Review of National Sustainable Development Policies, Priorities and Programmes Leading to Climate Change Adaptation and Mitigation

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वहाँ है खुशहाली।।

Ministry of Environment and Forests
Government of India

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Review of National Sustainable Development Policies, Priorities and Programmes Leading to Climate Change Adaptation and Mitigation

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India's development plans balance economic development and environmental concerns and the planning process is guided by the principles of sustainable development. In the last few years several measures relating sustainable development have been introduced in India, thus putting economic development on a climate-friendly path. All these measures directly or indirectly contribute to the objectives of United Nations Framework Convention on Climate Change (UNFCCC). Being a party to UNFCCC, India is required to furnish National Communication Report on implementation of the obligations under the Convention on various components of information and the various programmes/activities being taken or envisaged to be taken in accordance with Article 12.1 of the Convention.

In this context, Development Alternatives with the support from Union Ministry of Environment & Forests (MoEF) undertook a study with the purpose to review the national sustainable development policies/plans/programmes that lead to climate change mitigation and adaptation. The report eventually will contribute to India's Second National Communication to UNFCCC.

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CHAPTER 1

1.0 Climate Change Challenges

India is one of the fastest growing economies of the world. With a population of more than a billion and with nearly 28 per cent (2004-05) of population below poverty line, India's highest national priority is poverty alleviation and sustainable economic growth. Along with the growing concerns for poverty alleviation, fast depletion of natural resources, lack of access to basic facilities & infrastructure, malnutrition, social and gender equity issues, are some other development imperatives for the sustainable development of India.

In 1972, the Prime Minister of India, Mrs. Indira Gandhi emphasized, at the UN Conference on Human Environment at Stockholm, that the removal of poverty is an integral part of the goal of an environmental strategy for the world[1]. Since then it has been more than three decades that India started to plan its development pathway in a more sustainable way. With an economy largely based on natural resources, environmental management is crucial to sustainable development and vice- versa.

The fact is well recognized among planners that to achieve the national goal we need to look at various variables having direct and/or indirect impact on sustainable development. India through its 11th Five Year Plan (FYP) (2007-2012) recognizes the need for having inclusive growth. Mainstreaming sustainability concerns in developmental planning, integration/convergence of schemes, plans and programmes and its implementation in a sustainable way is integral to this type of growth strategy. To meet the target of nearly 10 per cent annual national economic growth rate at the end of the plan period and reflecting the multi-dimensional economic and social objectives of inclusive growth, the 11th FYP has set 27 monitorable targets under 6 major categories. It is for the first time that environment has been considered as a monitorable target (Annexure I) in the development plans.

This strategy could be well understood by taking an example of the Agriculture sector. 11th FYP targets for agriculture growth rate of 4% per year. Taking the inclusive approach forward, the government plans to link this sector with various schemes like PMGSY, RGGVY, Bharat Nirman, MGNREGS etc. The bottom up approach and participation of communities is being given importance by strengthening Panchayati Raj Institutions. It is also proposed that the activities under water management programmes should be linked with MGNREGS. This would help building the rural infrastructure, generate livelihood and at the same time water could be managed in a sustainable way.

India is a large developing country with nearly 700 million rural population directly depended on climate sensitive sectors (agriculture, forests and fisheries) and natural resources (such as water, biodiversity, mangroves, coastal zones, grasslands) for their subsistence and livelihoods. Further, the adaptive capacity of dry land farmers, forest dwellers, fishers and nomadic shepherds is very low. Climate change is likely to impact all the natural ecosystems as well as socio-economic systems as per the National Communications Report of India to the United Nations Framework - Convention on Climate Change (UNFCCC).

The Intergovernmental Panel on Climate Change (IPCC), in its 2007 report[2], predicts that global temperatures

1 Sustainable Development: Learnings and Perspectives from India
http://envfor.nic.in/divisions/ic/wssd/doc4/consul_book_persp.pdf

2 Intergovernmental Panel on Climate Change, 2007, Summary for Policymakers. Climate Change 2007: Impacts, Adaptation and Vulnerability Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

will rise by 2.0-4.5°C by the end of this century, with a 2.7-4.3°C increase over India by the 2080s. The panel also predicted an increase in rainfall over the Indian sub-continent by 6-8 per cent and that the sea level would rise by 88 centimetres by 2100.

Box 1: India's Development Goals

- Average GDP growth rate of 9% per year in the Eleventh Plan period (2007-2012)
- Generation of 58 million new work opportunities
- Agricultural GDP growth rate at 4% per year on the average
- Increasing the literacy rate for persons of age 7 years or more to 85 per cent by 2011-12
- Clean drinking water to be available for all by 2009, ensuring that there are no slip-backs by the end of the Eleventh Plan
- Total Fertility Rate to be reduced to 2.1 by the end of the Eleventh Plan (2007-2012)
- Malnutrition among children of age group 0-3 to be reduced to half its present level by the end of the Eleventh Plan (2007-2012)
- Anaemia among women and girls to be reduced to half its present level by the end of the Eleventh Plan (2007-2012)
- Ensuring that at least 33 per cent of the direct and indirect beneficiaries of all government schemes are women and girl children
- To ensure electricity connection to all villages and BPL households by 2009 and reliable power by the end of the Plan
- To ensure all-weather road connection to all habitations with population 1000 and above (500 and above in hilly and tribal areas) by 2009, and all significant habitations by 2015
- To increase energy efficiency by 20 per cent by 2016-17
- To increase forest and tree cover by 5 percentage points

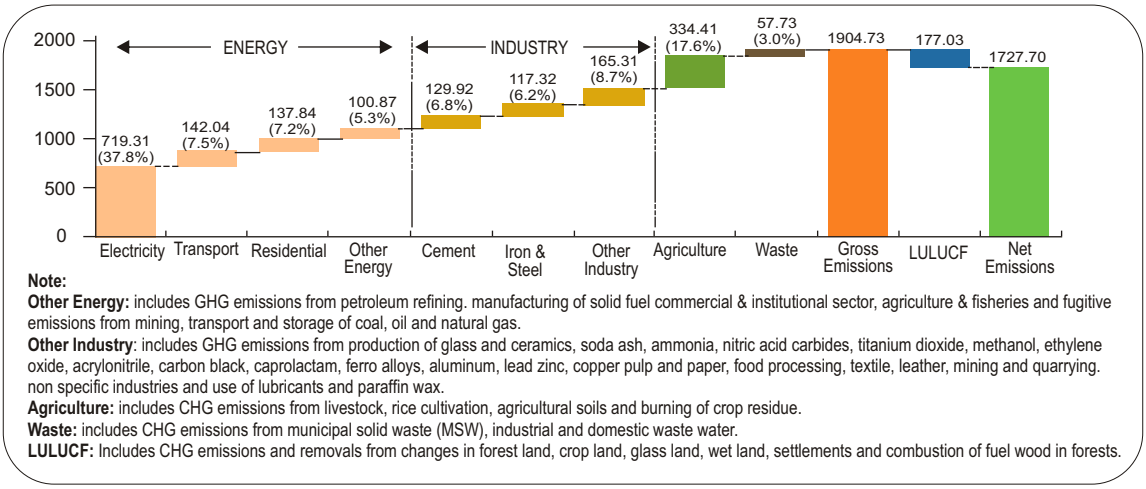
1.1 Climate Change Projections

In recent years, development planning in India has increasingly incorporated measurable goals for enhancement of human wellbeing, beyond mere expansion of production of goods and services and the consequent growth of per capita income. India has many future developmental targets, several of which are directly or indirectly linked to energy consumption and therefore to GHG emissions.

As per latest estimates by Government of India the net GHG emissions from India, that is emissions with LULUCF, in 2007 were 1727.71 million tons of CO_2 equivalent (eq) (Figure 1). Energy sector remains the highest contributor of ghg emissions from India, contributing 58 per cent of the net CO_2 eq emissions followed by, Industry (22%), Agriculture (17%) and Waste (3%). LULUCF sector was a net sink. It sequestered 177.03 million tons of CO_2 eq.[3] Per capita CO_2 eq emissions including LULUCF were 1.5 tons /capita in 2007.

3 India's Greenhouse Gas Emissions-2007, Indian Network for Climate Change Assessment, MoEF, 2009, Government of India

Figure1: GHG emissions by sector in 2007 (million tons of CO_2 eq)



Note:

Other Energy: includes GHG emissions from petroleum refining. manufacturing of solid fuel commercial & institutional sector, agriculture & fisheries and fugitive emissions from mining, transport and storage of coal, oil and natural gas.

Other Industry: includes GHG emissions from production of glass and ceramics, soda ash, ammonia, nitric acid carbides, titanium dioxide, methanol, ethylene oxide, acrylonitrile, carbon black, caprolactam, ferro alloys, aluminum, lead zinc, copper pulp and paper, food processing, textile, leather, mining and quarrying. non specific industries and use of lubricants and paraffin wax.

Agriculture: includes CHG emissions from livestock, rice cultivation, agricultural soils and burning of crop residue.

Waste: includes CHG emissions from municipal solid waste (MSW), industrial and domestic waste water.

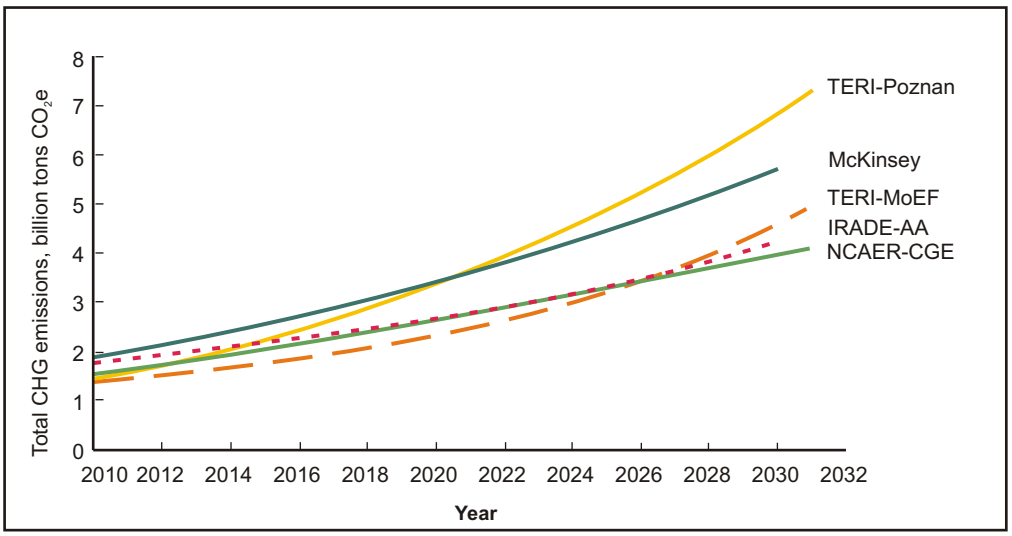
LULUCF: Includes CHG emissions and removals from changes in forest land, crop land, glass land, wet land, settlements and combustion of fuel wood in forests.

Source: India's Greenhouse Gas Emissions 2007, MoEF, 2009, Government of India

1.1.1 Green House Gas (GHG) Emission Projections

According to recent estimates, India's GHG emissions (in absolute terms) in 2031 may vary from 4.0 billion tonnes to 7.3 billion tonnes of CO_2eq, and two decades from now, India's total GHG emissions will remain under 6 billion tonnes of CO_2eq (Figure 2&3).[4]

Figure 2: Total GHG emissions projections for India (2010-2031)

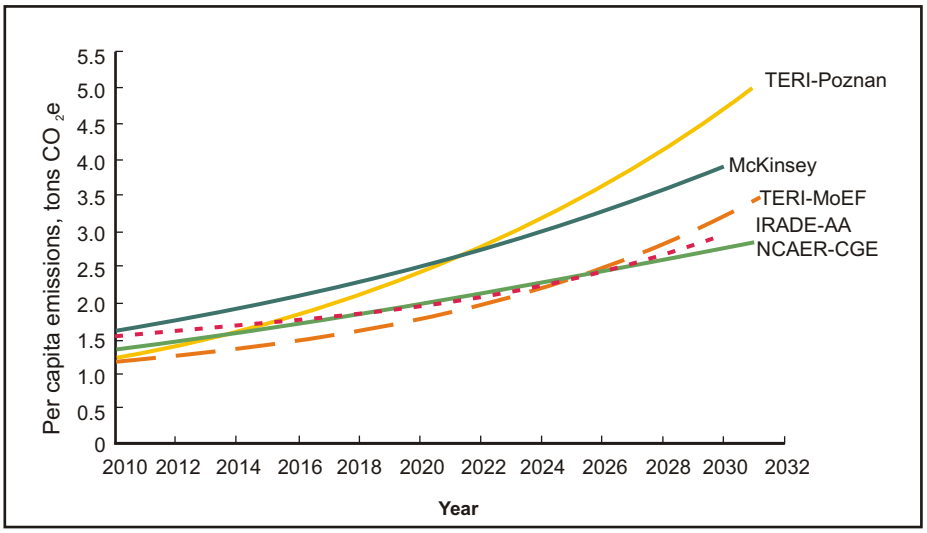


Source: Climate modeling forum, India's GHG Emissions Profile, MoEF, 2009

4 Figure 2& 3: Reference- GoI, MoEF, September 2009, Climate modeling forum, INDIA'S GHG Emissions Profile: Results of Five Climate Modelling Studies. Cumulative result of 5 modelling studies namely 1. NCAER-CGE: A computable general equilibrium (CGE) model study by India's National Council of Applied Economic Research (NCAER) 2. TERI-MoEF: A MARKet ALlocation (MARKAL) model study by The Energy & Resources Institute (TERI) 3. IRADe-AA: An Activity Analysis model study by the Integrated Research and Action for Development (IRADe) 4. TERI-Poznan: Another MARKAL model based study by The Energy & Resources Institute presented at the 14th Conference of Parties (COP) on Climate Change at Poznan 5. McKinsey: A detailed sector by sector analysis of GHG emissions by McKinsey and Company

The per capita GHG emissions of India are estimated to be 2.1 tonnes of CO_2eq in the year 2020, and 3.5 tonnes of CO_2eq in the year 2030. It is notable that the estimated per capita emissions of India in 2020 are expected to be well below those of the developed countries, even if the developed countries were to take ambitious emission reduction targets (25-40%) as recommended by the Intergovernmental Panel on Climate Change (IPCC) for the mid-term[5].

Figure 3: Per capita GHG emissions projections for India (2010-2031)



Source: Climate modeling forum, India's GHG Emissions Profile, MoEF, 2009

Both the energy intensity as well as the CO_2eq intensity of the Indian economy falls continuously till 2030-31. India's energy use patterns and GHG emissions profile will continue to be among the most sustainable in the world for the next generation[6].

Though the GHG emissions projection of India predicts less energy intensive growth, but other climatic variability projections raises concerns for the socioeconomic vulnerability and environmental sustainability of the country.

