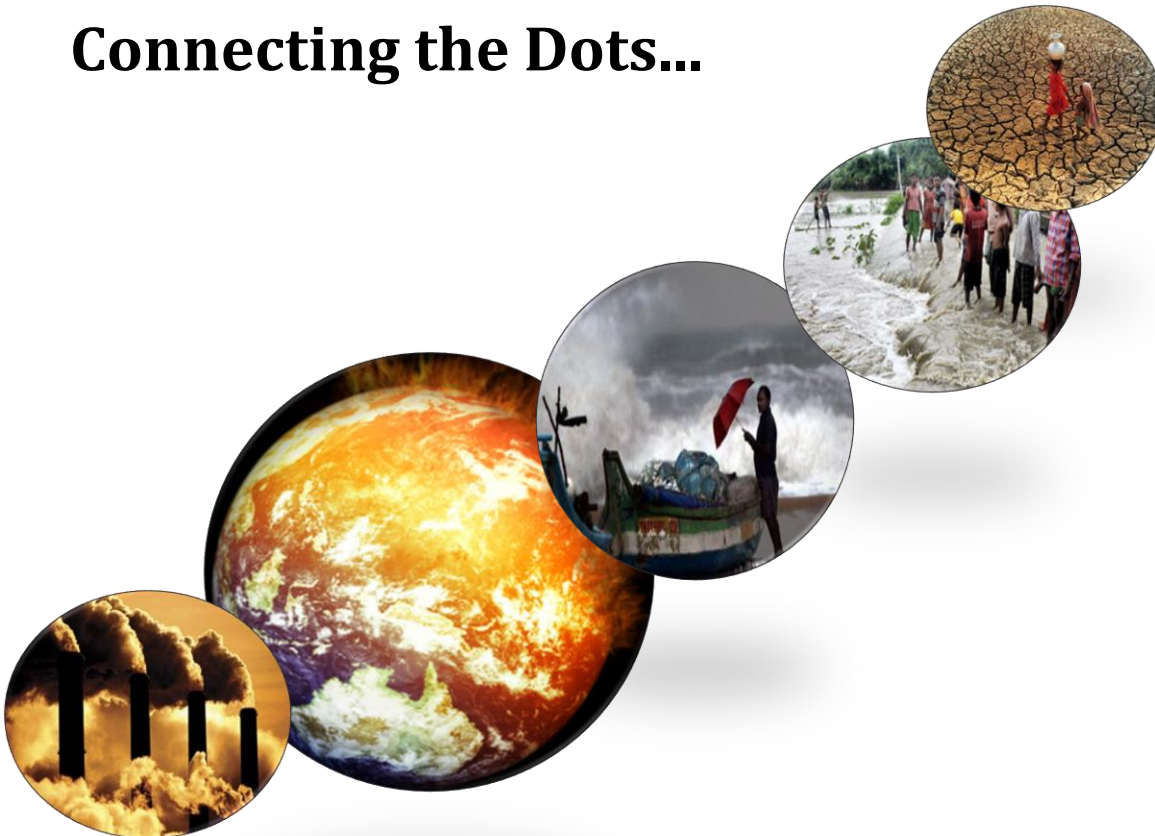


Contextualizing Climate Change

Connecting the Dots...



FOREWORD



This publication 'Connecting the Dots': Contextualizing Climate Change, is an excellent piece of work. It presents compelling facts on climate change, the biggest challenge that mankind faces today. India is at the forefront in facing this challenge. Climate change is going to impact India in multiple ways and is going to exacerbate our challenge of eradicating poverty and meeting development needs of millions of Indians. It is not only going to impact coastal regions through sea level rise but all parts of the country by increasing mean temperatures and variability in rainfall.

This toolkit gives various insights and explanation on the phenomenon of climate change outlining direct and indirect impacts on agriculture, health, biodiversity and other critical areas, articulating concepts and addressing solutions which could be put in place in India. It makes evident the need to take action on climate change as well as illustrates the benefits that accrue from early action.

Indian government has taken climate change seriously and have pledged to reduce the emission intensity of its GDP by 20-25% by 2020 in comparison to 2005 levels. Indian government has also formulated the National Action Plan on Climate Change which consists of 8 mission documents addressing adaptation and mitigation needs of the country. Though this is a good start we definitely need to do more in order to ensure sustainable development for all Indians as well as protecting the poor from adverse impacts.

I thank Athena Infonomics for putting this publication together which facilitates flow of information and know how about climate change. I hope this publication reaches out to the broader community to raise awareness about climate change and helps in starting a discussion to better equip India to tackle the challenge of climate change.

A handwritten signature in black ink, appearing to read 'Rudy', written in a cursive style.

Mr. Rajiv Pratap Rudy
Member of Parliament
*Convener of the Parliamentary Forum on Global
Warming and Climate Change*

Contents

Glossary	4
Introduction	5
Climate Change in India	6
Rise in Sea Levels and Surface Air Temperatures	6
Climate Change and its Impact on the Himalayan Region	8
Glacial Lake Outburst Flood	9
The Himalayan Tsunami	10
Impact of Climate Change on Uttarakhand	12
Initiatives from Leading Countries: United Kingdom	16
Flagship Legislative Process across the world on Climate Change	17
Key Missions of National Action Plan on Climate Change	18
Policy Initiatives – Uttarakhand	20
How Can YOU Combat Climate Change?	22
Case Studies	23
Reference Materials	24
About Athena Infonomics	26

Glossary

Carbon Cycle	Movement of carbon as it is recycled and reused in the biosphere which is key to sustaining life on earth
CC	Climate Change
CCS (Carbon Capture & Storage)	The process of capturing and storing waste carbon dioxide so that it does not enter the atmosphere
CDM (Clean Development Mechanism)	A mechanism through which developed countries may finance greenhouse gas emission reduction or removal projects in developing countries, and receive credits for doing so
CO₂	Carbon dioxide
Deforestation	Cutting down of trees and conversion of forest to non-forest
Erosion	Process by which soil and rock are removed from the earth's surface by natural processes such as wind or water flow and transported to other locations
Fossil Fuels	Fuels formed by natural processes. Includes coal, petroleum and natural gas
GHG (Greenhouse Gases)	The atmospheric gases that are responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO ₂), methane (CH ₄) and nitrous oxide (N ₂ O)
GLOF (Glacial Lake Outburst Flood)	A Glacial Lake Outburst Flood (GLOF) occurs when the dam containing a glacial lake fails
IPCC (Intergovernmental Panel on Climate Change)	Established in 1988, the IPCC surveys and publishes reports on climate change that are widely recognised
ISRO	Indian Space Research Organisation
NREGA	National Rural Employment Guarantee Act
Precipitation	Rain, hail, snow and other forms of water falling from the sky
SAARC	South Asian Association for Regional Cooperation
Salinity	Saltiness or dissolved salt content of a body of water or in soil
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs
UN	United Nations
UNEP	United Nations Environment Programme

Introduction

“One of the greatest environmental and development challenges in the twenty-first century will be that of controlling and coping with climate change.”

Kofi Annan, Former UN Secretary General (“In Larger Freedom”, 2005)

Climate change refers to changes in the earth’s climatic conditions occurring over a period of time, either due to human activity or nature’s inconsistencies. Rise in global average temperatures caused due to increased concentration of greenhouse gases (GHGs) such as carbon dioxide, nitrous oxide and methane have impacted the earth’s natural systems, causing extreme weather conditions, melting of polar ice caps, rise in sea levels, acidification of water bodies and increased number of natural disasters. **The concerns today are no longer associated with whether the climate is changing but with the timing and the magnitude of this change.**

Use of fossil fuels, land use changes occurring due to rapid urbanisation, industrialisation and economic development are largely responsible for the emission of GHGs in the atmosphere.

