our private forests continue to provide their great forest sink, it is critical we have the right policies in place that support and encourage forests and forest products. The following strategies can be recommended:
  a. Keep forests as forests;
  b. Create new forests through afforestation and replace them quickly – reforest them after fire, wind, insect attack and other disturbance;
  c. Manage forests, periodic tending, harvest and reforestation, to keep them healthy and resilient;
  d. Protect urban forests and increase the extent and diversity of tree cover; and
  e. Increase the use of forest products especially to extend carbon storage and replace other, more fossil fuel intensive products.

Solid Waste and Waste Water

Solid Wastes

- Promote waste minimization, waste segregation, composting and recycling through a combination of pricing, increased awareness, and administrative control measures.
- Reduce the need for incineration and, if incineration is needed, ensure that emissions meet most advanced global standards.
- Ensure that landfills are designed and managed professionally and that methane gas is captured for energy generation where possible.

Waste Water

- Introduce holistic and integrated approaches to flood protection and natural waste water purification, and expand waste water provision using natural systems such as constructed wetlands.
- Consider decentralized methods of treatment as coverage is expanded to pre urban areas.
- Consider low energy, anaerobic treatments, particularly in smaller cities and towns.
- Minimize carbon emissions from sludge disposal.

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CONVERSION FACTORS	
AREA	
1 Acre	8 Kanal Hectares.
1 Sq. Mile	2.5900 Sq. Kilometres.
1 Sq. Mile	640 Acres, 259 Hectares.
1 Sq. Yard	0.84 Sq. Meters.
1 Hectare	2.47105 Acres, 20 Kanals (Approx.).
1 Sq. Kilometre	0.38610 Sq. Mile.
1 Sq. Kilometre	100 Hectares.
1 Sq. Meter	1.196 Sq. Yards.
1 Marla	272 Sq. Feet.
20 Marlas	1 Kanal.
22 Yards/ 20.17 Mtrs	1 Chain.
220 Yards	1 Furlong.
WEIGHT	
1 Ounce (Oz)	28.3495 Grams
1 Ton	1000 Kgs.
1 Long Ton	1.01605 Metric Tonnes/ 0.907 Tonnes.
1 Short Ton	0.907185 Metric Tones/ 1.016 Tonnes.
1 Maund	0.037324 Metric Tonnes.
1 Kilogram	2.204623 Pounds.
1 Gram	0.0352740 Ounce
1 Quintal	100 Kilograms.
1 Ton	1.0160645 Metric tones/ 10.01605 Quintals.
1 Metric Ton	0.984207 Tons/ 10 Quintals.
1 Giga Gram	1000 Tones.
LENGTH	
1 Inch	25.4 Millimetres.
1 Yard	0.9144 Meters. (Approx.).
1 Mile	1.61 Kilometres / 1.760 Yards.
1 Millimetre	0.04 Inch.
1 Centimetre	0.393701 Inch.
1 Meter	1.094 Yards.
1 Kilometre	0.62137 Miles.
VOLUME	
1 Cubic Yard	0.7646 Cubic Meter.
1 Cubic Meter	1.3079 Cubic Yard.
1 Chain	22 Yards.
1 Cubic Feet	0.028 Cubic Meters.

UNITS	
^0C	Degree Centigrade – unit of temperature
ppm	parts per million
ppb	parts per billion
ppt	parts per trillion
km^2	Kilometer Square
m	Meters
mm	Millimetre
Gg	Giga Gram
MU	Million Units of Electrical Energy (1 unit = 1 kilo watt hour)
Tg	Teragram
t/ha	Tones/ hectare
ha	Hectare
kg	Kilogram
MT	Metric Tones
Mha	Million Hectare
m^3	Cubic Meter
km	Kilometer
MWh	Megawatt hour
MW	Mega Watt
kVA	Kilo-watt-unit of electrical energy

DECREASE YOUR FOOTPRINT

- Use both side of the paper.
- Keep bird baths and feeders
- Plant and nurture trees.
- Eat locally produced fruits and vegetables.
- Prefer home-made refreshments.
- Shift to walking, cycling and use public transport.
- Make festivals environment-friendly.
- ‘Carpool’ to work.
- Do not burn waste.
- Do switch of the ignition at the red light.
- Do not burn leaves, use them for composting
- Prefer organic food.
- Encourage local artisans.
- Prefer carbon neutral kitchen appliances.
- Carry a water bottle.
- Switch off appliances as you leave the room.
- Dry clothes in sunshine.
- Use stairs and avoid lifts.
- Say ‘NO’ to plastic bags. Use cloth bags.
- Compost biodegradable waste.
- Do not waste food.
- Be a responsible tourist-do not litter.
- Use leftover water to water plants.

INCREASE YOUR HANDPRINT

Reduce Carbon footprints

Increase Hand prints

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