1.2 Impacts

The Intergovernmental Panel on Climate Change, in its 2007[7] report, predicts that global temperatures will rise by 2.0 - 4.5^{0}C by the end of this century, with a 2.7-4.3^{0}C increase over India by the 2080s. The panel also predicted an increase in rainfall over the Indian sub-continent by 6-8 per cent and that the sea level would rise by 88 centimeters by 2100. Climate change is predicted to result in increase in mean sea level, as well as

5 GoI, MoEF, September 2009, Climate modeling forum, INDIA'S GHG Emissions Profile: Results of Five Climate Modelling Studies. Cumulative result of 5 modelling studies namely 1. NCAER-CGE: A computable general equilibrium (CGE) model study by India's National Council of Applied Economic Research (NCAER) 2. TERI-MoEF: A MARKet ALlocation (MARKAL) model study by The Energy & Resources Institute (TERI) 3. IRADe-AA: An Activity Analysis model study by the Integrated Research and Action for Development (IRADe) 4. TERI-Poznan: Another MARKAL model based study by The Energy & Resources Institute presented at the 14th Conference of Parties (COP) on Climate Change at Poznan 5. McKinsey: A detailed sector by sector analysis of GHG emissions by McKinsey and Company

6 GoI, MoEF, September 2009, Climate modeling forum, India'S GHG Emissions Profile: Results of Five Climate Modelling Studies

7 IPCC, Fourth Assessment Report, 2007

possible increases in the frequency and intensity of coastal surges and cyclones that already caused significant damage to coastal populations. A one meter rise in sea level is projected to displace approximately 7.1 million people in India and about 5,764 sq. km. of land area will be lost, along with 4,200 km, of roads (NATCOM I, GoI). As per latest estimates by National Institute of Oceanography mean sea level rise estimates were found to be slightly less than 1 mm/yr.[8]

For comprehensive national as well as state level impact assessments Government of India lunched "Indian Network of Climate Change Assessment (INCCA)" in 2009. Under INCCA, recently a report was released, which brings a review of impacts of climate variability in the four major climate sensitive regions of India, namely, the Himalayan region, the North-Eastern region, the Western Ghats and the Coastal region. The report presents climate change impact assessments in the 2030s on key sectors namely, Agriculture, Water, Natural Ecosystems and Biodiversity and Human Health. Assessments made at such short time lines are unique as they can be used to develop adaptation strategies for a foreseeable future. Estimates made on climate change scenarios and projections[9] for 2030s depicts following[10]:

Temperature: Simulations for the 2030s indicate an all-round warming over the Indian subcontinent associated with increasing GHG concentrations. The annual mean surface air temperature is projected to rise by 1.7°C and 2.0°C in 2030s. Seasons may be warmer by around 2.0°C towards the 2030s. The variability of seasonal mean temperature may be more in winter months. An annual mean surface temperature rise by the end of this century, ranging from 3°C to 5°C (under A2 scenario) and 2.5°C to 4.0°C (under B2 scenario), with the warming more pronounced in the northern parts of India. Assessment also indicates that both the daily extremes in surface air temperature, i.e. daily maximum and daily minimum may intensify in the 2030s. Night temperatures are likely to rise more over the south peninsula and central and northern India. Central and northern India may experience an increase in daytime warming also.

Precipitation: Estimates for all four regions i.e. Himalayan , Coastal, Western Ghats and North-Eastern region show a small increase in annual precipitation in the 2030s, with respect to the baseline, that is, 1961 1990s (or 1970s). Projections for the 2030s indicate that the frequency of rainy days is likely to decrease in most parts of the country. Presently, the intensity of a rainy day is more along the western coast, especially in the Western Ghats, and North-East India.

Cyclones: Observations since 1986 indicate a decreasing frequency in cyclones along the eastern coast surrounded by the Bay of Bengal and the Northern Indian ocean. Also, no trend is seen in the western coast along the Arabian sea for the same period. The projected number of cyclonic disturbances along both the coasts in the 2030s is likely to decrease with respect to the 1970s. However, cyclonic systems might be more intense in the future.

Sea Level Rise: Observations based on tide gauge measurements along the Indian coast, for a period of 20 years and more for which significantly consistent data is available indicate that the sea level along the Indian coast has been rising at the rate of about 1.3mm/year on an average. During 2000 to 2020 under the SRES-A1B scenario in the ensemble of Atmosphere-Ocean General Circulation Models (AOGCMs), the rate of thermal expansion

8 Investigating Impacts of climate change in India- An Indo-UK Collaborative Study 2008. GoI, MoEF, UK's Department for Environment, Food and Rural Affairs (DEFRA) Undertaken by IITM, IARI, TERI, IISc, NIO, NPL

9 Climate change scenarios have been derived from a regional climate change model PRECIS with the resolution of 50km X 50km and forced by a Green House Gas (GHG) emission scenario emanating from A1B, IPCC SRES (Special Report on Emission Scenario; IPCC,2000). The 2030s is the average of the period 1961 to 1990s , also refereed to as the 1970s or the baseline

10 Climate Change and India: A 4X4 Assessment. A sectoral and regional analysis for 2030s. Indian Network for Climate Change Assessment (INCCA), Nov 2010, Government of India

is projected to be 1.3 ± 0.7mm/year, and is not significantly different under the A2 or B1 scenarios (Meehl et al., 2007)[11].

Storm Surges: Storm surges return periods could only be estimated on a 100-year time scale. All locations along the eastern coast of India that are north of Vishakhapatnam, except at Sagar and Kolkata, show an increase in storm surge levels in the 100-year return period by about 15 per cent to 20 per cent with respect to the 1970s. For Sagar and Kolkata, the two stations considered in the head Bay, the increase in the 100-year return levels was found to be less than 5 per cent for the future scenario.

Climate changes characterized as global warming are leading to large-scale irreversible effects at continental and global scales. The likelihood, magnitude, and timing is observed to be increasing and accelerating. The IPCC reports that the effects of global warming will be mixed across regions. For smaller values of warming (1 to 3°C), changes are expected to produce net benefits in some regions and for some activities, and net costs for others. Greater warming may produce net costs in all regions. Developing countries are vulnerable to reduced economic growth as a result of global warming[12]. Number of studies has been conducted worldwide to estimate the future climate change impact on different sectors and communities. Some of the sectoral projections for India are presented below:

1.3 Projected Sectoral Impacts

1.3.1 Agriculture

Agriculture is one of the most vulnerable sectors to climate change. Weather changes will adversely affect crop yields, increasing the likelihood of short-run crop failures and long-run production declines, while encouraging weed and pest proliferation. There will be some gains in certain crops in specific regions of the world, but the overall impacts of climate change on agriculture are expected to be negative, which will threaten global food security. South Asia will be particularly worse hit (IFPRI, 2009).[13]

In India the effects will be felt more severe with the economy largely dependent on agriculture (Javed. 2005).[14] Most of the simulation studies have shown a decrease in the duration and yield of crops as temperature increased in different parts of India (Aggarwal et al., 2001)[15]. The magnitude of this response varied with crop, region and climate change scenario. With increase in temperature (by about 2 - 4° C) the wheat & rice potential grain yields would reduce in most places. However, if the temperature increases are higher, western India may experience some negative effect on productivity due to reduced crop durations (NATCOM-I, GoI).

Reductions in wheat yields as a result of climate change (with 2°C rise) are predicted to be more pronounced for rain fed crops (as opposed to irrigated crops) and under limited water supply situations (IARI, 2008)[16]. Study also predicts boundary changes in areas suitable for growing certain crops such as wheat due to climate

11 Meehl G A, Stocker T F, Collins W D, Friedlingstein, Gaye A T, Gregory JM, Kitoh A, Knutti R, Murphy J M, Noda A, Raper S C B, Watterson I G, Weaver A J and Zhao Z C, (2007). Global Climate Projections, Climate Change 2001: The Scientifi c Basis. Contributions of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. [Solomon S D, Qin, Manning M, Chen Z, Marquis M, Averyt K B, Tignor M and Miller H L (eds.)]. Cambridge University Press, Cambridge, UK. 385-432

12 State of Environment Report India 2009, MoEF, Government of India

13 International Food Policy Research Institute 2009. Climate Change: Impact on Agriculture and costs on adaptation. IFPRI Washington D.C.

14 Javed, A.2005. Vulnerability mapping: A GIS based approach to identity vulnerable regions to climate change. Available at http://www.gisdevelopment.net/magazine/years/2005/dec/28_1.htm

15 Aggarwal, P.K., Nagarajan, S. and Udai Kumar. 2001. Climate Change and Indian Agriculture: Current State of Understanding and Future Perspectives. Report submitted to the Indian Council of Agricultural Research, New Delhi

change**.** In sub tropical environments the decrease in potential wheat yields ranged from 1.5 to 5.8 per cent, while in tropical areas the decrease was relatively higher, suggesting that warmer regions can expect greater crop losses.[17] Reduction in rice yield with 2°C rise in temperature is also predicted[18]. Eastern regions are predicted to be most impacted by increased temperatures and decreased radiation, resulting in relatively fewer grains and shorter grain filling durations for rice. By contrast, potential reductions in rice yields due to increased temperatures in Northern India are predicted to be offset by higher radiation, lessening the impacts of climate change[19].

Recent estimates by Government of India showcase possible impacts of climate change on major crops (of Himalayan region, Coastal region, Western Ghats and North-Eastern regions), such as rice, maize and sorghum, apple and coconut plantations in the 2030s. Key findings are as follows:[20]

Rice

Western Ghats: The productivity of irrigated rice is likely to change + 5 to 11% , depending upon the location. A majority of the region is projected to lose the yield by about 4 per cent. However, irrigated rice in parts of southern Karnataka and the northern-most districts of Kerala are likely to gain. In the case of rain-fed rice, the change in yield will range between 35 and + 35%. A large portion of the region is likely to lose rice yields by up to 10 per cent. The results thus indicate that irrigated rice is able to benefit due to the CO_2 fertilization effect as compared to rain-fed rice, which is supplied with less amount of fertilizers.

Coastal Region: Climate change is projected to reduce the yields of irrigated rice by about 10 per cent to 20 per cent in this region. However, in some coastal districts of Maharashtra, northern Andhra Pradesh and Orissa, irrigated rice yields are projected to marginally increase by 5 per cent with respect to the 1970s. On the other hand, rain-fed rice yields are projected to increase up to 15 per cent in many of districts in the east coast, but reduce by up to 20 per cent in the west coast.

North Eastern Region: Irrigated rice yields in this region may range between about 10 per cent to 5 per cent with respect to the 1970s, while the impact on rain-fed rice is likely to be in the range of 35 per cent to 5 per cent in A1B 2030 climate scenarios in North-Eastern regions.

Maize and Sorghum

Western Ghats: Climate change is likely to reduce yields of maize and sorghum by up to 50 per cent, depending upon the region. These crops have a C4 photosynthetic system and hence do not have a relative advantage at higher CO_2 concentrations

Coastal Region: Impacts of climate change on irrigated maize in the coastal districts are projected to be high with yield loss between 15 and 50 per cent, whereas in the case of rain-fed maize, the projected yield loss is up

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16 Investigating Impacts of climate change in India- An Indo-UK Collaborative Study, 2008. GoI, MoEF, UK's Department for Environment, Food and Rural Affairs (DEFRA) Undertaken by IITM, IARI, TERI, IISc, NIO, NPL

17 Investigating Impacts of climate change in India- An Indo-UK Collaborative Study, 2008. GoI, MoEF, UK's Department for Environment, Food and Rural Affairs (DEFRA) Undertaken by IITM, IARI, TERI, IISc, NIO, NPL

18 Investigating Impacts of climate change in India- An Indo-UK Collaborative Study, 2008. GoI, MoEF, UK's Department for Environment, Food and Rural Affairs (DEFRA) Undertaken by IITM, IARI, TERI, IISc, NIO, NPL

19 Investigating Impacts of climate change in India- An Indo-UK Collaborative Study, 2008. GoI, MoEF, UK's Department for Environment, Food and Rural Affairs (DEFRA) Undertaken by IITM, IARI, TERI, IISc, NIO, NPL

20 Climate Change and India: A 4X4 Assessment. A sectoral and regional analysis for 2030s. Indian Network for Climate Change Assessment (INCCA), Nov 2010, Government of India

to 35 per cent. In some districts of coastal Andhra Pradesh, rain-fed maize yields are likely to increase by 10 per cent. The projected increase in seasonal maximum temperature in these areas is less than 1°C in the 2030 scenario.

North Eastern Region: Maize crop yields are projected to reduce by about 40 per cent in the region.

Coconut

Western Region: Coconut yields are projected to increase by up to 30 per cent in the majority of the region by the 2030s. Increase in coconut yield may be mainly attributed to the projected increase in rainfall (~10%) and relatively less increase in temperatures, apart from the CO_2 fertilization benefits. However, some areas like southwest Karnataka, parts of Tamil Nadu and parts of Maharashtra may show reduction in yields by up to 24 per cent.

Coastal Region: Yields of coconut are projected to increase in the west coast of India by up to 30 per cent (provided the 134 current level of water is made available in the future scenario as well), while in the east coast specifically in the north coastal districts of Andhra Pradesh, yields may increase by about 10 per cent. All other coastal districts in eastern coast and those in the Gujarat coast are projected to lose coconut yields by up to 40 per cent.

Fisheries: An increase in recruitment and catches of oil sardine during the post-southwest monsoon season along the coastal region, especially along the Kerala coast, is expected in the future due to warming, elevated Sea Surface Temperature (SST), favourable wind (and perhaps current) and increasing Coastal Upwelling Index (CUI) inducing higher chlorophyll concentration during the southwest monsoon. The Indian mackerel is predominant in the south-west coast. The Indian mackerel is able to take advantage of the increase in temperatures of subsurface seawater. Therefore, with increase in global temperatures and sea surface temperatures, it is likely to move northwards and deeper into the seas surrounding it. Threadfin breams (Nemipterus Japonicus and Nemipterus Mesoprion) are distributed along the entire Indian coast at depths ranging from 10m to 100m. In the climate change context, in the 2030s if the SST exceeds 28°C during April to September, an increase in catch might take place in the comparatively cooler months of October to March.

1.3.2 Water Resources

In India, demand for water has already increased manifold over the years due to urbanization, agriculture expansion, increasing population, rapid industrialization and economic development. Ad hoc expansion of surface and groundwater resources, random dumping of municipal and industrial wastes and application of agricultural inputs has led to the problem of water quality deterioration / pollution leading to challenges in water management and conservation. Today, in most agro climatic regions and river basins of India the hydrological cycle is being modified quantitatively and or qualitatively, by water storage, irrigation and drainage (Mall et al, 2006).[21] Anthropogenic climate changes, i.e. modifications in cropping and land-use patterns, over-exploitation of water storage and changes in irrigation and drainage in the Gangetic basin show a reduction in the Ganges discharge by 60 per cent over 25 years. This has led to about 50 per cent drop in water availability in surface water resources, drop in groundwater table and generation of new surface features having different thermal properties (Mall et al. 2007).[22]

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21 Mall, R.K., Gupta, A., Singh, R., Singh, R. S., & Rathore, L.S, 2006. Water Resources and climate change: An Indian Perspective. Current Sicence, Vol 19 (12), pp 1610-1626

22 Mall, R.K., Bhatla, R., & Pandey, S.N. 2007. Water Resources in India and Impact of climate change. Jlvigyan Sameeksha, Vol 22

Projections made under the India's First National Communication to UNFCCC (NATCOM - I, GoI) indicate overall increase in precipitation for major river basins i.e. Mahanadi, Brahmani, Ganga, Godavari, and Cauvery of India. In the remaining basins, a decrease in precipitation is projected. The resultant total run-off for the majority of the cases, except for the Narmada and Tapi, is projected to decline. Luni, the west flowing river of Kutchh and Saurastra are likely to experience acute physical water scarce conditions. The river basins of Mahi, Pennar, Sabarmati and Tapi are likely to experience constant water scarcities and shortage. The river basins of Cauvery, Ganga, Narmada and Krishna are likely to experience seasonal or regular water-stressed conditions. The river basins of the Godavari, Brahmani and Mahanadi are projected to experience water shortages only in a few locations.

Findings of Indian Institute of Tropical Meteorology (IITM)[23] to some extent are aligned to the above mentioned predictions. As per the study the hydrological cycle is predicted to be more intense, with higher annual average rainfall as well increased drought. There is a predicted increase in extreme rainfall and rainfall intensity in Ganga, Krishna and Godavari river basins towards the end of the 21st century. The intensity of daily rainfall is also predicted to increase. Results also indicate decrease in the number of rainy days with in the western parts of the Ganga basin. Although results show a general increase in surface water availability for Ganga basin (also for Krishna and Godavari) future population projections would need to be considered to project per capita water availability.