According to the Intergovernmental Panel on Climate Change (IPCC), “Global surface temperature change for the end of the 21st century is projected to be in the range of 1.5°C and 2°C.¹”



¹ IPCC Fifth Assessment Report, 2013

Climate Change in India

Rise in sea levels have almost doubled to 3.1 mm per year compared to a rise of 1.8 mm per year during 1961 and 2003.¹

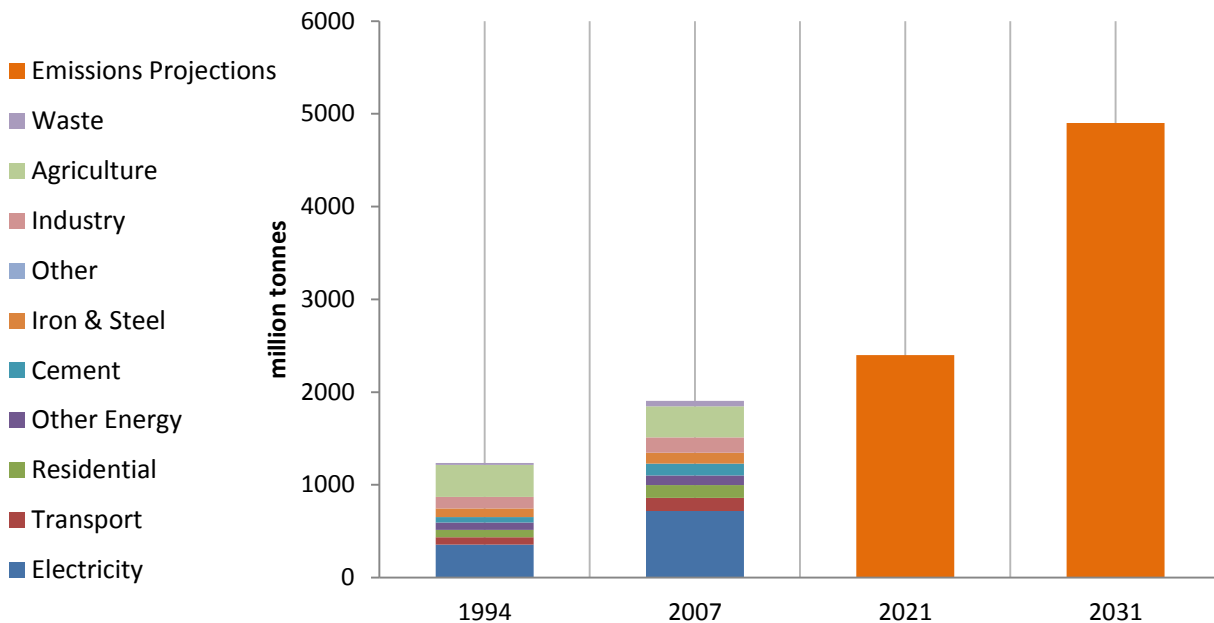
One meter rise in sea level would result in 5764 sq. km. of land area being lost to the sea in India.²

Rise in Sea Levels and Surface Air Temperatures

India has experienced a warming of 0.4 degree centigrade in surface air temperatures over the period 1901-2000. During this period, the Himalayan glaciers have also begun to recede.³

Temperatures are expected to increase by 3°C to 6°C by 2100 and 15-40% increase in rainfall is expected with high degree of regional variability.⁴ Rates of change in temperatures and precipitation have been found to vary across the country. Cyclonic activities are set to increase significantly with warmer oceans. The continuous warming and the changing rainfall pattern over the Indian region may jeopardize India's development by adversely impacting natural resources such as water, forests, coastal zones, and mountains on which more than 70% of the rural population is dependent. India's share of global CO₂ emissions amount to 4.6% making it the third highest in the world after USA (20.9%) and China (17.3%).⁵

Greenhouse Gas (GHG) emissions from India- 1994-2013



Source: TERI, Ministry of Environment and Forest

India's per capita CO₂ eq emissions was 1.5 tons in 2007 and is expected to reach 3.4 tons by 2031.⁶

¹ Oxfam, 2007

^{2,3,4} India Climate Change Assessment Report, MoEF, 2010

^{5,6} India's GHG Emissions Profile Report, MoEF, 2009

In central and south Asia, crop yields could fall by up to 30%, creating a very high risk of hunger in several countries.¹

Projected changes in Rainfall and Temperature by 2100²

- ⇒ Increase in rainfall by 15-40% with (high regional variability)
- ⇒ Warming more pronounced over land areas with maximum increase in north India
- ⇒ Increase in annual mean temperature by 3°C to 6°C.

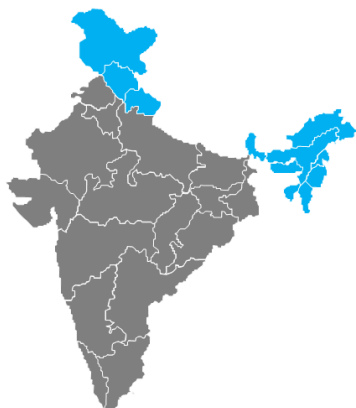
Impact on Various Sectors in India

	Impact	Outcome
Agriculture	As the temperature increases in different parts of India, crop yields are expected to decrease.	Studies show that on a 2°C increase in mean air temperature, rice yields could decrease by about 0.75 ton/hectare in the high yield areas and by about 0.06 ton/hectare in the low yield coastal regions.
Water Resources	By 2050s, the quantity of surface run off and availability of fresh water would decrease due to climate change particularly in the northern, central Indian and the southern river basins.	These conditions may lead to severe droughts in the future.
Human Health	The disease burden of climate dependent diseases such as malaria, diarrhoea, and heat stress is very high in India.	The most malaria endemic regions are the central and eastern Indian regions of India covering Madhya Pradesh, Jharkhand, Chhatisgarh, Odisha, West Bengal and Assam. Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise due to projected changes in the hydrological cycles.
Forests	It is projected that by 2085, upto 77% of the forested areas in India are likely to experience shifts in forest types.	

Source: BASIC Project Report, 2007

^{1,2}India Climate Change Assessment Report, MoEF, 2010

Climate Change and its Impact on the Himalayan Region



Warming in Himalayas is happening at an unprecedented rate, higher than the global average of 0.74 °C over the last 100 years, at least 2-3 times higher than global averages.¹

“The glaciers of the Himalayas are melting so fast they will affect the water supplies of a population twice that of the US within 22 years.”²

On a regional scale, mountain snow pack, glaciers and small ice caps play a crucial role in freshwater availability. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water availability, hydropower potential, and changing seasonality of flows in regions supplied by melted water.³

Impact

Impact on Precipitation

Throughout the Himalayas, there is increasing perception and documentation that precipitation is changing, becoming more erratic and intense. “Flooding may arise as a major development issue. It is projected that more variable, and increasingly direct, rainfall runoff will also lead to more downstream flooding”.⁴

Retreating glaciers

Excessive melt waters, often in combination with liquid precipitation, could trigger flash floods or debris flows. Available studies suggest changes in climatic patterns and an increase in extreme events. An increase in the frequency of high intensity rainfall often leading to flash floods and landslides has been reported.⁵