Regional estimates, by Government of India[24], of climate change impacts on water resources assessed the water yield for various river basins of India The water yield in the Himalayan region, mainly covered by river Indus, is likely to increase by 5 per cent to 20 per cent in most of the areas, with some areas of Jammu and Kashmir and Uttarakhand showing an increase of up to 50 per cent with respect to the 1970s. For North-Eastern region, the trend in precipitation exhibits considerable spatial variability in water yield in the 2030s but is in line with the projected patterns of precipitation and evapotranspiration. The northern parts of the North-East in the 2030s, with respect to 1970s, show a reduction in precipitation by 12 per cent. The central portion of the North-eastern region shows an increase in precipitation by 0 per cent to 25 per cent. However, the majority of the North-Eastern region except for Mizoram, Tripura, Manipur and Assam shows an increase in the evapotranspiration in the 2030s. As a result, a reduction in water yield by up to 20 per cent is projected for Arunachal Pradesh. The increase in the water yield in Assam and Manipur is projected to increase by 40 per cent. The northern portion of the Western Ghats shows a decrease in the water yield, ranging from 10 per cent to 50 per cent in the 2030s with respect to the 1970s. The central portion, however, indicates an increase in the water yield between 5 per cent and 20 per cent. The southern portions of Karnataka and Kerala show a decrease in the yields up to 10 per cent. There is a general reduction in water yield (as less as 40 per cent). in the eastern coastal region of West Bengal, Orissa and the northern coastal regions of Andhra Pradesh. However, in the southern parts of Andhra Pradesh and northern parts of Tamil Nadu, the water yield is projected to rise by 10 to 40 per cent. The western coastal region also shows an overall reduction in water yield (ranging from 1 per cent to 50 per cent) except for the coast along Karnataka, which shows an increase in water yield in the 2030s by 10 per cent to 20 per cent with respect to the 1970s. No change in water yield is projected for the 2030s in the southern tip of the coastal region.

Impact of above mentioned climate change projection on frequency of droughts and floods were also studied.

23 Investigating Impacts of climate change in India- An Indo-UK Collaborative Study 2008. GoI, MoEF, UK's Department for Environment, Food and Rural Affairs (DEFRA) Undertaken by IITM, IARI, TERI, IISc, NIO, NPL

24 Climate Change and India: A 4X4 Assessment. A sectoral and regional analysis for 2030s. Indian Network for Climate Change Assessment (INCCA), Nov 2010, Government of India

Estimates[25] shows an increase in the drought development for those areas of various regions that have either projected decrease in precipitation or have enhanced level of evapo-transpiration in the 2030s. Similarly, the weeks belonging to moderate soil moisture stress show an increase in severity of drought from baseline to the mid-century scenario, which is self-evident. It is very evident from the depiction that the moderate to extreme drought severity has been pronounced for the Himalayan region where the increase is more than 20 per cent in many areas despite the overall increase in precipitation. Study also indicates that the flooding varies from 10 per cent to over 30 per cent of the existing magnitudes in most of the regions. This will have a very severe implication for existing infrastructure such as dams, bridges, roads, etc., in the areas and will require appropriate adaptation measures to be taken up.

1.3.3 Forestry

India is a mega-biodiversity country with forests accounting for almost 20 per cent (64 million ha) of the geographical area. Climate change is predicted to result in a large scale shifting and change of forest biomes throughout India. Over half of the vegetation is likely to find itself less optimally adapted to its existing location, making it vulnerable to adverse climatic conditions and to biotic stresses (Ravidranath et al, 2006)[26]. Whilst this may benefit some forest biomes, it may also cause irreversible damage to others, rendering several species extinct and affecting markets, water supply, and energy production. These shifts will impact livelihoods at a community level, as well as impact trade of forest products at the regional and national levels[27].

Considerable shifts in vegetative cover are likely to occur throughout India in the short, medium, and long term, as a result of climate change. The biome type most seriously impacted is the Dry Savanna. The country's dominant forest cover, characterized by Moist Savanna (32.5%) and Dry Savanna (33%) is projected to change (year 2085), such that Tropical Dry Forest (37.2%) and Tropical Seasonal Forest (28.4%) become dominant. To a smaller extent, Xeric Shrubland is set to decrease in area and Xeric Woodland is expected to increase in the drier regions, while in the colder regions, Boreal and Temperate Conifer coverage decreases while Temperate Deciduous and Temperate Evergreen coverage increases (IISc, 2008)[28]. More recently, regional predications by Government of India[29] concluded that the forest vegetation types in the four eco-sensitive regions are vulnerable to projected climate change in the short term, that is, in the 2030s, even under a moderate climate change scenario (A1B). The impacts vary from region to region and are as follows:

Himalayan region: The Himalayan region considered in the study includes the states of Jammu and Kashmir, Uttarakhand and Himachal Pradesh. Of the 98 IBIS grids covering this region, 56 per cent of the grids are projected to undergo change in the 2030s. The net primary productivity (NPP) is projected to increase in the region by about 57 per cent on an average by the 2030s.

North-Eastern region: Much of the dense forests of Assam, Nagaland and Arunachal Pradesh are part of the Himalayan biodiversity hotspot. In the North- Eastern region only about 8 per cent of the 73 forested grids are projected to undergo change in the 2030s. The region is projected to see an increase of 23 per cent in NPP on an average.

25 Climate Change and India: A 4X4 Assessment. A sectoral and regional analysis for 2030s. Indian Network for Climate Change Assessment (INCCA), Nov 2010, Government of India
26 Ravidranath. N.H, Joshi, N.V, Sukumar, R. and Saxena, A. 2006. Impact of Climate change on forests in India. Current Science, Vol 90 (No. 3)
27 Investigating Impacts of climate change in India- An Indo-UK Collaborative Study. 2008. GoI, MoEF, UK's Department for Environment, Food and Rural Affairs (DEFRA) Undertaken by IITM, IARI, TERI, IISc, NIO, NPL
28 Investigating Impacts of climate change in India- An Indo-UK Collaborative Study. 2008. GoI, MoEF, UK's Department for Environment, Food and Rural Affairs (DEFRA) Undertaken by IITM, IARI, TERI, IISc, NIO, NPL
29 Climate Change and India: A 4X4 Assessment. A sectoral and regional analysis for 2030s. Indian Network for Climate Change Assessment (INCCA), Nov 2010, Government of India

Western Ghats: The entire Western Ghats region is covered by 54 forest grids, out of which 18 per cent are projected to undergo change in the 2030s. The NPP of the region is projected to increase by 20 per cent on an average.

Coastal region: The coastal region is defined by all districts that lie on the Indian coast. The entire coastal region is covered by 96 grids, excluding the grids in the Western Ghats. Of these, 30 per cent are projected to undergo change. The NPP in this region is predicted to rise by 31 per cent on an average.

1.3.4 Health

The health affects of climate change on disease patterns across the world will be severe, especially in developing countries due to their existing vulnerabilities related to poor health. Climate change will add to this challenge, worsening this burden and posing challenging questions for public and global health (UCL, 2009).[30] The estimates indicate that there will be a rise in temperature related illnesses, vector borne diseases, health impacts related to extreme weather events and effects due to food insecurity (DEFRA,2008).[31]

A assessment by Government of India[32] indicates that morbidity and mortality of the human population in the Himalayan, Coastal, western, and North-eastern regions are likely to increase with warming temperatures and variable precipitation as they have direct as well as indirect effects. Direct effects can manifest as heat stress and indirect effects can be in terms of vector borne diseases, water borne diseases and malnutrition etc. Projections of malaria transmission windows for the 2030s, reveal introduction of new foci in Jammu and Kashmir and an increase in opening of more transmission months in districts of the Himalayan region[33]: and north-eastern states. The transmission windows in Jammu and Kashmir, however, still remain open only for 02 months in the 2030s. For North-Eastern region there is a likelihood that the windows of transmission of malaria may increasingly remain open for at least 79 months and may even remain open for a larger number of months (10-12 months) in a year. While in the Western Ghats malaria transmission is projected to experience no change with respect to current scenario (likely to remain open for 10-12 months in a year) for coastal regions (particularly the east coast) it is projected to experience reduction in the number of months open for transmission. The number of times it is open for in 10-12 months may reduce by 34 per cent. The rise of these diseases are likely to heighten problems in the rationing of health care, which already presents complex moral and social dilemmas (UCL, 2009).[34] In India it is estimated that there will be a much greater impact than other countries in similar positions (UNIDO, 2008).[35] This will be due to a 'unique combination of its geography, diverse population characteristics and extremely high dependence on fossil fuels. The National Rural Health Mission (NRHM), the flagship programme of India's strategy for health improvement, is focusing on strengthening the health delivery systems. However, there is a risk, that these efforts may be undermined by the additional climate-related burden of disease. It is also recognized that climate change may delay progress towards achieving many of the Millennium Development Goals (MDGs) (Confalonieri, et al. 2007).[36]

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30 UCL (2009) Managing the Health Effects of Climate Change. The UCL Lancet Commission on Managing the Health Effects of Climate Change

31 Investigating Impacts of climate change in India- An Indo-UK Collaborative Study. 2008. GoI, MoEF, UK's Department for Environment, Food and Rural Affairs (DEFRA) Undertaken by IITM, IARI, TERI, IISc, NIO, NPL

32 Climate Change and India: A 4X4 Assessment. A sectoral and regional analysis for 2030s. Indian Network for Climate Change Assessment (INCCA), Nov 2010, Government of India

33 In this assessment, the study area in the Himalayan region includes the northern states in the North-Eastern region as well as the states of Jammu and Kashmir, Himachal Pradesh and Uttarakhand in the North-western Himalayas.

34UCL (2009) Managing the Health Effects of Climate Change. The UCL Lancet Commission on Managing the Health Effects of Climate Change.

35 UNIDO (2008) India more vulnerable to climate change. The Times News Network

36 Confalonieri U, Menne B, Akhtar R, Ebi KL, Hauengue M, Kovats RS, Revich B, Woodward A.2007, Human health In: Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. ML Parry, OF Canziani, JP Palutikof, PJ van der Linden, CE Hanson. Eds. Cambridge: Cambridge University Press. pp. 391-431

2.0 Climate Change

- Development Linkages

Poverty alleviation and sustained economic growth are two prime national development imperatives. Climate change projections showing erratic rainfall and weather patterns, natural hazards, rising temperature etc. would have an adverse impact on food security, energy security, livelihood security and environmental sustainability which would affect the socio-economic condition of the nation.

2.1 Food Security

Climate change associated variables such as CO_2 and temperature can influence food availability through their direct effect on growth processes and yield of crops. In addition, it may also impact crop production through indirect effects caused by, for example, change in rainfall induced irrigation availability, soil organic matter transformations, soil erosion, changes in pest profiles, and decline in arable areas due to the submergence of coastal lands. Equally important determinants of food supply are socioeconomic environment including government policies, capital availability, prices and returns, infrastructure, land reforms, and intra- and international trade that might be affected by climatic change (NATCOM-I, GoI).

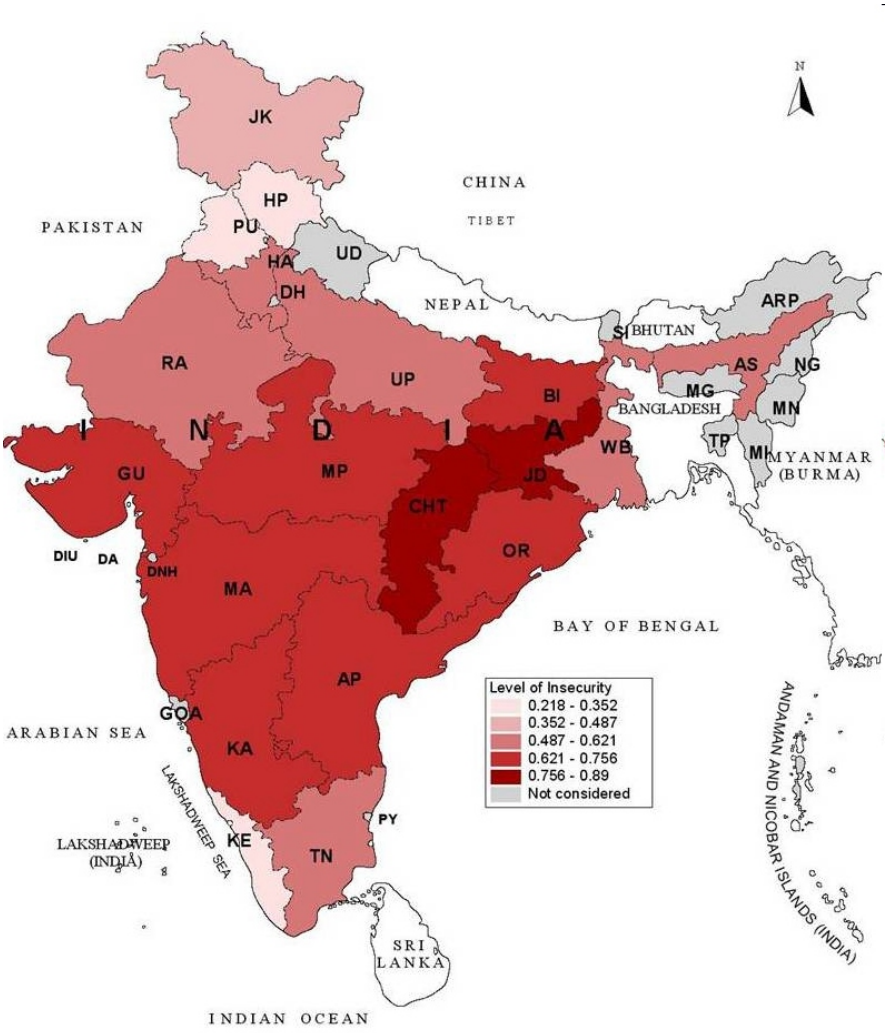
India is home to more than 230 million undernourished people, which is 21 per cent of the national population (Figure 4)[37]. Climate change will act as a multiplier of existing threats to food insecurity. Food security of India may be at risk in the future due to the threat of climate change leading to an increase in the frequency and intensity of droughts and floods, thereby affecting production of small and marginal farms, (SoE India-2009).[38] By 2050, the risk of hunger is projected to increase by 10 - 20 per cent, and child malnutrition is anticipated to be 20 per cent higher compared to a no-climate change scenario. In the past 50 years, there have been around 15 major droughts, due to which the productivity of rain crops in those years was affected (SoE India -2009).[39]

Sea level rise and warming of inland waters would also have effects on fisheries. Fish products provide more than 2.8 billion people (2.6 billion of whom are from developing countries) with about 20 percent of their average per capita intake of animal protein. Climate change impacts on fisheries will potentially act across the four dimensions of food security: availability, stability, access and utilization. It is very likely that over the short term (within a few years), there will be negative impacts on the physiology of fish in localities where temperatures increase, through limiting oxygen transport. This would have significant impacts on aquaculture and result in changes in distribution, and probably abundance, of both freshwater and marine thereby affecting livelihoods as well as food security.[40]

Decreasing availability of water and food will also increase sanitation and health problems and increase the risk of diseases and malnutrition. Competition over increasingly scarce resources will also increase the risk of conflicts, displacement and migration, which in turn will again increase the risk of food insecurity.[41]

37 FAO, 2008. State of Food Insecurity in the World
38 State of Environment Report India (2009), MoEF, Government of India
39 State of Environment Report India (2009), MoEF, Government of India
40 FAO, Rome , 2008, Climate Change For Fisheries And Aquaculture, Technical Background Document From The Expert Consultation Held On 7 - 9 April 2008
41 Climate Change, Food Insecurity and Hunger Technical Paper for the IASC Task Force on Climate Change Submitted by WFP, FAO, IFRC and OXFAM, as well as WHO, WVI, CARE, CARITAS and Save the Children, November 2009

Figure 4: Food Insecurity Map of India



Source: WFP, MSSRF 2008, Report on the State of Food Insecurity In Rural India

2.2 Livelihood Security

60 per cent of India's work force is dependent on agriculture. Temperature changes, erratic rainfall and weather patterns would have additional pressure on livelihood and employment in India thus affecting the development imperatives of economic growth & poverty alleviation.

Livelihood of a significantly large population in India is dependent on the ecosystem products of the Himalayas such as agriculture & forests. Climate Change projections indicate that the water resources dependent on glaciers in this region will enhance in the short term but will rapidly deplete. As a result agriculture thriving in this region is likely to face huge adverse impacts. Similarly die back and shifting of certain forest species have been projected in this region[42]. This impact would adversely affect livelihood based on agriculture & forestry in Himalayas. For India major impacts of climate change will be on rain fed crops (other than rice and wheat),

42"Climate Change and India: Towards Preparation of a Comprehensive Climate Change Assessment." MoEF, GoI

which account for nearly 60 per cent of cropland area.[43] In the past 50 years, there have been around 15 major droughts, due to which the productivity of rain crops in those years was affected. Limited options of alternative livelihoods and widespread poverty continue to threaten livelihood security of millions of small and marginal farmers in the rain-fed agriculture region(SoE India - 2009).[44]

Sea level rise is projected to displace populations in coastal zones, increase flooding in low-lying coastal areas, loss of crop yields from inundation and salinization[45]. In India, potential impacts of 1 m sea-level rise include inundation of 5,763 km^2. Climate change would affect coastal communities depending on fisheries as their main livelihood option. Fishery-dependent communities may also face increased vulnerability in terms of less stable livelihoods, decreases in availability or quality of fish for food, and safety risks due to fishing in harsher weather conditions and further from their landing sites[46]. Significant losses of coastal ecosystems would affect the aquaculture industry, particularly in heavily-populated mega-deltas.

2.3 Energy Security

In India over 487 million people have no access to electricity (2005)[47]. In order to deliver a sustained growth of 8 per cent through 2031, India would at least need to grow its primary energy supply by 3 to 4 times whereas the electricity supply needs to grow at the rate of 5 to 7 times the present (2006) consumption.[48]

Many sectors affected by climate change will have indirect impacts on the energy sector. A major sector that causes indirect impact on energy is agriculture. Agriculture is very sensitive to climate change. Climate change in India will result in temperature rise and a changing precipitation pattern. The evaporation rate is also expected to rise because of the temperature increase. All these put together will affect the water requirement for agriculture which will be greater, resulting in a higher demand of energy for irrigation. The domestic water demand is also expected to increase, which would in turn affect the energy required for the water supply system (NATCOM - I, GoI).

Meeting the basic needs of access to energy and at the same time addressing the growing concerns of climate change is a challenge for India. Enhancing energy supply and access to energy is a key component of the national development strategy. At the same time focus of policies and programmes on reducing energy intensity & enhancing energy efficiency should be stressed.

2.4 Gender Equity

The fact that the women in the developing world will be one of the biggest sufferers from the effects of climate change has been widely recognized. According to a recent report from the World Conservation Union/

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43 Climate Change and Food Security in India. Dr. N. Chattopadhyay Department International Symposium on Climate Change and Food Security in South Asia August 25-30, 2008 Dhaka, Bangladesh
44 State of Environment Report India, 2009, MoEF, Government of India
45 Climate Change and Food Security in India, Dr. N. Chattopadhyay Department International Symposium on Climate Change and Food Security in South Asia August 25-30, 2008 Dhaka, Bangladesh
46 FAO, Rome , 2008, Climate Change for Fisheries And Aquaculture, Technical Background Document From The Expert Consultation Held On 7 T0 9 APRIL 2008
47 Prodipto Ghosh 2009, National Action Plan on Climate Change, MoEF, GoI
48 Planning Commission-ASCI-KSG Seminar Series Background paper #3 Ananth Chikkatur and Ambuj Sagar Belfer Center for Science and International Affairs Kennedy School of Government, Harvard University

Women's Environment and Development Organization (WEDO, 2008), women and children are 14 times more likely to die than men during disasters.[49]

For India, water borne diseases, health implications of climate change, lack of knowledge & capacities to cope with disasters, lack of basic facilities, increased drudgery to avail basic resources like water & cooking fuel, financial insecurity etc. is making rural women more vulnerable to climate change. Climate change is likely to enhance the burden of women in arid regions where further scarcity in water availability with respect to the current situation is projected[50].

A Christian Aid report projects that one billion people will be displaced by 2050 and that climate change is likely to exacerbate existing challenges around migration, particularly forced migration (Christian Aid 2007).[51] Migrating men may contribute little to family incomes, increasing the workload of those left behind, often women, who become de facto heads of households and must take on men's farming roles in addition to their existing agricultural and domestic responsibilities. This may lead to changes in gender roles as women have more opportunities for decision-making and exercise greater control over household resources (FAO 2003).[52] Despite the clear connection between climate change, disaster risk reduction, and gender-focused approaches to development, there still needs to be an increased awareness of this important nexus.[53]

2.5 Economics of Climate Change

The cost of adaptation/mitigation to climate change would raise the cost of development. Meeting the needs which would arise due to climate change impacts like food security, risk management, health issues, management of resources, climate proofing etc. would require additional finds for sustainable development. If the economic needs are not met then the vulnerable sections of the society would become more vulnerable as they would lack coping mechanisms & tools to deal with climate variability and disasters. Assessment of climate risks, insurance schemes, development of efficient technologies, infrastructure development and energy diversification are some of the areas which would demand major financial shares in order to meet the challenge of climate change.

India's economy is growing at the rate of 9 per cent per annum and needs to grow at 9 per cent plus in the medium term to lift people above poverty line. This would naturally lead to GHG emissions. Estimates suggest that it will cost USD 130 billion simply to ensure that all Indian households enjoy access to electricity by 2030 a cost that would rise if this power were to come from clean fuel sources. Calculations by the Indian government suggest that investment to reduce emissions by 550 $MtCO_2$ in the steel, cement and power sectors might cost USD 25 billion; this sum is similar to the Government's planned expenditure to meet its social development goals.[54]

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49 Women Environment and Development Organisation, 2008 Gender Climate Change and Human Security, Lessons from Bangladesh, Ghana and Senegal. WEDO . Available at http://genderinclimatechange.wordpress.com/page/3/

50 Climate Change and India: Towards Preparation of a Comprehensive Climate Change Assessment, MoEF, GoI

51 Christian Aid, (2007), Human Tide: The Real Migration Crisis, UK: Christian Aid. Available at www.christianaid.org.uk/Images/human-tide.pdf

52 Available at www.bridge.ids.ac.uk/reports/Climate_Change_DFID.pdf

53 United Nations, 2008, Mr. Sálvano Briceño Director, United Nations, secretariat of the International Strategy for Disaster Reduction, Gender Perspectives: Integrating Disaster Risk Reduction into Climate Change Adaptation Good Practices and Lessons Learned.

54 Ref: H.A.C. Prasad, J.S. Kochher, March 2009, Climate Change and India- Some Major Issues and Policy Implications Department of Economic Affairs Ministry of Finance Government of India: The paper examines issues of climate change related to Development & Finance

For India to reduce its carbon emissions a major reorientation of the energy strategy is required. Murthy, Panda and Parikh (2000)[55] estimated costs associated with a low GHG energy strategy in terms of the consequences of alternative CO_2 emission reduction strategies on economic development, and in particular, the implications for the poor. This was empirically implemented through an economy-wide model across the country over a 35-year time horizon. The result shows that CO_2 emissions reduction imposes costs in terms of lower GDP and higher poverty. A 30 per cent CO_2 reduction over a period of 30 years using annual emissions reduction targets leads to a fall in GDP of 4 per cent and raises the number of poor by 17.5 per cent in the 30th year (that is, if 2000 were taken as the baseline, these changes would occur by 2030).

55 Murthy N.S., Manoj Panda and Kirit Parikh, 2000, "CO2 Emissions Reduction Strategies and Economic Development of India", IGIDR Discussion paper.

3.0 Sustainable Development Programmes and Policies

- Climate Change Adaptation and Mitigation Linkages

Today for India pivotal area of concern is economic development & poverty alleviation. Meeting these national imperatives would certainly create pressure on energy demand which would lead to increased carbon emissions. As per latest estimates, in 2007 total GHG emission from India was 1727.71 million tons of CO_2 equivalents (eq) and per capita emission was 1.5 tons[56]. The projected scenarios for GHGs emissions for 2030 shows that India's GHG emissions would remain low as compared to many developed countries.

Being a party to non- annex I countries, India can seek to avoid any voluntary GHG emission reduction targets. However, the planning process, contained in the Five-Year Plans (FYPs) and manifested through budgetary regulations is a key indicator of the country's response mechanism towards the threat of anthropogenic climate change.[57]

Steps are also being taken to build capacities and create access to basic facilities so that the country could build its communities' adaptive capacity to the impacts of climate change. Economic development of the country is also seen as the principal way to foster adaptation to climate change, since adaptive capacity is a function of the level of economic development of the rural and urban poor in India.[58]

For more than nearly two decades India has been quite proactive towards assessing results of climate change and studying its impacts

- 1992: Countywide methane campaign initiated
- 1994: Study was done on the impacts of climate variability on Indian agriculture and the likely impacts of 1m sea level rise along the Indian coast
- 1998: Assessment of India's GHG emissions, under the Asia Least Cost Abatement Strategy (ALGAS) Project
- 2001: Towards the preparation of India's initial national communication to UNFCCC various studies were done in this area
- 2010: India's Greenhouse Gas Emissions, report, 2007 providing updated information on India's Greenhouse Gas Emissions for the year 2007. India has become the first "non- Annex I" (i.e. developing) country to publish such updated numbers

3.1 Increasing Concerns of Environment & Climate Change in Indian Planning Process

It has been nearly 60 years of developmental planning[59] of India which has slowly moved its focus from being

56 India's Greenhouse Gas Emissions 2007, MoEF, 2009, Government of India
57 CENTAD -India's Climate Change Policy and Trade Concerns: Issues, Barriers and Solutions
58 Centre for European Policy studies (CEPS) Policy Brief No. 206 February 2010, Understanding India's Climate Agenda, Noriko Fujiwara and Christian Egenhofer
59 The Planning Commission was set up in March, 1950 by a Resolution of the Government of India

sector specific to more inclusive in its approach towards a sustainable development pathway. Though economic growth & poverty alleviation has always been India's highest development priorities but environment protection & conservation was considered to be an integral part of sustainable development all through the development process.

India's development plans balance economic development and environmental concerns. The planning process is guided by the principles of sustainable development. In the last few years several measures relating sustainable development have been introduced in India. Table 1 presents some of the milestones of Indian planning process which clearly show the increasing concerns for environment & climate change in Indian planning process.

Table1: Milestones of Indian Planning Process - Growing concerns of environment & Climate change

Five Year Plan Period	Milestones
1st (1951-56)	- May 12, 1952 Formulation of Forest Policy Resolution - Soil and Water conservation programmes were initiated during the First Plan period
2nd (1956-61)	- Focus continued towards afforestation and improvement of poorer areas in the forests, extension forestry and soil conservation
3rd (1961-1966)	- Natural resources came up as an independent sector for national planning
4th (1969-1974)	- 1971 Small Farmers Development Agencies (SFDA) programme - Wild Life Protection Act 1972 - 'Project Tiger', initiated in 1973 - 1972-73Accelerated Rural Water Supply Programme (ARWSP) - 1973-74 Drought Prone Areas Programme (DPAP)
5th (1974-1979)	- Constitution of Central Pollution Control Board in September 1974- under the Water (Prevention and Control of Pollution) Act, 1974 - Petroleum Conservation Research Association (PCRA), as a registered society under Ministry of Petroleum and Natural Gas, was created in 1978 to formulate strategies and to promote measures for accelerating conservation of petroleum products - 1977-78 Desert Development Programme (DDP) - 1979- Crop Insurance scheme - Rashtriya Barh Ayog (National Flood commission) set up in 1976 - During 1976-77 and 1977-78, a new scheme of watershed management was taken up in the Himalayan Region and extension of the same was proposed for other catchments of flood prone rivers - Environment considered as a separate sector of national development - Programmes initiated for biogas production

Five Year Plan Period	Milestones
6th (1980-85)	- October 2nd 1980- Integrated Rural development programme (IRDP) - Air (Prevention and Control of Pollution) Act, 1981 - Integrated Rural Energy Programme (IREP) lunched in the plan period - April 1981National Rural Employment Programme (NREP) - National Project on Biogas Development (NPBD) started in 1981-82 - October 1983 - A 12-point strategy was adopted by India for Wild Life protection and development - Department of the Environment (DOE) established - Focus on energy efficiency, energy conservation and optimum utilization of energy
7th (1985-90)	- Training, research, awareness, communication was stressed in the field of environment - Major thrust on National Watershed Development Programme for Rainfed Agriculture - Environment (Protection) Act, 1986 - Concept of energy audit introduced - National Wastelands Development Board (NWDB) was set up in June 1985 - Island Development Authority was constituted in August, 1986 - National Water Policy was adopted in September, 1987 - Joint Forest Management initiated in 1990 - National Waste Management Council (NWMC) was constituted in 1990 - 1987- National Water Management Project(NWMP) - 1986-87National Programme on Improved Chulha (NPIC) - Integrated Afforestation and Eco-Development Projects (IAEPS) Scheme (1989-1990)
8th (1992-97)	- Eco Mark Scheme 1991 - National Conservation Strategy and Policy Statement on Environment and Development, 1992 - In March 1992, an Expert Group was constituted by the Planning Commission to formulate a National Policy for the integrated development of the Himalayas - Ministry of Non-Conventional Energy Sources (now known as Ministry of New and Renewable Energy (MNRE) was created in 1992 - National Disaster Mitigation Programme (NDMP) (1993-94) - National river conservation plan 1995 - Environmental Impact Assessment Notification (EIA) of 1994 - 1995-96- Rural Infrastructure Development Fund (RIDF)
9th (1997-2002)	- Recycled Plastic Use Rules, 1998 - National Committee on the Conservation and Management of Mangroves and Coral Reefs, set up in September 1998 - Hydro Policy 1998 - Biological Diversity act 2002

Five Year Plan Period	Milestones
	- National Agriculture Insurance Scheme- 1999-2000 - Municipal Solid Waste Management and Handling Rules, 2000 - National Lake Conservation Plan started in 2001 - Exploration and exploitation of Coal Bed Methane - Energy security strategy in the 9th plan included Energy conservation, Energy efficiency standards , energy labelling of equipment, appliances, technologies and processes, Fuel consumption norms, technology upgradation and phase out inefficient equipment, Energy-audit should be made mandatory in energy intensive units - Concern for climate change impacts highlighted- India as insignificant contributor to climate change - Lead in gasoline had been phased out since 2000 - National Policy for hydro power development - National Action Programme (NAP) to combat desertification 2001 - National Land Use & Conservation Board (NLCB) reconstituted in - Pradhan Mantri Gram Sadak Yojana on 25th December, 2000 - Energy Conservation Act 2001 - Remote Village Electrification (RVE) Programme 2001-02
10th (2002-2007)	- National Environment Policy, 2006 - National Agriculture Policy 2000 - Bharat Nirman is a programme to build rural infrastructure, was launched by the Government of India in 2005 - National Rural Health Mission (2005-12) - Six projects mainly of non-conventional energy sources having been selected for funding from Netherlands under the CDM - First National Communication to UNFCCC in 2004 - NREGA 2005 - Six projects mainly of non-conventional energy sources having been selected for funding from - JNNURM 2005 - Disaster Management Act, 2005 - Energy Conservation Building Code (ECBC) 2006 - Rural Electrification Policy-2006 - Integrated Watershed development programme, 2008 (this programme includes DPAP, DDP & Integrated wasteland development proggramme - National Rainfed Area Authority (NRAA), 2006
11th (2007-2012)	- Inclusive approach for development - National Action Plan on Climate change launched 2008 - Development of Solar Cities" started in February 2008 - Environment protection considered as one of the monitorable target - India's GHG emission report launched - National Hydro Energy Policy

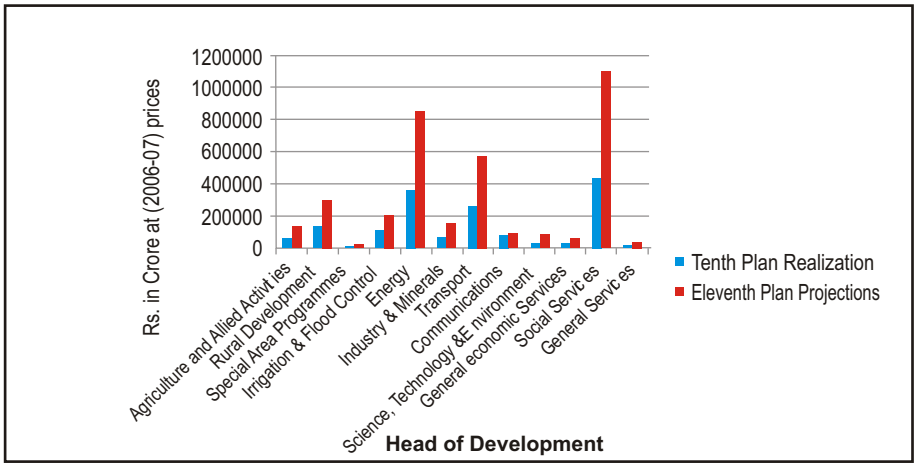
Five Year Plan Period	Milestones
	- Introduction of Rashtriya Krishi Vikas Yojana (RKVY) - Increase in forest cover by 5 per cent of total geographical area - Reduction in energy intensity per unit of GHG by 20 per cent from the period of 2007-08 to 2016-17 - Contribution of RE to increase by 2-3 per cent in the plan period - removals by India's forests to 6.35 per cent of India's annual total GHG emissions by the year 2020 - National Green Tribunal Act

In recent years Indian government has under taken number of steps meeting national objectives of poverty alleviation and sustainable development while simultaneously dealing with climate change. Programmes like MGNREGA with a primary focus on employment generation, also includes activities like afforestation, watershed management, soil conservation etc. These kind of initiatives serve the dual purpose of environment management & employment generation by empowering local communities. Increased economic strength of the rural area & a better managed environment would help the vulnerable rural population in adapting to the climate change impact.