Higher frequency of flash floods and (Glacial Lake Outburst Flood) GLOF events

In the eastern and central Himalayas, glacial melt associated with climate change, has led to the formation of glacial lakes behind terminal moraines. The moraine dams are comparatively weak and could breach all of a sudden, leading to the discharge of huge volumes of water and debris. The resulting glacial lake outburst floods (GLOFs) can cause catastrophic flooding downstream. There is an indication that the frequency of GLOF events has increased in recent decades. In the Hindukush Himalayan (HKH) region two hundred and four glacial lakes have been identified as potentially dangerous lakes, which can burst at any time.⁶

¹ IPCC, 2007a; Du et al., 2004

² Rachendra Pachauri. Chairman IPCC. Interview to Financial Times, September 22, 2013

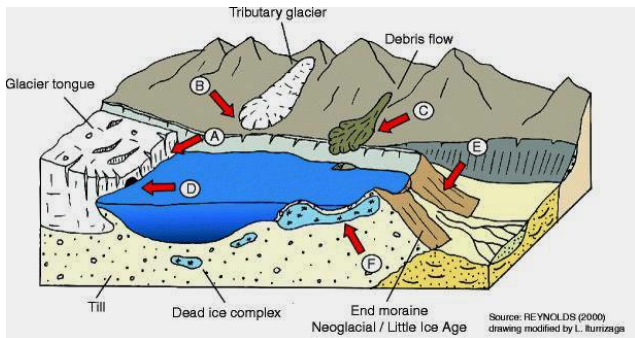
³ Fourth Assessment Report of the Intergovernmental Panel on Climate Change (page 49)

⁴ Changing With The Seasons: How Himalayan communities cope with climate change, Chicu Lokgariwar, People’s Science Institute

⁵ Chalise and Khanal, 2001; ICIMOD, 2007a

⁶ ICIMOD, 2007b

Glacial Lake Outburst Flood

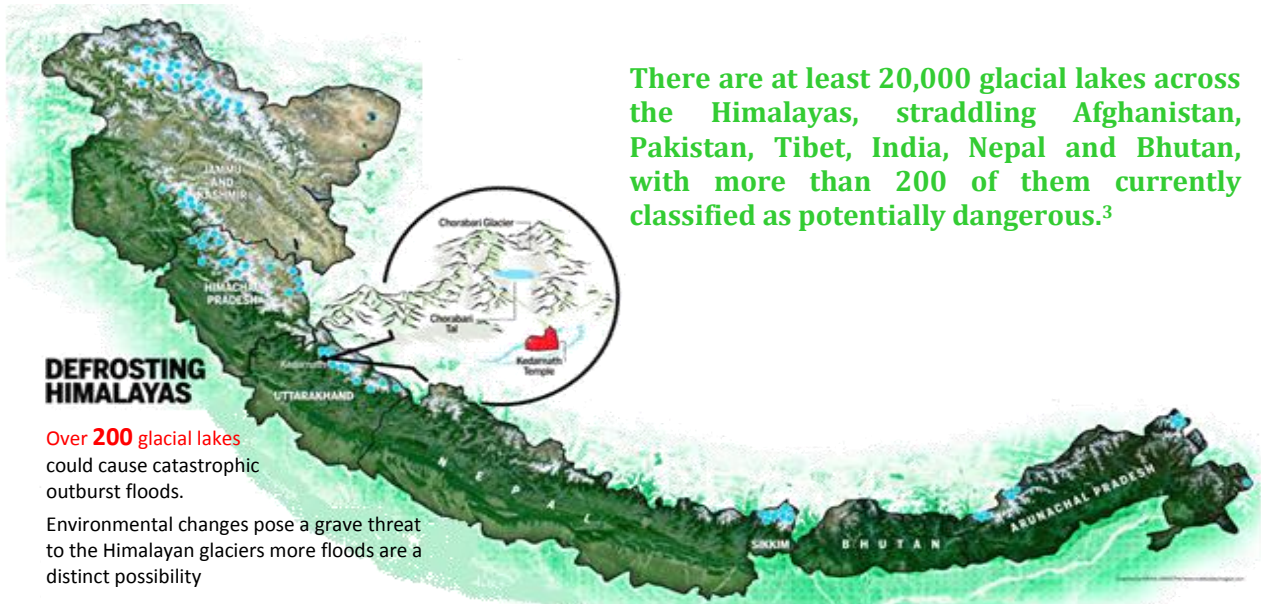


Hazardous moraine-dammed glacial lake. Hazards – (a) large lake volume, (b) narrow and high dam, (c) ice within dam, and (d) limited freeboard. Potential triggers – avalanche displacement waves from (A) calving glaciers, (B) hanging glaciers, and (C) rock falls; (D) settlement or piping; (E) melting ice; and (F) catastrophic glacial drainage.
 Source: RGSL (2003)

A glacial lake outburst flood (GLOF) occurs when the dam containing a glacial lake fails. The warming of the climate is resulting in the recession of glaciers and formation of glacial lakes. The dam can consist of glacier ice or a terminal moraine.¹ The sudden failure of a moraine dam on a glacial lake can release a very large amount of water called a Glacial Lake Outburst Flood. The released water may destroy property hundreds of kilometres from the source.

Human activities including settlement, hydropower production, forestry, mining, and wilderness tourism in mountainous areas have increased conflict with glacial hazards including moraine dam failures and Glacial Lake Outburst Floods.²

Failure can happen due to erosion, a build-up of water pressure, an avalanche of rock or heavy snow, an earthquake, or if a large enough portion of a glacier breaks off and massively displaces the waters in a glacial lake at its base.



There are at least 20,000 glacial lakes across the Himalayas, straddling Afghanistan, Pakistan, Tibet, India, Nepal and Bhutan, with more than 200 of them currently classified as potentially dangerous.³

Over 200 glacial lakes could cause catastrophic outburst floods.

Environmental changes pose a grave threat to the Himalayan glaciers more floods are a distinct possibility

Image Source: India Today

¹ Moraine Dam Failure and Glacial Lake outburst Floods Scot H. Dahms 12/1/06

² RGSL 2003

³ Pradeep Mool, scientist at International Center for Integrated Mountain Development (ICIMOD)

The Himalayan Tsunami: Heaven's Deluge

"I have never seen anything like this. It was as if someone was throwing water from under the ground,"

- (Uttarakhand Resident)

"The Kedarnath floods may be only a small precursor to never-seen-before mega floods."

-(Maharaj K. Pandit, Director, ICIMOD)

What happened?

The monsoon reached Uttarakhand almost two weeks earlier than normal, resulting in cloud bursts and very heavy (124.5 – 244.4 mm) rainfall in several parts of the higher reaches of the Himalayas. Further, the water surge was caused by a breach in the boundary of Chorabari Lake due to heavy rainfall upstream. This resulted in the release of huge volume of water along with large boulders, devastating the towns of Kedarnath, Rambara, Gaurikund and others in its wake.¹

Estimated impact²

- Over 6000 feared dead or missing
- Over 4,200 villages affected
- Over 9,200 cattle/livestock lost
- About 3,320 houses were fully damaged and about 995 public buildings were damaged
- Close to 9,000 km of roads were affected and 85 motor bridges and 140 bridle bridges were damaged
- Left over 70,000 tourists and 100,000 local inhabitants stranded in the upper reaches of the State

Will it happen Again?

The increase in global temperature will cause increased occurrence of GLOFs (Glacial lake outburst floods) and will affect the size of the glacial lakes. The breakage of such lakes can be extremely devastating to human habitations.

Precipitation is expected to increase by 60 to 206 mm by 2030 and magnitude of flooding is expected to increase by 10 to 30 percent.

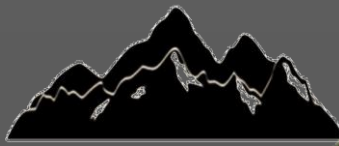
What can be done?