More recently India released its National Action Plan on Climate Change (NAPCC) to outline its strategy to meet the challenge of Climate Change. The National Action Plan advocates a strategy that promotes, firstly, the adaptation to Climate Change and secondly, further enhancement of the ecological sustainability of India's development path.

For the first time environment is been considered as a monitorable target in the 11th FYR Plan (2007-2010). Figure 6 shows there is more than 200 per cent increase[60] in the projected outlay for the 11th FYR plan in the area of science technology & environment. Apart from this increased outlay in the development area of agriculture, rural development, flood control etc. would also help in better adaptation to climate change.

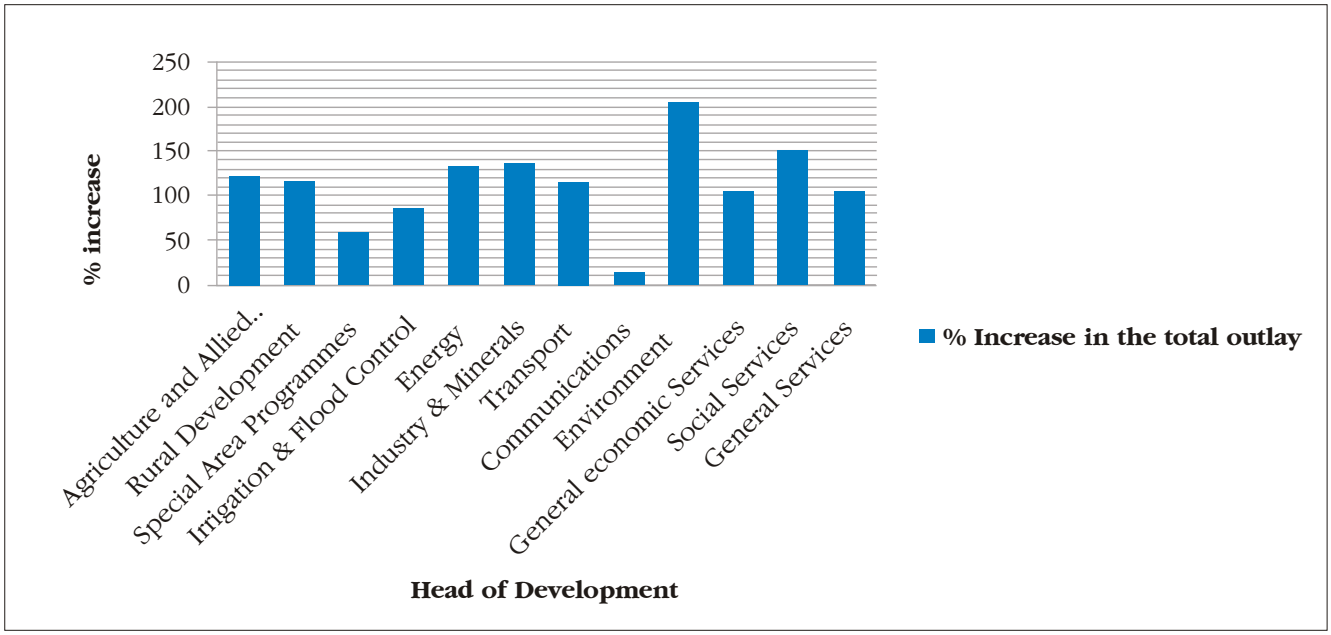
Figure 5: Sectoral Allocation for Public Sector's Resources Tenth Plan (2002-07)



Source: Eleventh Five Year Plan Document, Section III

60 Data Source: 11th Five Year Plan document, Section III

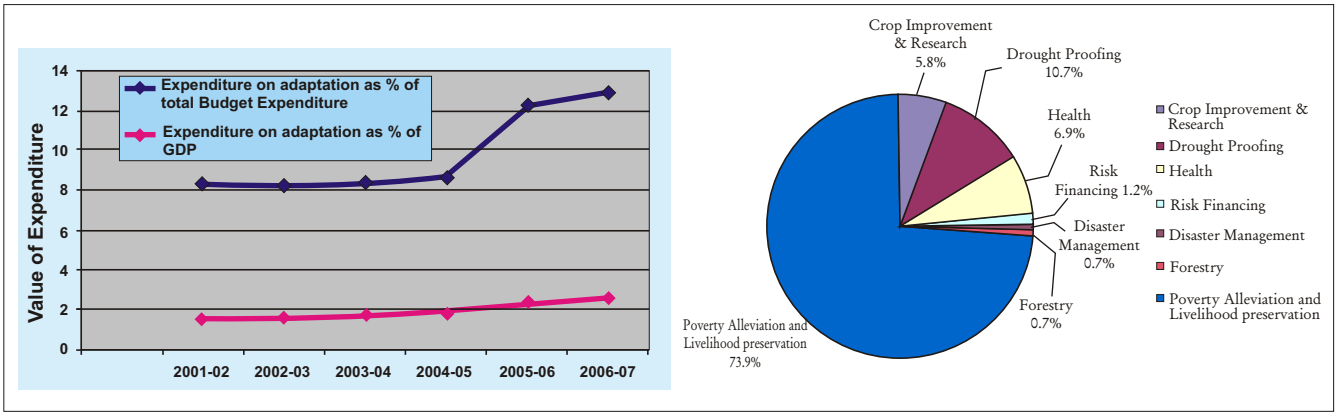
Figure 6: Sectoral Allocation for Public Sector's Resources per cent increase in Tenth Plan (200207) Realizations and Eleventh Plan (200712) Projections (based on central, State & Union Territory Total Outlay)



Source: Eleventh Five Year Plan Document, Section III

Government of India's current investments (2006-2007) in adaptation measures is already exceeding 2 per cent of the GDP, with agriculture, water resources, health and sanitation, forests, coastal zone infrastructure and extreme weather events, being specific areas of concern (Figure 7).

Figure 7: Percentage of Adaptation Expenditure to Total Expenditure and GDP and Expenditure Adaptation Component: 2006-07



Source: MoEF, 2007

The coming sections would elaborate on India's national development policies, priorities and programmes related to sustainable development also leading to climate change mitigation of as well as adaptation.

3.2. National Action Plan on Climate Change - *A multipronged Strategy for Sustainable Development*

Recognizing the importance of climate change issues, a Council on Climate Change was established in June 2007, under the chairmanship of the Prime Minister of India, to co-ordinate national action for assessment, adaptation, and mitigation of climate change.

NAPCC identifies measures to promote India's development objectives while also yielding co-benefits for addressing climate change effectively. NAPCC outlines eight national missions based on he principles of protection of poor and vulnerable sections, enhancement of ecological sustainability, efficient and cost-effective strategies for end use demand side management, deployment of appropriate technologies for both adaptation and mitigation of greenhouse gases emissions, development of market, regulatory and voluntary mechanisms to promote sustainable development, participation of various stakeholders and building international cooperation mainly for research & development, sharing and transfer of cost effective & innovative technologies. The eight national missions under the action plan are presented in Table2.

Table 2: Missions of the National Action Plan on Climate Change

National Missions on Climate Change	Objective
National Solar Mission	20,000 MW of Solar power by 2020
National Mission for Enhanced Energy Efficiency	10,000 MW of energy savings by the end of 11th FYP in 2012
National Mission on Sustainable Habitat	Energy efficient buildings, transport, waste management systems, energy efficiency as an integral component of urban planning, improving the resilience of infrastructure, community based disaster management, capacity building
National Water Mission	Increasing water use efficiency by 20 per cent through regulatory mechanisms with differential entitlements and pricing. Devise basin level management strategies. Establish water conservation measures
National Mission for Sustaining the Himalayan Ecosystem	Understand the glacial changes through glacial monitoring, participatory management of Himalayan ecosystems
National Mission for a Green India	6 million hectares of afforestation over degraded land by the end of the 12th Five year plan (2017)
National Mission for Sustainable Agriculture	Drought proofing, climate risk management, improving productivity of rainfed agriculture
National Mission on Strategic Knowledge for Climate Change	Assess vulnerability & identify responses to climate change through high quality and focused R&D

Out of the 8 missions 5 national missions focus on Adaptation & 2 missions focus on mitigation. The national mission on Strategic Knowledge for Climate Change is a cross cutting mission for adaptation & mitigation. For the implementation of these missions, they are being institutionalized by respective ministries and organized through inter-sectoral groups which include in addition to related Ministries, Ministry of Finance and the Planning Commission, experts from industry, academia and civil society. So far three national missions namely National solar mission, National Mission on Enhanced Energy Efficiency & National Mission on Sustainable Habitat (NMSH) have been approved by the Government. Based on the similar lines various states across India are also coming up with the climate change actions plans for their respective states. In this regard Delhi and Orissa have developed their state action plan. Tamilnadu, Madhya Pradesh, Gujarat and Goa are also going to release the climate change action plans for their states.

Besides state action plans number of Indian states are pro-actively taking initiatives to deal with the issues relating sustainable development and climate change. For instance, the State Government of Rajasthan has notified a policy to support development of non-conventional energy sources. Rajasthan Renewable Energy Corporation (RREC), has been designated as nodal agency for RE. The State Govt. has also announced to formulate a new Policy for Solar Energy, which will provide further fillip to solar generation in the State. With the creation of the Gujarat Energy Development Agency (GEDA) in 1979 schemes relating to solar energy were introduced in Gujarat. In 1999 the Gujarat Electricity Regulatory Commission (GERC) came into existence. The GERC is the first State Regulatory Commission to issue a comprehensive tariff order on solar energy. The GERC has also issued the Gujarat Electricity Regulatory Commission (Procurement of Energy from Renewable Sources) Regulations 2010 setting out an updated regulatory framework for renewable energy. State Government has also announced its ambitious Solar Power Policy 2009. Himachal Pradesh (HP) Government is implementing programmes towards making the state carbon neutral. The Government of Himachal is also implementing a programme named Community Led Assessment, Awareness, Advocacy and Action Programme for Environment Protection and Carbon Neutrality in Himachal Pradesh (CLAP-HP).

3.3 Sectoral Policy Responses by Government - *With Potential of Addressing Climate Change*

Now, there is a heightened interest in making GHG mitigation strategies compatible with national sustainable development priorities. Rather than exclusively targeting the abatement of green house gas emissions, integrated policy measures promise to deliver "co-benefits" (implied in Nordhaus 1991; estimated in Ayres and Walter 1991; explained in Krupnick et al. 2000). In India, the National Action Plan on Climate Change (GoI) identifies measures that promote India's development objectives while also yielding co-benefits for addressing climate change effectively. It outlines a number of steps to simultaneously advance India's development and climate change related objectives of adaptation and mitigation (NAPCC). Co-benefits are the locally desirable and additional sustainable development benefits that would accompany climate actions in various sectors such as transportation, agriculture, forestry, industry and infrastructure[61].

3.3.1 Agriculture

The Agriculture sector including crop and animal husbandry, fisheries, forestry and agro processing provides

61 IGES White Paper, 2008, Climate Change Policies in the Asia-Pacific: Re-uniting Climate Change and Sustainable Development

the underpinnings of our food and livelihood security. Agriculture provides significant support for economic growth and social transformation of the country. As one of the world's largest agrarian economies, the

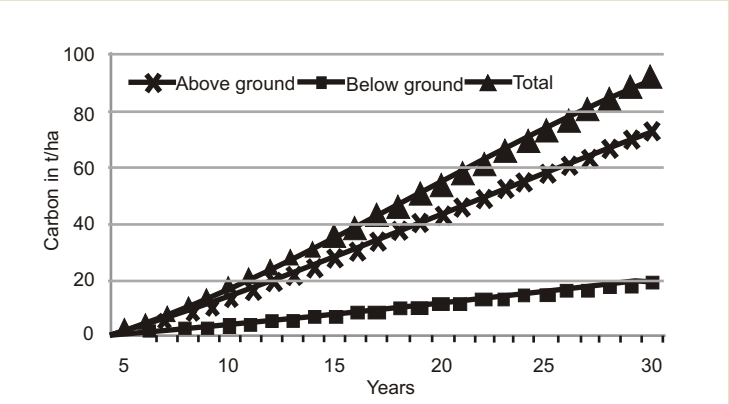
Box 2: MNREGA (Mahatma Gandhi National Rural Employment Guarantee Act)
- potential of generating co-benefits

Though the main aim of the Act is to provide guaranteed employment to rural poor, environmental concerns of sustainability and adaptation to the changing climate have been built into the grammar of NREGA guidelines. The kind of activities permitted under the Act reflects that while there are some activities that contribute to reduction in emissions and off-set the impact through plantation, afforestation, horticulture, land-development and de-siltation of traditional tanks, there are others which possibly contribute to emissions through their use of cement (roads, wells, leach-pits, renovation of ponds etc.

A study conducted by Indian Institute of Science and Centre for Sustainable Technologies, assessed the environmental services provided by the MNREGA activities implemented and the vulnerability reduction potential for Chitradurga district of Karnataka. Preliminary results of the assessment shows that MNREGA activities, apart from providing employment and income, provided multiple environmental services such as increased ground water recharge, increased water percolation, enhanced water storage in tanks, increased soil fertility, enabled reclamation of degraded lands and carbon sequestration.

Biomass or wood production and carbon sequestration potential was projected for activities such as tree planting on crop and tank bunds and wastelands, using a potential conservative growth rate of 3t/ha/year. Cumulative carbon sequestration after 30 years (*Figure*) is projected to be 93 tC/ha (74 tC/h aboveground and 19 tC/ha belowground).

Figure : Projected cumulative total carbon stocks in Pongamia pinnata (block plantation raised under NREGA at density of 300 trees/hain Parashurampura)



MNREGA activities also reduced the vulnerability of crop production, water availability and livelihoods to uncertain and low rainfall, low water availability and poor soil fertility.

Source: Environmental Services, Vulnerability Reduction and Natural Resource conservation from NREGA Activities-Case study of Chitradurga District. Indian Institute of Science, Centre for Sustainable Technologies. Accessed on 22 September 2010. www.nrega.net/...resources/.../Executive_summary_FINAL_NHR.doc

agriculture sector (including allied activities) in India accounted for 15.7 per cent of the GDP (at constant 2004-05 prices), in 2008-09. The sector contributed 10.2 per cent of national exports in 2008-09. Notwithstanding the fact that the share of this sector in the GDP has been declining over the years, its role remains critical as it provides employment to around 52 per cent of the workforce. Food grain area sown in kharif season declined by 6.5 per cent compared to year 2007-08 and food production is expected to be short by 16 per cent compared to the fourth advance estimates of 2008-09 (Economic Survey of India, 2008-2009)[62].

Over the last few years, erratic patterns of rainfall, weather variability, extreme events like floods & droughts, lack of infrastructure & connectivity, could be seen as the common region specific constraints for low productivity of agriculture. The changing weather and increased frequency of extreme events could be attributed to climate change. One of the study estimates a loss of agriculture GDP in the range of USD 1.1-86.7 billion (where the temperature scenario was 28.1ºC and precipitation of 13.6 mm/month) and USD1.5-47.8 billion (where the temperature scenario was 27ºC and precipitation of 16.4 mm/month)[63].

As about 68 percent of the net sown area in India is rainfed[64]; hence changes in precipitation patterns form a regular risk factor for agricultural yields and agriculture-based incomes. Increase in events like floods & drought would further lead to declined productivity due to negative impacts on soil fertility. Decreasing water levels would affect irrigation facilities causing low productivity. Rice & wheat production would be greatly affected by climate change as projected. Thus raising concerns for the food security. Low agriculture productivity would also lead to increased migration from the rural areas and impact the socioeconomic conditions including livelihood security.

The relationship between agriculture and climate change is two way and contribution of agriculture sector to climate change (in terms of GHG emissions) is rather considerable. The sector accounted for 17 per cent to the total ghg emissions in the year 2007 (INCCA, 2010).[65] The sources of emissions included in the agriculture sector are: livestock (enteric fermentation, animal manure, rice cultivation, agriculture soils, field burning of agriculture crop residue.

Government of India has formulated and implemented various plans and policies to establish sustainable agriculture system in the country. Investments in agriculture apart from increasing the agriculture productivity also provide avenues for employment and income generation thus enhancing adaptive capacity of rural community.

Agriculture growth is one of the highest priorities of national development plans with the target growth rate of 4 per cent of GDP per annum for the 11th FYP period. Programmes like crop diversification, risk management, watershed management, access to basic infrastructure, R & D in efficient technologies, better economic growth through enhanced market linkages would lead to better agriculture productivity and strengthened

62 Economic Survey of India 2008-2009, Planning Commission, Government of India
63 (xxii Climate Change Impact on Southeast Asian Agriculture by Robert Mendelsohn, Nov 2005)
64 (http://www.dhan.org/rainfed/index.htm)
65 Climate Change and India: A 4X4 Assessment. A sectoral and regional analysis for 2030s. Indian Network for Climate Change Assessment, Nov 2010, Government of India

socioeconomic situations of rural areas. This would in turn help in building more resilience and increase the adaptive capacity of rural communities. Emphasis on gender empowerment, public private participation, mainstreaming agro-climatic concerns in district development planning, strengthening of local bodies in implementation of programmes are some implementation approaches which looks at inclusive growth of the agriculture sector in a participatory way. Government is also looking at convergence of schemes for large scale implementation of programmes. For example MGNREGA with a primary focus on employment generation also includes activities like land development, water conservation, flood control & protection etc.

Several Government initiatives within the agriculture sector have the potential of yielding co-benefits relating climate change adaptation and mitigation both.

Integrated Watershed Management Programme (IWMP), PIM, Micro irrigation schemes are some of the programmes which focuses on optimum use of water in the agriculture sector. Inefficient irrigation systems not only create pressure on water resources but also lead to increased energy consumption thus increased GHG emissions. Programmes looking at efficient irrigation system & Demand Side Management (DSM) would also help in climate change mitigation. The Demand Side Management (DSM) in agriculture provides immense opportunity in reducing the overall power consumption without affecting the output. A number of agricultural management practices (organic agriculture, low or no tillage) capture carbon from the atmosphere and store it in soil. This "soil carbon sequestration" is estimated to be nearly 90 percent of the technical mitigation potential of agriculture.[66]

Table 3: Government Responses in Agriculture Sector (only indicative)

Response Measures	Salient Feature
National Policy on Agriculture	Attain output growth rate in excess of 4 per cent per annum in agriculture sector based on efficient use of resources
Integrated Watershed Management Programme	Restore ecological balance by harnessing, conserving and developing degraded natural resources such as soil, vegetative cover and water
National Watershed Development Project for Rainfed Areas	Sustainable management of natural resources, enhancement of agricultural, restoration of ecological balance in the degraded and fragile rainfed ecosystems, reduction in regional disparity between irrigated and rainfed areas and; creation of sustained employment opportunities for the rural community including the landless

66 Harvesting agriculture's multiple benefits: Mitigation, Adaptation, Development and Food Security, FAO, Policy Brief, 2009

Response Measures	Salient Feature
Rashtriya Krishi Vikas Yojana	Assist States in development and implementation of district level agricultural plans, based on local agro-climatic conditions and bring about quantifiable changes in the production and productivity of various components of Agriculture and allied sectors by addressing them in a holistic manner
National Food Security Mission	Aims at increasing production of rice, wheat and pulses through area expansion and productivity enhancement in a sustainable manner; restoring soil fertility and productivity at the individual farm level; creation of employment opportunities; and enhancing farm level economy
National Project on Organic Farming	Aims to promote production, promotion and market development of organic farming in the country
Micro Irrigation Scheme	Increase the area under efficient methods of irrigation viz drip and sprinkler irrigation for efficient use of surface as well as ground water resources
Weather Based Crop Insurance Scheme	Aims to mitigate the hardship of the insured farmers against the likelihood of financial loss on account of anticipated crop loss resulting from incidence of adverse conditions of weather parameters like rainfall, temperature, frost, humidity etc.
National Bamboo Mission	Aim to promote holistic growth of the bamboo sector through regionally differentiated strategies; enhance yield of bamboo; strengthen market base for bamboo based handicrafts; enhance technologies for bamboo production, generate employment opportunities
National Horticulture Mission	To provide holistic growth of horticulture sector through regionally differentiated strategies, including research, technology promotion, extension, post harvest management, processing and marketing. It also aims at creating employment generation opportunities for skilled and unskilled persons
National Project on Management of Soil Health and Fertility	Facilitate and promote Integrated Nutrient Management (INM) through judicious use of chemical fertilizers in conjunction with organic manures and bio-fertilizers, for improving soil health and its productivity
Bharat Nirman	This programme is a time bound business plan for rural infrastructure and also includes the target of bringing additional 1crore Ha of land under assured irrigation by 2012

Alliance with National Action Plan on Climate Change (NAPCC) : Various programmes & policies formulated for increasing the energy efficiency in irrigation, natural resource management, watershed development, risk management, market linkages etc. along with a more inclusive & participatory approach would help in fulfilling the objective of three national missions of NAPCC, national mission on enhanced energy efficiency, water mission & national mission on sustainable agriculture.

Box 3: Bundelkhand Package

Often called as the heartland of India, the Bundelkhand Region of central India is comprised of 13 contiguous districts, 7 in Uttar Pradesh and 6 in Madhya Pradesh. The vulnerability of the community is higher given that over 80 per cent of population is dependent on agriculture, livestock and products from forest. On an average 96 percent of the farmers' income is being earned from the crop and livestock enterprise alone.

As per historical records there have been only twelve drought years in Bundelkhand region during the whole of 19th and 20th century i.e. once in 16 years. Frequency of drought increased from one to three in 16 years during 1968-1992. The past four years since 2004-05 are experiencing drought like conditions in some parts of the region. This has led to reduced water availability; surface water availability has been minimal and groundwater water sources have been extensively tapped for agricultural purposes.

The situation is likely to further worsen with climate forecasts for the region indicating a decrease in monsoon precipitation by almost 15 per cent and a rise in mean summer temperatures by about 1.5°C by the year 2030. In order to cope with the situation farming community has taken to large scale migration to nearby cities and towns.

The prevailing conditions have led the central and state governments to take notice of the Bundelkhand region and special packages have been prepared for the region. The Bundelkhand Package is primarily targeted for drought mitigation.

The Bundelkhand package is diversified and covers various sectors within agriculture and has about 8000 crore rupees fund allocations

Allocation wise the thrust area in the package is on Watershed Management which includes various interventions such as farm ponds, construction of new dug wells, renovation of existing wells and tanks. The second most import thrust area is that of agriculture advancement wherein modern technologies such as micro irrigation and zero tillage will be introduced. Modernization of the irrigation system and institutional debt are the other major areas.

3.3.2 Energy

Energy is needed for economic growth, for improving the quality of life and for increasing opportunities for development. Some 600 million Indians do not have access to electricity and about 700 million use biomass as primary energy resource for cooking. Ensuring assured supply of clean energy is essential for nurturing inclusive growth, meeting the millennium development goals and raising India's human development index (Planning Commission, Government of India)[67].

India's primary energy use is projected to expand massively to deliver a sustained GDP growth rate of 9 per cent through 2031-32 even after allowing for substantial reduction in energy intensity. In order to fuel this on sustained basis, the growth of around 5.8% per annum in primary energy supply would be required.

67 Planning Commission , Government of India. Available at http://www.planningcommission.gov.in/sectors/energy.html

Commercial energy supply would need to grow at about 6.8% per annum as it will replace non-commercial energy, but this too involves a reduction of around 20 per cent in energy use per unit of GDP over a period of ten years (Planning Commission, Government of India)[68].

This growth should ideally be attained in a sustainable manner while addressing climate change concerns.

According to recent estimates by Government of India GHG emissions from energy sector constituted 58 per cent of the net CO_2 eq emissions in year 2007. The estimates accounted for emissions due to fossil fuel combustion in electricity generation, transport, commercial / institutional establishments, agriculture/fisheries, and energy intensive industries such as petroleum refining and manufacturing of solid fuels, including biomass use in residential sector. Fugitive emissions from mining and extraction of coal, oil and natural gas are also accounted for in the energy sector[69].

As far as industry sector is concerned it contributed about 22 per cent of the net CO_2 eq emissions in year 2007. Industry sector emissions have been estimated from manufacturing of minerals, metals, chemicals, other specific industries, and from non-energy product use. The emissions covered in the industry sector include fossil fuel combustion related emissions as well as the process based emissions.

It has been estimated that for India the CO_2 emissions will continue to grow for some time, because there is a need to increase the currently low per capita levels of energy use to support growth, reach the Millennium Development Goals. Most of the available projections indicate that India's CO_2 intensity per unit of GDP is likely to continue to decline through 2030-2050. India is a relatively low carbon economy by global comparison by two measures, CO_2 emissions per capita and CO_2 emissions per unit of GDP in PPP terms (Planning Commission, Government of India).[70]

The biggest challenge for India is that besides ensuring energy security of the nation India also needs to develop its infrastructure & increase the industrial production and at the same time reduce the emissions GHGs from these sectors.

In the recent years, the government has rightly recognized the energy security concerns of the nation and more importance is being placed on energy independence. Government of India has taken various initiatives towards diversification of energy sources, energy efficient technologies, energy conservation measures, regulatory frameworks, etc. to meet the national goals as well as simultaneously addressing climate change concerns. India is probably the only country in the world with a full-fledged ministry dedicated to the production of energy from renewable energy sources. Additionally, India is emerging as a growing market for solar, wind and hydroelectric power. The Government of India has an ambitious mission of 'Power for all by 2012'.

The reduced energy intensity of the Indian economy, in the period since 2004, has been marked by an economic growth rate of over 9 per cent per annum, which has been achieved with an energy growth of less

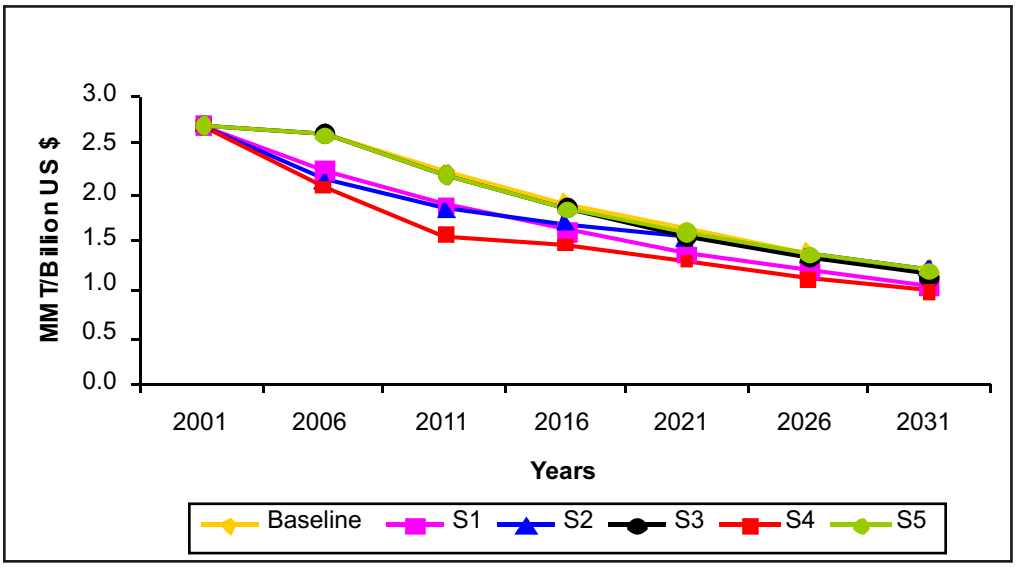
68 Planning Commission , Government of India Available at http://www.planningcommission.gov.in/sectors/energy.html
69 India's Greenhouse Gas Emissions 2007, MoEF, 2009, Government of India
70 Available at http://www.planningcommission.gov.in/sectors/energy.html

than 4% per annum. This reduced energy intensity, at the relatively low level of India's per-capita GDP, has been made possible by a range of factors, including India's historically sustainable patterns of consumption, enhanced competitiveness, proactive policies to promote energy efficiency, and more recently, the use of the Clean Development Mechanism to accelerate the adoption of clean energy technologies.[71]

Energy conservation potential for the economy as a whole has been assessed as 23 per cent with maximum potential in industrial and agricultural sectors. Energy conservation and increased efficiency is gradually taking an important place in the energy and industry sector plan in India. India has installed state-of-the-art energy-efficient technologies to curtail their energy bills. Increased competition arising from the liberalization of the economy, the increase in energy prices, and the promotion of energy efficiency schemes with the introduction of the Energy Conservation Act in 2001 have contributed to reductions in the energy intensities of the service and industry sectors.

Figure 8 represents the trend of CO_2 intensity based on five scenarios simulated by MARKAL (2001-2031), and shows a decreasing trend. It is worth mentioning that carbon emission intensity of India is amongst the lowest in the world and has always been low. And as per the MARKAL simulations it would decrease further under all the 5 scenarios.