- Planned infrastructure development and tourism planning
- Structural measures for mitigation such as flood protection measures and increased forest coverage
- Improved land use pattern and increased vegetation
- Increased preparedness of disaster management teams
- Increased awareness among people living in high risk prone areas

¹ India: Uttarakhand Disaster Recovery Project, The World Bank

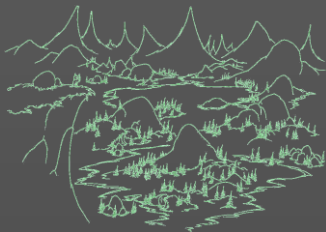
² Ministry of Home Affairs, (Disaster Management Division), Dated 29th July, 2013, India: Uttarakhand Disaster Recovery Project, The World Bank

Impact of Climate Change on Uttarakhand¹



1.7 C° - 2.2 C° is the estimated net increase in temperatures in the Himalayan region by 2030

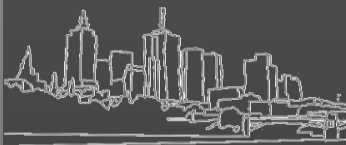
The Gangotri glacier in the Uttarkashi district of Uttarakhand has been receding at the rate of **20-22 m** annually



Increasing global temperatures threatens the existence of alpine meadows, making them vulnerable to extinction

Rising temperature could lead to

- Increased pest infestation
- Reduction in apple production
- Reduction in crop yield

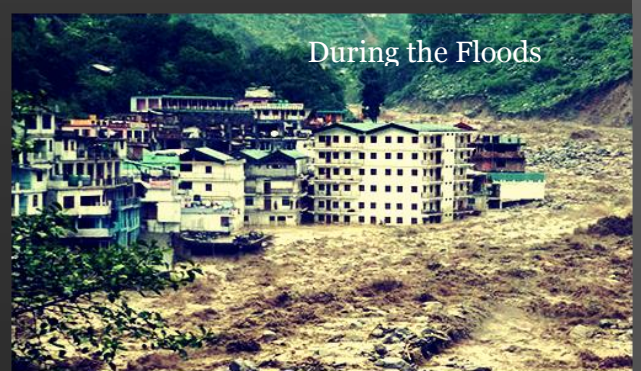


66% of urban settlements lack adequate water supply

20 % of the villages in the state do not have access to clean drinking water



Unplanned growth of towns in Uttarakhand has caused immense pressure on the urban infrastructure and services leading to risk of loss of life and property



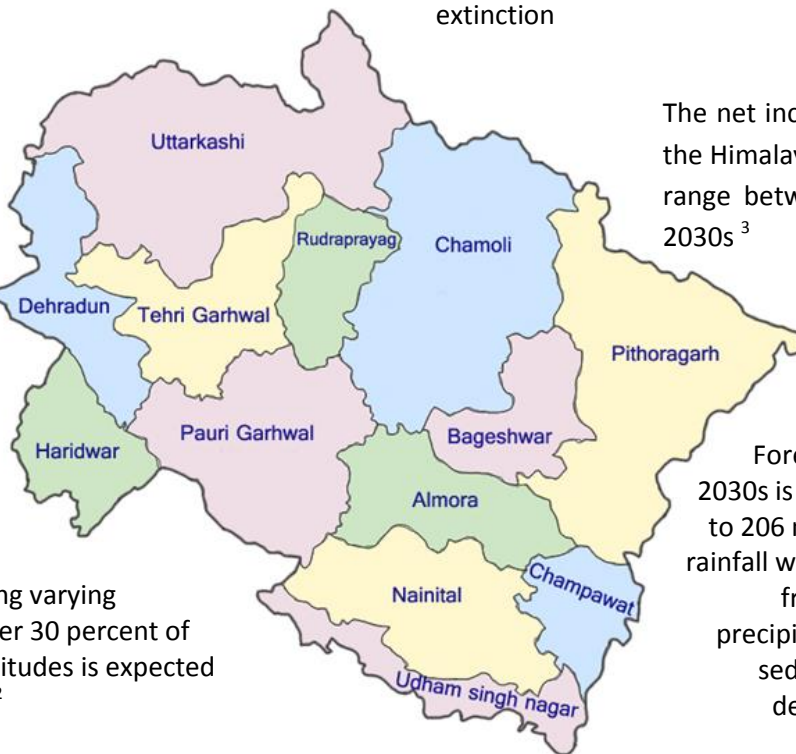
Impact of Climate Change on Uttarakhand

The Gangotri glacier in the Uttarkashi district of Uttarakhand has been receding at the rate of 20-22 m annually, with grave implications for water availability downstream and hydropower generation ¹

The Himalayan Eco-system is particularly at risk with the rise in global temperatures. The bio-diversity which resides in the higher altitudes will have lesser and lesser place to occupy and will be at increased risk of extinction

High rainfall during the months of August/September instead of the normal peak July/August would damage monsoon crops and increase frequency and severity of landslides

The net increase in temperatures in the Himalayan region is projected to range between 1.7 C °to 2.2 C ° in 2030s ³



Increase in flooding varying between 10 to over 30 percent of the existing magnitudes is expected in all the regions ²

Forecasted precipitation in the 2030s is expected to increase by 60 to 206 mm. The increase in annual rainfall with respect to 1970s ranges from 5 to 13 percent. Rise in precipitation results in increase in sediment yield which could be detrimental to existing water resources ⁴

The increase in global temperature will cause increased occurrence of GLOFs (Glacial lake outburst floods) and will affect the size of the glacial lakes. The breakage of such lakes can be extremely devastating to human habitations.

^{1,2,3,4} Uttarakhand State Action Plan on Climate Change, 2012

Impact on various sectors in Uttarakhand



Forestry and Biodiversity:

- The area under forest in Uttarakhand is 3.4 million ha, which is 61.45 percent of total land available for utilization in the state.¹
- The Himalayan eco-system is particularly at risk with the rise in global temperatures. The bio-diversity which resides in the higher altitudes will have lesser and lesser place to occupy and will be at increased risk of extinction
- The alpine meadows have high soil organic content and are very good at sequestering carbon. They are also extremely rich in biodiversity. The increase in global temperatures threatens the existence of alpine meadows and makes them vulnerable to extinction
- Change of moisture regime in different forest types is expected
- Upward altitudinal migration of plants in the Himalayas could reduce the alpine meadows and related vegetation, thus impacting the habitats of several high altitude mammals including wild sheep, goat, antelope and cattle

Agriculture:

Temperature and Rainfall:

- The net increase in temperatures in the Himalayan region is projected to range between 1.7 C° to 2.2 C° in 2030s. ²
- Forecasted precipitation in the 2030s is expected to increase by 60 to 206 mm. The increase in annual rainfall with respect to 1970s ranges from 5 to 13 percent. Rise in precipitation results in increase in sediment yield which could be detrimental to existing water resources. ³
- More precipitation could exacerbate the likelihood of flash floods and water logging conditions.