Figure 8: Change in India's CO_2 intensity as a result of Government Policy initiatives

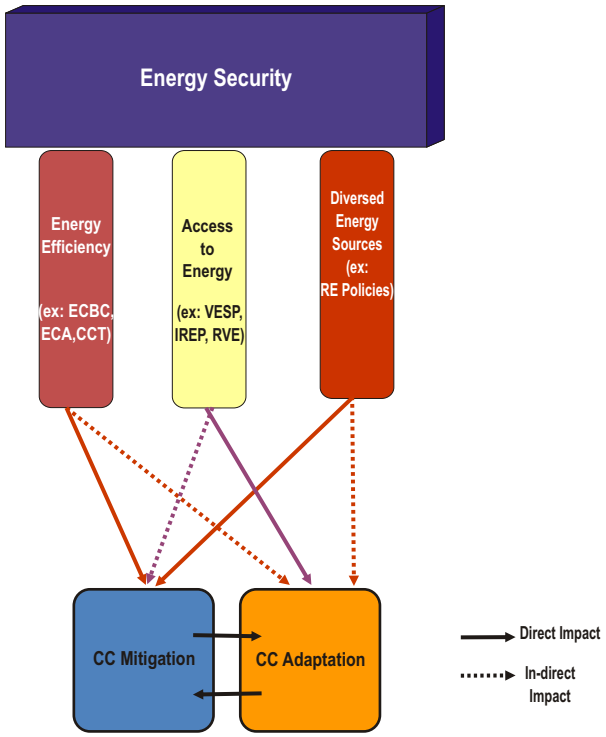


Source: Results of policy scenarios from MARKAL, TERI, 2005[72]

Most of the policy initiatives formulated by Government of India to ensure energy security also has a great potential to reduce GHG emission and thus helps in mitigation (Figure 9). Energy conservation building code, programmes to diversify energy sources based on renewable energy. On the other hand any policy/programme formulated to ensure access to energy would lead to better adaptive capacity of the area/community.

71 India: Addressing Energy Security and Climate Change, MoEF 2007
72 Results of policy scenarios from MARKAL, Ritu Mathur, TERI (India), 2005. http://envfor.nic.in/mef/per5.pdf Accessed on April 2010

Figure 9: Illustration showing policy linkages



Box 4: 11th FYP - Some Highlights in the Energy Sector

- Additional sources of energy such as Coal Bed Methan (CBM) must be fully exploited
- To reduce the energy intensity per unit of GHG by 20 per cent from the period 2007-08 to 2016-17 and initiate action to increase our access to cleaner and renewable energy
- Renewable energy contribution to increase by 2 per cent - 3 per cent
- Content of ethanol in petrol to increase up to 10 per cent
- Depending upon the bio-diesel production and availability, the entire country may be progressively covered with sale of 5% bio-diesel blended diesel
- EURO IV equivalent norms in identified cities and EURO III equivalent norms in the entire country would be introduced w.e.f. 1 April 2010
- Setting up of a National Energy Fund (NEF [R&D]) for supporting R&D in energy sector
- Encouragement through suitable fiscal concessions to be provided for manufacture and assembly of fuel-efficient and hybrid vehicles and for use of alternative fuels for promoting energy conservation and environmental protection
- 10 per cent increase of installed capacity in renewable (Wind, small-hydro and biomass)
- Achieve 10,000 MW of avoided capacity by 2012 through standards& labeling of appliances, building energy efficiency, efficient lighting, Municipal & Agriculture DSM

Below listed are some government responses with a potential to mitigate and/or adapt to climate change impacts (Table 4).

Table 4: A Brief on Government's Initiatives

Response	Salient feature
Integrated Energy Policy, 2006	Aims to reliably meet the demand for energy services of all sectors including the energy needs of vulnerable households with safe, clean and convenient energy at the least-cost. This must be done in a technically efficient, economically viable and environmentally sustainable manner
Energy Conservation Act, 2001 (ECA)	A legal framework towards efficient use of energy and its conservation and came into force in the year 2001. The ultimate objective of the act is energy security through conservation & efficient use of energy
Electricity Act, 2003	Central Government shall, after consultation with the State Governments, prepare and notify a national policy, permitting stand alone systems (including those based on renewable sources of energy and non-conventional sources of energy) for rural areas
Village Energy Security Programme (VESP)	Provide energy security in villages by meeting energy needs for cooking, electricity and motive power through various forms of biomass material based on available biomass conversion technologies and other renewable energy technologies, where necessary
National Draft Policy Statement on New and Renewable Energy	An exclusive and comprehensive policy on RE, aiming to raise RE capacity to 100,000 MW by 2050
National Policy on Bio-fuels	Mainstreaming of bio-fuels and, therefore, envisions a central role for it in the energy and transportation sectors of the country in coming decades
Development of Solar Cities	To promote use of renewable energy in urban areas by providing support to the Municipal Corporations for preparation and implementation of a road map to develop their cities as solar cities
Energy Conservation Building Code (ECBC)	To provide minimum requirements for the energy-efficient design and construction of buildings. This aims to reduce the baseline energy consumption by supporting adoption and implementation of efficiency saving and saving in GHG emission

Response	Salient feature
MNRE Scheme on Green Buildings	Based on the climatic conditions, and in particular the construction of non-AC buildings, a National Rating System – GRIHA has been developed which is suitable for all types of buildings in different climatic zones of the country. One of the criteria under GRIHA is to meet 1 per cent of total connected load for interior lighting and space conditioning through solar photovoltaics
Tariff Policy, 2006	The legal framework which states that a minimum percentage of the energy, as specified by the Regulatory Commission, is to be purchased from RE sources
Programme on Biomass Energy and Co-generation (nonbagasse) in Industry	The installation of biomass co-generation projects (excluding bagasse co-generation) is to be promoted in industry, with at least 50% of power for captive use, and a provision for the surplus power to be exported to the grid
National Electricity Policy 2005	Stipulates that progressively the share of electricity from non-conventional sources would need to be increased. It also envisages appropriate preferential pricing to promote non-conventional technologies before they can compete with the conventional sources in terms of cost
Scheme on Biogas based Distributed / Grid Power Generation Programme	To promote biogas based power generation, specially in the small capacity range, based on the availability of large quantity of animal wastes and wastes from forestry, rural based industries
Remote Village Electrification Programme (RVE)	To provide access to electricity through renewable to households in remote villages, which are not likely to get covered through grid extension
Rajeev Gandhi Grameen Vidyutikaran Yojana	Aims at providing electricity to 100 per cent rural households. It has the provision of Decentralized Distribution and Generation (DDG) through use of renewable energy sources. Under the RGGVY DDG through use of renewable energy sources is also being promoted. DDG is being pursued as an option in those villages which are not electrified, remote and where conventional grid will be economically unviable

Box 5: Some Facts & Figures on India's Renewable Energy Development

- India is fifth worldwide in total existing wind power capacity and is rapidly expanding many forms of rural renewable such as biogas and solar PV
- India was among the top five countries for renewable power capacity in 2009, including small hydropower
- India added nearly 130 MW of hydropower in 2009, for a total of more than 2.5 GW of small hydro, and total domestic hydropower capacity approached 37 GW by early 2010
- In India, an estimated 20,000 solar hot water systems are installed each year
- India's current five-year plan targets 12.5 GW of added renewables by 2012 (including wind, small hydro, and bio- mass power), and in 2009 the country adopted targets for solar power of 1 GW by 2013 and 20 GW by 2022 (including 1 GW of off-grid solar PV by 2017)
- India is home to some 4 million biogas systems, according to recent figures from the Ministry of New and Renewable Energy
- In India today there are approximately 7,000 solar-powered irrigation pumps

National targets for Renewable Energy

- Renewable capacity: 12.5 GW added 2007-2012; 15% share of added power capacity 2002-2022
- Solar PV and CSP: 1.1 GW by 2013, 10 GW by 2017, 20 GW by 2022
- Wind power: 9 GW added 2007-2012
- Small hydro: 1.4 GW added 2007-2012
- Biomass/cogeneration: 1.7 GW added 2007-2012
- Waste-to-energy: 0.4 GW added 2007-2012
- Solar hot water: 15 million m2 by 2017; 20 million m2 by 2022
- Rural lighting systems: 20 million by 2022

Source: Renewables 2010, Global Status Report

Box 6 (a): Some New Initiatives in Power Generation

Clean Coal Technology

Since electricity generation in India is largely dependent on coal the Government has laid thrust on Clean Coal Technology (CCT) which seeks to reduce harsh environmental effects by using multiple technologies to clean coal and reduce emissions. Department of Science & Technology, commissioned a study on Clean Coal Technology (CCT) in 2006 to develop a future road map for clean coal technology in the entire Coal-Energy Chain. Research has been initiated on CO_2 sequestration and Indian CO_2 Sequestration Applied Research network was launched for dissemination of information. India has announced a levy a clean energy cess on coal, at the rate of Rs. 50 (~ USD 1) per ton, which will apply to both domestically, produced and imported coal. This money will go into a National Clean Energy Fund that will be used for funding research, innovative projects in clean energy technologies, and environmental remedial programmes.

Box 6 (b): Some New Initiatives in Power Generation

Centre for Power Efficiency & Environmental Protection (CenPEEP)

National Thermal Power Corporation (NTPC) established Centre for Power Efficiency & Environmental Protection (CenPEEP) in collaboration with USAID with a mandate to reduce GHG emissions per unit of electricity generated by improving the overall performance of coal-fired power plants. Towards the reduction of Greenhouse Gas (GHG) emission from Indian thermal power plants, NTPC has been promoting and deploying efficient power generation technologies and practices from design stage to operation stage and building local institutional capacities for continuously striving for eco-friendly technologies.

India as a nation is confronted with fundamental structural issue of fragmentation at all levels of government, often hampering and or delaying policy and decision making. To address the issue platforms or single window systems are required for trans-sectoral policy coherence and coordinated action. One such example is establishment of Bureau of Energy Efficiency (BEE) under the provisions of the Energy Conservation Act 2001. The Bureau is responsible for spearheading the improvement of energy efficiency of the economy through various regulatory and promotional instruments. The mission of the Bureau of Energy Efficiency is to develop policy and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy.

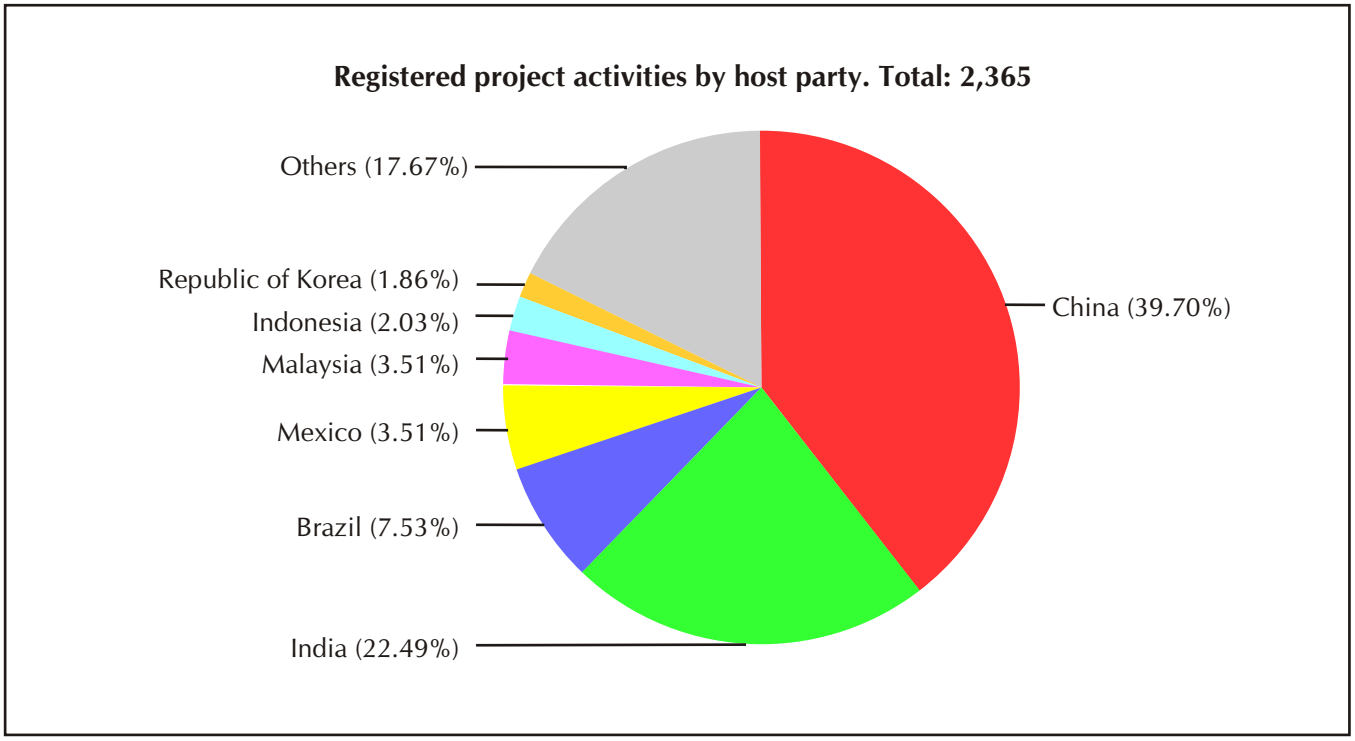
Clean Development Mechanism

Going forward, given the recent successes of Indian industry in energy efficiency, renewable energy and green buildings and enhanced commitment to address climate change issues, the 20-25 per cent emission intensity reduction goals, set out by the Indian Government, should be achievable. As India reduces emission intensity of its economy by 20-25 per cent by 2020, numerous investment opportunities are likely to emerge in the key sectors. These include (a) Industrial energy efficiency: An investment opportunity of Rs 82575 million exist in industrial energy efficiency leading to annual saving potential of Rs 37510 million (b) Renewable energy: 20,000 MW target of solar energy capacity by 2022 and pipeline of other renewable energy projects such as biomass, wind and small hydro present huge investment opportunity in the sector in coming years (c) Green Buildings: One billion sq. ft. of green buildings is being targeted to be set-up in India by the year 2012, leading to significant investment requirement in the sector and (d) Cleaner Conventional Energy Technologies: Indian Government has set a target of having upto 50 per cent of new thermal power generation capacity based on clean coal technologies. The investment requirement in clean conventional energy technologies is relatively higher, at present.

Government of India has initiated major regulatory changes coupled with incentives to promote businesses that reduce GHG emissions. India aims to increase the share of grid connected renewable energy to 10 per cent by 2012. 20 GigaWatts of solar power generation is planned by 2022 as part of the Jawaharlal Nehru National Solar Mission (JNNSM). The National Mission for Enhanced Energy Efficiency in Industry (NMEEE) aims to improve energy efficiency in priority industries such as power, cement, fertiliser, aluminium, iron and steel, railways, pulp and paper, and textiles. The India Union Budget 2010-11 includes a new National Clean Energy Fund. Such measures, expected to be maintained or strengthened in coming years, will present growth potential for many sectors; particularly energy, transport, industry, agriculture and forestry.

Indian companies can exploit numerous business opportunities that are likely to arise out of climate change mitigation and adaptation. Infact The private sector in India has been rather aggressive to seize and take commercial advantage from the unfolding global and national low carbon development opportunities. This is clearly reflected in the number of Clean Development Mechanism (CDM) projects registered from India 532 projects which is 22.5 per cent of the global total, second only to China (Figure 10).