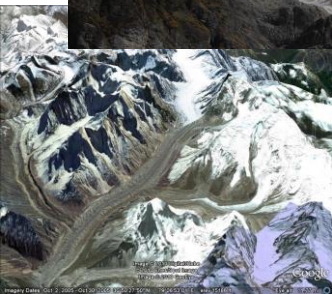


Crop Productivity:

- Productivity of most crops would decrease due to increase in temperature and decrease in water availability. Greater loss is expected in Rabi as compared to Kharif crops
- Rise in temperatures could result in shortening of maturity period of winter crops and increased pest infestation. Apple yields are expected to be affected
- High rainfall during the months of August/September instead of the normal peak July/August would damage rainy season crops and increase frequency and severity of landslides
- Winter precipitation in January/ February instead of December/ January and decline in intensity of snowfall would result in delayed sowing of winter crops, decline in barley and wheat yields
- Increase in instances of cloud burst could result in heavy losses to life and property

^{1,2,3} Uttarakhand State Action Plan on Climate Change, 2012

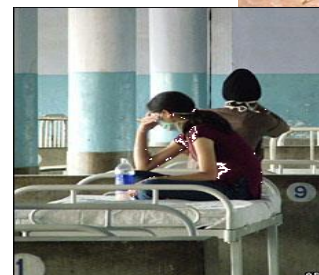
Water Resources:



- Of the 63 urban locations in the state, only a third have near adequate supply of water. There are 15165 villages in the state and nearly 20 per cent of them have a range of problems impeding the availability and provision of drinking water.¹
- Climate change can affect the hydrological regime changing water flows, global and regional precipitation levels, evaporation and snow cover. Rising temperatures also cause rapid glacial melt consequently impacting freshwater supply and quality.
- While some regions will receive excess precipitation, there might be reduction in other regions (adversely affecting arid and semi-arid areas); increased evaporation; changes in runoff and available surface flow also causing changes in the groundwater recharge.
- The Gangotri glacier in the Uttarkashi district of Uttarakhand has been receding at the rate of 20-22 m annually, with grave implications for water availability downstream and hydropower generation.²
- A 10 to 30 percent increase in flooding magnitude is expected in all the regions.³

Health:

- Extreme climate events are expected to become more frequent as a result of climate change. The effects of climate change are expected to have substantial impacts on human settlements.
- Altered frequency and /or intensity of other weather events – leading to injuries, psychological stress; damage to public health infrastructure, by floods & other natural calamities is expected
- Climate change would lead to less availability of fresh water, in turn leading to lack of hygiene and thus increase in water born diseases
- Effects on range and activity of infective vectors and parasites – leading to changes in geographic areas and incidence of vector borne diseases e.g. malaria, dengue fever and several types of encephalitis could accelerate



^{1,2,3} Uttarakhand State Action Plan on Climate Change, 2012

Urban Life:



- Climate change is likely to negatively impact infrastructure and worsen access to basic urban services and quality of life in cities.
- Unplanned development, together with rapid urban growth and the inflow of tourists and pilgrims has made critical impacts on the urban environment of Uttarakhand
- Most of the towns in Uttarakhand have grown in an unplanned manner causing immense pressure on the urban infrastructure and services resulting in degradation of the urban environment and of natural resources.
- Major environmental concerns associated with such unplanned urban development are depletion of forest area, loss of bio-diversity, potential urban pollution in the form of air, water shortages and quality, noise pollution, issues of solid and liquid waste management, and landslides.
- Lakes and water bodies, which are also attraction for tourists, are polluted due to uncontrolled discharge of wastewater and disposal of solid wastes.
- The unplanned growth of places as centres of tourism has had a severe and negative impact on the environment.

Rural Life:

- Majority of the rural population are largely dependent on agriculture, which is sensitive to climate.
- Due to lack of opportunities in the rural areas, there is large migration of rural population to urban areas, is in turn putting pressure on the urban infrastructure.
- Inadequate sanitation facilities in the rural areas have led to a rise in biological contamination of large number of drinking water sources.
- Excessive use of phosphate-based fertilizers has resulted in presence of increased concentrations of their residues in water.



Initiatives from Leading Countries: United Kingdom



Climate Change Legislation, Pledges and Policy

- The Climate Change Act established a legal duty on the government to reduce UK's GHG emissions by at least 80% of 1990 levels by 2050 (along with an interim target of 34% cuts by 2020)
- The UK established a Low Carbon Transition Plan 2020 for transforming the power sector, homes and workplaces, transport, farming and the way land and waste is managed, to meet these carbon budgets, and protect the most vulnerable.

Global Climate Negotiations

- UK assumes a leadership position in Global Climate Negotiations and is taking action domestically as well as through climate diplomacy to encourage others to follow UK's example.

Emission Reduction

- The government has allocated £1bn for a Carbon Capture and Storage (CCS) demonstration facility.

Climate Finance

- UK will spend £2.9bn on climate finance (International Climate Fund) by 2015.

Renewable Energy

- The UK is legally committed to delivering 15% of its energy demand from renewable sources by 2020.

Energy Efficiency

- Over the last 10 years, UK energy intensity has fallen by 27%, compared to 16% in Japan and United States, 20% in Germany and 14% in France.

"Green" Jobs and Investments

- A total of £12.7bn investment related to the renewables had been announced between 1 April 2011 and 31 July 2012. The energy efficiency sector in the UK already accounts for about 136,000 jobs and had sales of £17.6 billion in 2010/11.

Flagship Legislative Process across the world on Climate Change

Country	Name of Law / Policy	Main Purpose	Year of enactment
United Kingdom	Climate Change Act	<p>The Climate Change Act stipulates a legally binding target of at least an 80% cut in GHG emissions by 2050 to be achieved through actions in the UK and abroad. In the short term it requires UK to reduce emissions by at least 34% by 2020. Both these targets are against a 1990 baseline.</p> <p>The rationale behind the Climate Change Act was to provide a long term framework for improving carbon management, to help the transition to a low carbon economy, encourage investment in low carbon goods and provide an international signal. It also created yearly “carbon budgets”.</p>	2008
India	National Action Plan on Climate Change	<p>India’s NAPCC outlines existing and future policies and programmes directed at climate change mitigation and adaptation. The plan sets out 8 national missions.</p>	2008
European Union	Climate and Energy package	<p>The core of the package comprises four pieces of complementary legislation:</p> <ol style="list-style-type: none"> 1. Revision and strengthening of the EU emissions trading scheme (ETS) 2. Reducing GHG emissions fairly taking into account the relative wealth of the EU member states. 3. A framework for the production and promotion of renewable energy 4. A legal framework for the environmentally safe geological storage of carbon dioxide. 	2008
United States of America	Clean Air Act	<p>Following the ‘endangerment findings’, the Environment Protection Agency (EPA) is now required to regulate gases for their GHG potential under Clean Air Act.</p>	1963 (amended 1976 and 1990)
China	12 th Five year plan	<p>The 12th five year plan includes targets to decrease the carbon intensity of GDP by 17% by 2015; to decrease the energy intensity of GDP by 16%; to increase the share of non fossil fuel primary energy consumption to 11.4%; and to increase forest coverage by 21.6%.</p>	2011
Brazil	National Policy on Climate Change (NPCC)	<p>The NPCC is based on Brazil’s international commitment within the UNFCCC and incorporates previous related government instruments (i.e the national plan on climate change, the national fund on climate change and others).</p>	2009
South Africa	National climate Change Response Policy (NCCRP)	<p>The National Climate Change Response Policy is a comprehensive plan to address both mitigation and adaptation in South Africa in the short, medium and long term (Up to 2050) Strategies are specified for the following areas: Water, agriculture and commercial forestry, health, biodiversity and ecosystems; human settlements; and disaster risk reduction and management.</p>	2011

Key Missions of National Action Plan on Climate Change

Background

India's NAPCC outlines existing and future policies and programmes directed at climate change mitigation and adaptation. The eight national missions set out by the action plan recognizes the need to maintain a high growth rate for increasing the living standards of the vast majority of people and reducing their vulnerability to adverse impacts of climate change.

Key Missions

Sector	Name of Mission	Objective
Alternative Energy	National Solar Mission	To increase the share of solar energy in the total energy mix, while recognising the need to expand the scope of other renewable energy and fossil fuel options such as nuclear energy, wind energy and biomass.
Environment	National Mission for Green India	To enhance ecosystem services including carbon sinks to be called Green India. The programme will be scaled up to cover all degraded forest land in the country.
Environment	National Water Mission	To ensure integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within States.
Agriculture	National Mission for Sustainable Agriculture	To devise strategies to make Indian agriculture more resilient to climate change. The mission would identify and develop new variety of crops and alternate cropping patterns that can withstand extremes of weather.
Knowledge	National Mission for Strategic Knowledge for Climate Change	To enlist the global community in research and technology development and collaboration through mechanisms including open source platforms and establishment of Strategic Knowledge Mission.
Energy	National Mission for Enhanced Energy Efficiency	To enhance initiatives taken for implementation of energy efficiency measures that would result in energy savings of 20,000 MW by 2022.
Environment	National Mission for Sustaining Himalayan Ecosystem	To launch and evolve management measures for sustaining and safeguarding the Himalayan glacier and mountain eco-system.
Biodiversity	National Mission on Sustainable Habitat	To make habitat sustainable through improvements in energy efficiency in buildings, management of solid waste and modal shift to public transport.

Policy Initiatives – India

Area	Initiative/Event	Contribution
Science & Research	1 Indian Network for Climate Change Assessment (INCCA)	Network of 120 research institutions and 250 scientists launched; major conferences were held in May and November 2010
	2 Himalayan Glaciers Monitoring Programme	Comprehensive programme to scientifically monitor the Himalayan glaciers - Phase I completed; Phase II launched; Discussion Paper on State of Himalayan Glaciers released
	3 Launch of Indian Satellite to Monitor Greenhouse Gases	ISRO launched a micro-satellite in 2010 to study aerosols (soot particles), followed by a comprehensive satellite in 2011 to monitor GHG gases; India joined the elite club of countries to do so
	4 India's Forest and Tree Cover as a Carbon Sink	Research estimates the value of India's forests as a carbon sink - assessment shows that they neutralise 11% of India's annual GHG emissions
	5 India's GHG Emissions Profile	India's GHG Emission Pathways shows India will remain a minor per capita emitter even in 2030 (under different assumptions made public)
Policy Development	6 Expert Group on Low Carbon Economy	Planning Commission-led group set up to develop strategy for India as a low carbon economy
	7 State Action Plans on Climate Change	Delhi becomes first state to release Climate Change Action Plan; other states finalising their plans
	8 National Policy on Bio-fuels	National Policy on bio-fuels approved by cabinet to promote cultivation, production and use of bio-fuels for transport and in other applications
Policy Implementation	9 National Missions under National Action Plan on Climate Change	National Missions on Solar Energy, Energy Efficiency and Strategic Knowledge approved; other Missions in final stages of preparation
	10 First National Conference on Green Building- Materials and Technologies	Conference to stimulate green building sector; to set an example, the government proposes that all its new buildings will be GRIHA 4* compliant subject to site conditions
	11 30 "Solar Cities"	In-principle approval given to 30 'Solar Cities' with aim of 10% deduction in projected demand of conventional energy through a combination of energy efficiency and renewable energy
	12 Energy Efficiency Standards for Appliances	Energy efficiency ratings made mandatory for 4 key appliances — refrigerators, air conditioners, tube lights and transformers from January 7, 2010
	13 Fuel Efficiency Norms	Plan for fuel economy norms for vehicles announced; to be made operational in two years
	14 CDM Program	India assessed as Best CDM Country; India to neutralise 10% of emissions
International Cooperation	15 India to host 'Rio+20'	India hosted 11th COP of Convention on Biodiversity (CBD) in 2012, marking 20th anniversary of Rio
	16 UN Climate Technology Conference	India successfully hosted a global conference on technology; Delhi Statement adopted
	17 SAARC Environment Ministers Conference	India successfully hosted SAARC Ministers Conference and agreed on joint actions on Climate Change; 2010 SAARC Summit was on the theme of Climate Change
	18 India's Submissions to UNFCCC	Report documenting India's 12 proactive submissions to UNFCCC released
Forestry	19 State of Forests Report 2009	Latest State of Forest Report released; shows continued rise in India's forest cover
	20 Launch of CAMPA	Ambitious Rs 11,700 crore (USD 2.5bn) programme for forest conservation launched
	21 Green India Mission	New mission under NAPCC to fast-track re-forestation finalised
	22 Capacity Building in Forestry Scheme	New Rs 369 crore (USD 80mn) scheme for HRD for forest personnel
	23 Intensification of Forest Management	New Rs 600 crore (USD 125mn) scheme to improve forest management, infrastructure, fires, etc.
	24 Inclusion of Forestry within NREGA	Forestry related activities included as part of India's flagship employment guarantee scheme to fast-track reforestation; pilots being implemented

Source: Ministry of Environment and Forests, 2010

Policy Initiatives – Uttarakhand

The state lays equal emphasis on both ‘hard’ and ‘soft’ adaptation approaches – where ‘hard adaptation options’ include options that have physical attributes (e.g. infrastructure and engineering structures) and ‘soft adaptation options’ include the development of skills, processes, institutions, social systems, policies and programmes.

The key elements of the climate response strategy for Uttarakhand also involves flexibility (within livelihoods, economic, social, cultural, ecological and institutional systems), diversification (involving multiple independent flows to livelihood and natural systems), learning and education (from events at both individual and institutional levels and knowledge base required to develop new systems when existing ones are disrupted), mobility (an attribute of flexibility), operational techniques (for risk reduction before and following disruptions), convertible asset and innovation (designing new systems and options).

Sector Wise Initiatives	
Agriculture	<p>There are 1110 micro watersheds in Uttarakhand, out of which 584 are being treated by various agencies/programmes such as the Employment Assurance Programme, Uttarakhand Decentralized Watershed Development Project and others.</p> <p>Ago-climatic Planning and Information Bank (APIB): To harness the natural resources in sustainable manner, Government of Uttarakhand has started detailed mapping of natural resources.</p>
Forests and Biodiversity	<p>The State has village level institutions adept at managing chunks of forests called Van Panchayats. Presently more than 12000 Van Panchayats are entrusted with the management of 5500 sq. km. of forests.</p> <p>The state has established a network of one Biosphere Reserve, six National Parks, six Wildlife Sanctuaries and two Conservation Reserves to conserve its biodiversity.</p>
Urban Infrastructure	<p>Uttarakhand Urban Sector Development Investment Program (UUSDIP) seeks to improve infrastructure and operational sustainability in water supply in 5 towns and sewerage infrastructure in 2 towns.</p> <p>Solid waste management (SWM) plans have been developed and approved for the three JNNURM mission towns, and SWM action plan for the other 60 ULBs are be prepared under UUDSIP</p> <p>Uttarakhand Plastic Usage & Disposal of non-biodegradable Waste Act 2012</p> <p>Through the Sparsh Ganga program, thrust is being given to keep river Ganga clean by not allowing untreatable urban waste into Ganga as it flows through townships like Uttarkashi, Tehri Garhwal, Devprayag, Rishikesh, and Haridwar etc.</p>
Water Resources	<p>Inclusion of roof top rain water harvesting in building by laws has been made compulsory in the State</p>
Energy	<p>Uttarakhand Solar Power Policy 2013 aimed at harnessing solar energy using unutilised space on rooftops and wasteland around buildings</p> <p>In order to promote renewable energy in the state, the Uttarakhand Power Corporation Limited (UPCL), is providing a rebate at Rs. 100 per month for each 100 litre installed capacity of solar water heaters</p> <p>Uttarakhand Renewable Energy Development Agency is in progress of installing a 2.4 MW Grid Interactive Wind Power Generation Project at Bacheli Khal, Distt. Tehri Garhwal, Uttarakhand.</p>

Source: Uttarakhand State Action Plan on Climate Change, 2012

Recommendations and Solutions

A combination of adaptive and preventive measures is required for combating climate change.

Adaptation

“Climate adaptation refers to the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities, or to cope with the consequences.”

Mitigation

Climate Change Mitigation refers to efforts to reduce or prevent emission of greenhouse gases. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behaviour. It can be as complex as a plan for a new city or as simple as improvements to a cook stove design. (UNEP)

Sector	Adaptive Measures	Preventive Measures
1 Agriculture	<ul style="list-style-type: none"> Promotion of less water intensive hybrid crops Development of drought resistant crops Altering the timing or location of cropping activities Using climate forecasting to reduce risk 	<ul style="list-style-type: none"> Restoration of degraded lands Promotion of better crop residue management, crop management, pasture improvement, livestock management and manure management techniques
2 Energy and Power	<ul style="list-style-type: none"> Decentralised distribution and generation of power, thereby making more power available to rural areas 	<ul style="list-style-type: none"> Promotion of non conventional and renewable sources of energy such as solar, biomass, hydro, and wind
3 Water Resources	<ul style="list-style-type: none"> Measures to combat salt water intrusion Improvement of water use efficiency by recycling water Increasing storage capacity by building reservoirs and dams Efforts to expand rain water storage Promotion of indigenous practices for sustainable water use 	<ul style="list-style-type: none"> Curbing the discharge of industrial wastes into water bodies Waste water and sludge treatment Setting up sewerage plants
4 Industry	<ul style="list-style-type: none"> Integrate climate risk management as an overall business strategy for weather dependent industries such as mining and agricultural products 	<ul style="list-style-type: none"> Enforcement of pollution control measures – carbon taxes, etc. Using energy efficient technologies Compulsory treatment of industrial waste
5 Health	<ul style="list-style-type: none"> Establishing early warning systems for heat waves and disease outbreaks Public awareness campaigns on water safety to prevent spread of water borne diseases 	<ul style="list-style-type: none"> Enforcement of pollution control measures to reduce spread of air borne and water borne diseases
6 Forestry	<ul style="list-style-type: none"> Adoption of natural resource management techniques Expansion of reserve systems Controlled burning and other techniques to reduce forest fires 	<ul style="list-style-type: none"> Efforts to increase forest cover Measures to curb the loss of forests to industry such as mining

Source: IPCC, Fourth Assessment Report, 2007

Mitigation Measures for Climate Risk Management in the Himalayan Region

Structural Measures for Mitigation

Flood Protection Measures: Communities along river banks are prone to flooding and property damage during the monsoons. Therefore flood protection measures help in mitigating such risk and damages. Construction of wired boulder walls along the rives to check the overflow of water and soil erosion have been useful in Bhutan and Himachal Pradesh.

Traditional water Harvesting Structures: Greater occurrences of droughts in the Hindu Kush Himalayas hilights the need for water conservation measures in the region. Construction of *Khattris* (Khatri is a small reservoir built at the foot of the mountains, to capture drops of moisture inherent in the mountain rocks) in Himachal Pradesh has ensured availability of water all year year round in many communities.

Non-structural Measures

Plantations: Plantations have multiple benefits in the context of climate related uncertainties and disasters. Plantations not only protect the forest cover but also work as a tangible flood mitigation measure. In flood and landslide prone areas they help stabilise the soil, while in drought prone areas they help in retaining the much needed soil moisture. Furthermore, they also support the community by providing livelihood options, fodder, and fuel wood.

Land Use Planning: Appropriate land use planning and its proper implementation reduces the risk of land degradation and promote income generation for vulnerable communities. In Dhokla district of Nepal, an agroforestry nursery was created based on the specific needs of the communities. Seedlings of plants that provide food and fodder were be made available to the people through the nursery.

How Can YOU Combat Climate Change?

- ✓ Ensure dissemination of information about climate change and its impact at the local level and the various ways to mitigate it
- ✓ Advocate renewable and cleaner energy options in areas such as transportation
- ✓ Support sustainable agricultural practices
- ✓ Support local vulnerability assessments of climate change and its impact
- ✓ Work along with ministers and peers to ensure the widespread dissemination of information on climate change and educate others on how to adapt and mitigate climate change
- ✓ Take initiatives to join existing government forums on climate change and ensure effective implementation of state specific plans on climate change
- ✓ Lobby to ensure that climate change is high on your party's agenda as it threatens socioeconomic development
- ✓ Raise questions and bring attention to issues around climate change in party meetings and parliamentary sessions
- ✓ Advocate greater budget allocation for climate change issues
- ✓ Identify clear activities in the City Development Plan to address climate change issues
- ✓ Closely engage with the private sector/ industries in your area to create enabling environment for them to invest (including their CSR budget) in environmental / clean technology / renewable energy projects

Case Studies

Select Case Studies from Across the Country

Flood Protection Measures ¹	In Bhutan, gabion walls were constructed along the river banks to avoid flooding in Bajo-Thango, Wangdue Phodrang. Along the river banks of Samdingkha, Bhutan, boulder lining in lieu of gabion wall (concrete flood protection wall), was constructed at the breach points. This was an example of a quick, easy, and cost effective risk mitigation measure. The first layer constituted of stone linings, followed by bamboos planted along the Samdingkha stretch. Bamboos have high carbon intake and are therefore stronger than most other trees, reducing the impact of floods.
Climate Change Mitigation: Solar City Thane	The Solar City Master Plan developed by ICLEI South Asia for Thane city was approved by the Thane Municipal Corporation (TMC). The municipal street lighting scheme has witnessed a 30% energy saving resulting in average saving of USD 0.4 million per annum.
Climate Change Adaptation – A Success Story in Sirpur Constituency, Dhule District	With support from the local MLC, water conservation expert Suresh Khanapurkar has demonstrated the productive use of an innovative, cost-effective, and environment-friendly model to conserve water and improve ground water situation in Sirpur constituency of Dhule district in north Maharashtra. It has not only made water available to 30 villages but also improved their ground water level. Currently the villages are able to diversify into two to three crop patterns and increase their farm productivity.
Traditional water Harvesting Structures ²	In Kangra district of Himachal Pradesh, the main hydro-meteorological hazard stems from acute shortage of water. This has resulted in large-scale migration of men for better part of the year. With a view to overcome this challenge, the traditional practice of storing and conserving water in 'Khatris' was supported under the RCRRP. Khatri is a small reservoir built at the foot of the mountains, to capture drops of moisture inherent in the mountain rocks. These structures ensure that water is stored for use all year round and meets the drinking and household requirements of the communities
Nammakal Solid Waste Management	Nammakal is probably the only and the first town in the country to become a zero garbage town. It has introduced the practice of door to door collection, night sweeping, and removal of encroachments from all roads and streets.
High Rate Biomethanation Power Project from Dairy waste at Haibowal, Ludhiana	In order to enable scientific disposal and recovery of energy from animal dung along with reducing methane (CH ₄) emissions from the atmosphere, Punjab Energy Development Agency (PEDA) set up a high rate biomethanation plant in vicinity of Haibowal dairy complex, Ludhiana. A quantity of 235 tons of cattle dungis being processed daily recovering about 18,000 kWhs of electrical energy and additionally produces 47 tons of nutrient rick bio manure per day in a land area of 2.42 acres.
Promotion of alternate sources of energy in agricultural activities	Punjab Energy Development Agency (PEDA) has been promoting the use of alternative energy besides biomass and bio-waste in the farm sector. With the help of Central Assistance,, farmers are being provided with 2 HP solar water pumping systems at subsidized cost of Rs 35,000 against the actual cost of Rs 0.45 million per pump. This initiative is aimed at saving enormous amount of diesel used in normal agricultural pump sets in Punjab.
Remote Village Electrification Programme	Supported by the MNRE, the government of West Bengal is installing solar home and street lights in the Sundarbans. Installation of solar PV systems and improved chulha for the 100 identified schools under south 24 Parganas, North 24 Parganas and Murshidabad districts has been proposed under school education programme, for West Bengal.
Low Carbon Energy Efficient LED Technology in Street Lighting	The governments of West Bengal and Odisha are piloting LED street lights project by ULBs and municipalities with support from the UK and Foreign Commonwealth Offices. Each pilot covers 350 street lights.
Afforestation Programme, Odisha	The government of Odisha is in the process of assisting natural regeneration and afforestation through planting of samplings in degraded forests. It is expected that a total of 2 lakh hectares will be covered under this programme by March 2012.
Restoration of Wetland	The state of Odisha has constituted the Odisha Wetland Development Authority with the objective of conserving the biodiversity of the area, and restoring the wetlands and protecting them against the discharge of depleting ground water.

Source: State Action Plan Reports, Ministry of Environment and Forests

^{1,2} "Managing Climate Risks in the Himalayas: A Community-centric Approach" (RCRRP)

Reference Materials

Name	Source
Key Government Documents and Websites	
12 th Five Year Plan (Volume I)	http://planningcommission.gov.in/plans/planrel/12thplan/welcome.html
Economic Survey 2012-13 (Chapter 12)	http://indiabudget.nic.in/survey.asp
Energy Efficiency	http://www.beeindia.in/
Energy Sector Management Assistance	http://www.esmap.org/esmap/
Environment Information Centre Punjab	http://punenvis.nic.in/index.aspx?langid=1
Environmental Planning, promotion & coordination	http://moef.nic.in/index.php
Guidebook on environmental awareness	http://paryavaranmitra.in/PM_Book.pdf
Environment Statistics of Punjab 2011	http://www.npr.org/documents/2009/apr/punjab_report.pdf
India's 4X4 study on climate vulnerability	http://moef.nic.in/downloads/public-information/fin-rpt-incca.pdf
India's carbon emission trajectories	http://www.moef.nic.in/downloads/home/GHG-report.pdf
India's domestic action on climate change	http://moef.nic.in/downloads/public-information/India%20Taking%20on%20Climate%20Change.pdf
India's GHG emission Inventory 2007	http://moef.nic.in/downloads/public-information/Report_INCCA.pdf
India's National Communication to UNFCCC	http://moef.nic.in/downloads/public-information/India%20Second%20National%20Communication%20to%20UNFCCC.pdf
Indian Council for Sustainable Development	http://www.icsusdev.org/
Ministry of Environment and Forests, Government of India	http://envfor.nic.in/modules/about-the-ministry/CCD/
National Action Plan on Climate Change	http://pmindia.gov.in/climate_change_english.pdf
Planning Commission – Interim Report on Low carbon Pathways for India	http://planningcommission.nic.in/reports/genrep/Inter_Exp.pdf
Planning Commission, Government of India	http://planningcommission.nic.in/aboutus/committee/wrkgrp12/enf/wgsub_climate.pdf
Uttarakhand State Action Plan on Climate Change	http://www.uttarakhandforest.org/Data/SC_Revised_UAPCC_27june12.pdf
Solid Waste Management Sector In India	http://www.pppinindia.com/pdf/ppp_position_paper_solid_waste_mgmt_112k9.pdf
Sustainable Agriculture Practices	http://punenvis.nic.in/index3.aspx?sslid=92&subsublinkid=3469&langid=1&mid=1
The Energy and Resources Institute (TERI)	http://www.teriin.org/themes/climate-change/pro1-high2.php
United Nations Development Programme, India	http://www.undp.org/content/india/en/home/ourwork/environmentandenergy/overview.html
Climate Science	
2050 Low Carbon Pathway	http://2050-calculator-tool.decc.gov.uk/
Clean Revolution	http://www.theclimategroup.org/about-us/
Climate Action Tracker	http://www.climateactiontracker.org/
Climate Analytics	http://www.climateanalytics.org/publications
Climate Change Consensus – NASA	http://climate.nasa.gov/scientific-consensus
Grantham Institute on climate change	http://www3.imperial.ac.uk/climatechange/publications
Inter Governmental Panel on Climate Change	http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#URuTax1kS04
IPCC AR 4	http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml
Renewable energy country attractiveness indices	http://www.ey.com/Publication/vwLUAssets/CAI_issue-35_Nov-2012/\$FILE/CAI_issue-35_Nov-2012_DE0372.pdf
Stern Review on the Economics of Climate Change, Executive Summary	http://siteresources.worldbank.org/INTINDONESIA/Resources/226271-1170911056314/3428109-1174614780539/SternReviewEng.pdf
Tyndall Centre for Climate Change	http://www.tyndall.ac.uk/biblio
UKCIP tools & methods to understand climate vulnerability and plan for future	http://www.ukcip.org.uk/tools/
United Nations Convention on Climate Change	http://unfccc.int/2860.php

Name	Source
Research Publications	
An overview of Indian Energy Trends: Low Carbon Growth and Development Challenges	http://www.prayaspune.org/peg/publications/item/74.html
Climate change impacts in drought and flood affected areas : Case studies in India	http://reliefweb.int/sites/reliefweb.int/files/resources/09C0395A8FE2D522492575C20006E337-Full_Report.pdf
Green Futures- India Innovation Nation	http://www.forumforthefuture.org/greenfutures/shop/special-edition/india-innovation-nation
Low Carbon Development in Emerging Economies	http://www.wri.org/project/low-carbon-development
Low Carbon Infrastructure	http://www.idfc.com/foundation/policy/india_infrastructure_report.htm
Low Carbon Transport System	http://www.teriin.org/index.php?option=com_ongoing&task=about_project&sid=88
Solar Rooftop PV in India	http://www.prayaspune.org/peg/index.php?option=com_k2&view=item&id=186:solar-rooftop-pv-in-india
International Bodies	
British High Commission, India Department of Energy and Climate Change	http://ukinindia.fco.gov.uk/en/about-us/working-with-india/climate-change/ https://www.gov.uk/government/organisations/department-of-energy-climate-change
Oxfam International	http://www.oxfam.org/en/category/oxfam-general/environment
United Nations Environment Programme World Bank	http://www.unep.org/climatechange/ http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/0,,menuPK:176751~pagePK:149018~piPK:149093~theSitePK:244381,00.html

About Athena Infonomics

Athena Infonomics is a boutique strategy and research consulting firm with a mission to generate research that will enhance policy design, planning and program implementation. With a multi-disciplinary team consisting of statisticians, engineers, economists, social scientists and management professionals, and a distinguished advisory board headed by Dr S Narayan (former Finance Secretary, Government of India and Economic Advisor to the Prime Minister of India), the organisation is well equipped to cater to a wide variety of policy questions and research problems.

The focus of the organisation is on sectors that will fuel the next phase of economic growth – SMEs, urban infrastructure, human capital, energy and sustainability. Athena specialises in delivering well researched and analytically rigorous services such as policy design, policy risk analysis, and program design & impact evaluation, among others. Athena's distinctiveness lies in its unrelenting focus on methodological rigor and multi-disciplinary approach to tackling the toughest policy issues of the day.