Figure 10: Registered Project Activities by UNFCCC



Source: UNFCCC, 2010

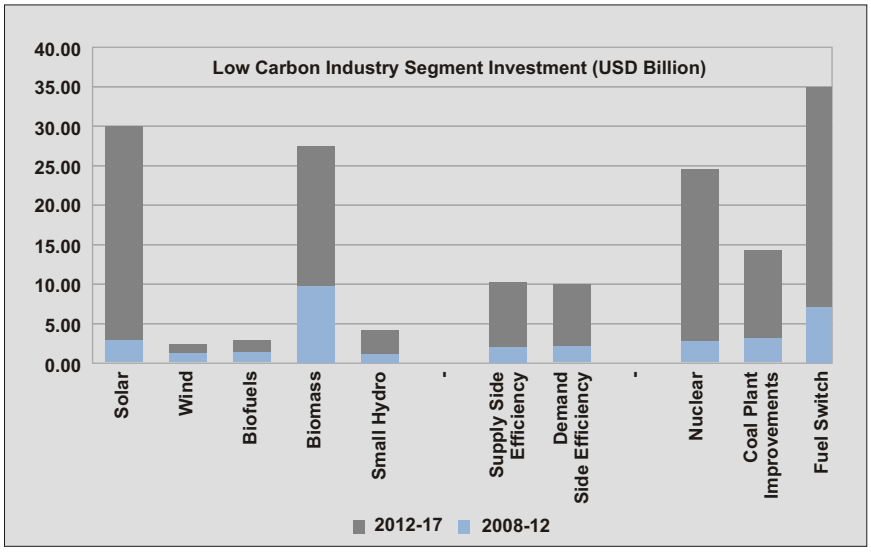
The global market for low carbon technologies is estimated to amount to USD 3 trillion per year by 2050, throwing up significant commercial opportunities. Already it is estimated that Industries such as renewable energy, waste management and water treatment will be worth USD 700 billion globally by 2010 on par with the value of the global aerospace industry (OECD Environmental Policy Committee, 22 Feb 2008) .Over 700 CDM projects have been approved by the CDM National Designated Authority, and about 300 of these have been registered by the CDM Executive Board. The registered projects have already resulted in over 27 million tones of certified CO_2 emissions reductions, and directed investment in renewable energy and energy projects by reducing the perceived risks and uncertainties of these new technologies, thereby accelerating their adoption. (MoEF, MoP, BEE 2007).[73]

Indian industries have grabbed the opportunity provided by the Clean Development Mechanism (CDM) with both hands. According to a recent study done by McKinsey & Company[74] on opportunities and costs of GHG

73 India: Addressing Energy Security And Climate Change. 2007. Ministry of Environment and Forests, Ministry of Power, Bureau of Energy Efficiency, Government of India. Available at http://envfor.nic.in/divisions/ccd/Addressing_CC_09-10-07.pdf
74 McKinsey & Company. Environmental and Energy Sustainability: An Approach for India, 2009

abatement in India, there is an opportunity to reduce emissions from industry by about 680 million tons of carbon dioxide equivalent (CO_2eq) per year by 2030 (Indian Industry and Climate Change, Stimson). Another study by the HSBC (Figure 11) indicates the industry segments where low carbon business opportunities are available, including future markets beyond 2012.

Figure11: Anticipated investments in low carbon industry sectors in India



Source: Robins N et al, (2008) 'Wide Spectrum of Choices', HSBC

Alliance with National Action Plan on Climate Change (NAPCC): Central and state governments are laying considerable emphasis on deployment of clean energy. The National Action Plan on Climate Change, formulated by Government of India in the year 2008 visualises rapid growth of Renewable Energy (RE) with its share in consumption reaching a level of 15 per cent by year 2015. The mandatory energy efficiency standards under the National Action Plan for Climate Change in nine major energy consuming sectors (eight industrial sectors and the railways) and allowing these sectors to trade domestically in energy-saving certificates is a good starting point. The policies & programmes formulated in various government programmes would assist the fulfillment of two national missions focusing on mitigation, namely the solar mission & national mission on enhanced energy efficiency.

Box 7: Solar Energy Intervention in Sagar Island, Sunderbans, West Bengal, Kolkata

The remote villages and hamlets situated in the southern part of Sundarbans in the Gangetic delta of Bengal, suffer from chronic shortage of energy due to non-availability of grid power. It is difficult to extend transmission lines to this area due to separation from the main land by rivers or creeks resulting technical limitations and prohibitive cost.

The West Bengal Renewable Energy Development (WBRED) Agency took the challenge of making off grid renewable energy power available to local communities and also accomplished the task of making these projects sustainable and popular. The advent of renewable energy in the Sunderbans has changed the face of the islands considerably. Out of the 2 million off-grid SPV (Solar Photovoltaic) consumers in the world, the Sunderbans alone comprise almost 4 per cent.

The fist intervention of solar based electrification started with the electrification of the Youth hostel at Sagar Island with a small solar power unit. After a prolonged research and hard work the first solar power station was set up Sagar Island in 1993. By December 1995, the first 25 kW solar power station of the country was set up at Kamalpur Village of Sagar Island in Sunderbans. Along with the power plant , a 4 km supply line was also constructed to provide power to the locals. Presently 30,000 villagers in Sagar Island use solar power. Presently 50 persons work towards the maintenance of the plant and the distribution line. There are 11 shops in the island selling solar power equipment.

WBREDA has installed about 2000 individual solar systems in houses around Sagar islands. The idea of this project was to innovate further by connecting people to mini-grid systems. Currently there are 11 power plants in operation supplying stable and reliable 400/230 volts three phase 50 hertz power for six to seven hours a day through local distribution lines. The combined capacity of the plant is 400 k W and WBREDA estimates that a further 400 kW is needed in order to electrify all the villages in the two islands. WBREDA charges users flat rate of USD 3 per month for 120W and USD 9 per month for 360W.WBREDA have now started to install prepayment meters to ensure that consumers actually pay what they use. The project has employed innovative way of integrating water pumps into the mini-grid systems and is using tem to bring clean, safe drinking water to the surface from deep aquifers during the day when the grid is switched off. The mini-grids are operated by cooperative societies formed by the people using the grids. The societies are responsible for the selection of consumers, choosing of roots for distribution lines and setting of the tariff in consultation with WBREDA. They are also responsible for the collection of payments from consumers, passing them on to WBREDA, and dealing with non payment problems. WBREDA supports the cooperatives, advising them on administrative and financial, matters and provides technical input through a junior engineer who is permanently stationed on the island. The project is funded by a combination of grants, loans and revenue.

Today in 2007, thousand of families in Sunderbans are enjoying grid quality electricity from different off grid power stations. Households that are situated outside the mini grid coverage have been provided with individual solar home lighting systems that are placed on the roof top. About 35000 families of Suderbans now use solar home systems to light up their homes. Most of the solar home lighting system comprise 74 W (watt) solar PV modules under standard test conditions with following items.

In addition more than 700 solar street lights are working as an uninterrupted power source during night time on the river banks where thousand of people cross the river. Sunderbans have the highest concentration of stand alone renewable energy systems not only in India but in the entire world.

Box 8: World's Largest Solar Steam Cooking System at Tirumala, Andhra Pradesh

The world's largest solar steam cooking system has been installed by the Tirumala Tirupathi Devasthanam (TTD) at Tirumala in Andhra Pradesh. The system has a capacity to prepare food for 15,000 people/day and employs automatic tracking solar dish concentrators, which convert water into high pressure steam. The steam thus generated is being used for cooking purposes in the kitchen of TTD. The system is expected to save around 1,18,000 litres of diesel per year, valued at Rs. 2.3 million.

3.3.3 Waste

According to recent estimates about 42 million tonnes of solid waste (1.15 lakh tonnes per day) and 6000 million cubic meters of liquid waste is generated every year by our urban population[75]. The total GHG emissions from waste sector in 2007 was 57.73 million tons of CO_2eq, of which, 2.52 million tons was emitted as CH_4 and 0.16 million tons as N_2O. It is estimated that the MSW generation and disposal resulted in the emissions of 12.69 million tons of CO_2 eq in 2007. Waste water management (domestic & industrial together) emitted 45.03 million tons of CO_2 equivalent emissions.[76]

Waste to energy projects, projects based on recycling of waste, and proper management of municipal solid waste as well as capturing landfill methane is helpful in reducing the GHG emissions from the waste sector. Biogas can be used as an excellent fuel for many applications including power generation. Biogas plants offer a very useful source of decentralized energy supply based on local resources. Use of biogas as cooking fuel provides an efficient way of converting fuels to heat and reduces indoor air pollution. The other environmental benefits include improved waste management, reduced emission of methane to the atmosphere and reduction in deforestation[77].

Waste to energy projects holds good potential for the reduction in the generation of greenhouse gases from the waste. Additional advantages of such projects includes-reduction in quantity of waste by nearly 60 per cent to 90 per cent , decrease in demand for land for land filling , reduced cost of transportation of waste to landfill sites, reduction in environmental pollution including the ground water pollution from leachates & reduction in emission of harmful gases. Three projects for energy recovery from Municipal Solid Wastes with an aggregate capacity of 17.6 MW have been installed in 3 cities of India namely, Hyderabad, Vijayawada and Lucknow. A Total of 8 Projects for energy recovery from urban wastes with an aggregate capacity of 19.05 MWeq. have so far been set up in the country. Anaerobic Digestion/ Biomethanation, Combustion / Incineratio, Pyrolysis / Gasification, Landfill Gas Recovery, Densification/ Pelletization are some of the technologies used in waste-to-energy projects. Some other emerging technologies such as Plasma Arc Technology is also being attempted for energy recovery from waste.

The Biomethanation project was sponsored by UNDP-GEF and the Government of India, and implemented by the Ministry of New and Renewable Energy (MNRE) beginning 1994. The basic objective of the project was "to enable India to contribute towards protecting the global and local environment by developing aggressive plans which will gainfully utilize the wastes generated in municipal, industrial and agricultural sectors for energy recovery." Several activities were implemented including waste-to-energy demonstration projects, capacity building through training programs and workshops, and information dissemination.

Biomethanation for Treatment of Slaughterhouse Waste at Medak, Andhra Pradesh (2 units of plants):

The first phase biomethanation plant for treatment of abattoir waste has been completed at M/s Al kabeer Exports Ltd., Medak, Andhra Pradesh, having an installed capacity of slaughtering and processing 500 - 600 buffaloes and 1500 - 2000 sheep / day. The methane digester is based on UASB (Up-flow Anaerobic Sludge

75 Ministry of New & Renewable Energy
76 3 India's Greenhouse Gas Emissions-2007, Indian Network for Climate Change Assessment, MoEF, 2009, Government of India
77 India Country Profile on Animal Waste Management for Methane to Markets
http://www.methanetomarkets.org/documents/ag_cap_india.pdf

Blanket) technology and results in COD reduction of 75 to 80 per cent and BOD reduction of 85 to 90 per cent, besides producing about 3500 to 4500 cum/day of biogas having a methane content of about 65 per cent. Adoption of the biomethanation technology has resulted in a saving of Rs.30 lakhs per annum on account of expenditure on chemicals besides an additional annual saving of Rs.30 lakhs on account of saving of furnace oil. The successful adoption of this innovative technology has encouraged M/s Al-kabeer to set up one more biogas plant for the treatment of solid wastes, which is based on a state-of-the-art technology obtained from Austria. These biomethanation installations have shown the way to solve the problem of waste treatment and disposal in environmentally benign manner, which also appears to be financially profitable (MNRE, Government of India).

Box 9: Energy Recovery From Industrial Waste
Pulp and Paper Industry is considered to be one of the highly polluting industries and consumes a large amount of energy and water in its various unit operations. The wastewater discharged by the industry is highly heterogeneous as it contains compounds from wood or other raw materials, processed chemicals as well as compounds formed during processing. A biogas plant based on UP flow Anaerobic Sludge Blanket (UASB) Technology for the treatment of about 4000 cum. Black liquor per day was set up at in Satia Paper Mills Ltd., Muktsar, Punjab in the year 1997-98. About 10,000 cum. Biogas being produced by this plant is being used as a fuel in the boiler, saving about 20-22 tonnes of rice husk costing over Rs. 3.00 lakh per month. This plant also leads to other indirect benefits like savings in electricity and chemicals required for the treatment of wastewater through conventional activated sludge process.

Below given table 5 highlights some of the initiatives of the Government of India which has the potential to reduce GHG emissions from the waste sector.

Table 5: Brief on Government's Initiative

Responses	Salient Feature
National Biogas and Manure Management Programme (NBMMP)	Apart from providing clean bio- gaseous fuel for reducing use of LPG and other conventional fuels; mitigation of Climate Change by preventing black carbon and methane emissions is also one of the objectives of the programme
Accelerated Programme on Energy Recovery from Urban Wastes – Sanction for the Year 2005-06	To accelerate the promotion of setting up of projects for recovery of energy from urban wastes; To create conducive conditions and environment, with fiscal and financial regime, to develop, demonstrate and disseminate utilisation of wastes for recovery of energy;. It also targets to harness the available potential of MSW-to-energy by the year 2017
Scheme on Biogas based Distributed / Grid Power Generation Programme	The main objective is to promote biogas based power generation, specially in the small capacity range, based on the availability of large quantity of animal wastes and wastes from forestry, rural based industries (agro / food processing), kitchen wastes, etc.

Responses	Salient Feature
Programme on Recovery of Energy from Industrial Wastes	The scheme provides for Central Financial Assistance in the form of capital subsidy and Grants-in-Aid in respect of the following activities: (i) Industrial waste to biogas (ii) Power generation from biogas (iii) Power generation from solid industrial waste. (iv) Promotional activities. (v) R&D, Resource assessment, technology upgradation and performance evaluation, etc.

Use of Fly Ash in Construction Sector

Fly ash includes all categories or groups of coal or lignite ash generated at the thermal power plant such as Electrostatic Precipitator (ESP) ash, dry fly ash, bottom ash, pond ash and mound ash. India produces about 70 million tons of coal ash per year from burning about 200 million tons of coal per year for electric power generation. Coal-ash management poses a serious environmental problem for India[78]. The notification S.0.763 (E) dated 14th September, 1999[79] was published with a view to protect the environment, conserve top soil and prevent the dumping and disposal of fly ash discharged from coal or lignite based thermal power plants on land. It restricts the excavation of top soil for manufacture of bricks and promotes the utilisation of fly ash in the manufacture of building materials and in construction activity within a specified radius of 50 Kms from the thermal power plants. The notification was amended in August 2003 (S.O. 979 (E)[80]) to extend the area to 100 kms. It also widened the scope from brick manufactures to construction activities in the public (housing boards) as well as private sectors (apartments, hotels, resorts and cottages) Every construction agency engaged in the construction of buildings within a radius of fifty to one hundred kilometres from the thermal power plant shall use fly ash clay or cement bricks, blocks, or tiles, or a combination of them by 31st August 2007 in a phase wise manner.

The notification was further modified in November 2008 (S.O. 2623 (E)[81]) such that all construction activity within 100 kms shall use only fly ash based products. It also prescribes the minimum percentage by weight of fly ash to be used in the various products. The increase in the amount of ash generated and lying unutilized lead to the supersession of the 1999 notification by S.O 513(E)[82] dated 3rd April 2007. It states that any person involved in any activity involving building construction shall use building material composed wholly or partially of fly ash given the cost and technological feasibility. Due to the notifications ash based building materials have gained more acceptance and the use has increased. However they are not rigidly imposed and hence ash bricks and blocks are still occupy only a small percentage of the total brick/ block share. This process

78 http://www.iitk.ac.in/infocell/soil/testing2.htm
79 http://envfor.nic.in/legis/hsm/flyash.html
80 http://envfor.nic.in/legis/hsm/so979(e).htm
81 http://envfor.nic.in/legis/hsm/2623.pdf
82 http://envfor.nic.in/legis/hsm.htm

helps in the disposal of waste in a resourceful manner. It also prevents the depletion of top soil used to make conventional bricks and thus reduces the embodied energy of the building making it greener.

Alliance with National Action Plan on Climate Change (NAPCC): National mission on Sustainable Habitat under NAPCC also lays emphasis on management of solid waste management systems. It looks at recycling of material and Urban Waste Management as a major component of ecologically sustainable economic development. A special area of focus is on the development of technology for producing power from waste. The National Mission will include a major R&D programme, focusing on bio chemical conversion, waste water use, sewage utilization and recycling options wherever possible.

3.3.4 Land Use, Land - Use Change and Forestry (LULUCF)

Land use change such as converting forests to agricultural plantations or any other land use type could decrease total carbon stocks. Mitigating carbon emission through forestry provides a promising way of reducing CO_2 in the atmosphere. Maintaining existing carbon pools by adopting activities that promote the conservation of the remaining forest cover, or that reduce deforestation. Activities that destroy forests such as slash-and-burn farming, logging and conversion to other land uses (deforestation) could significantly reduce the stored carbon in the forest. Since carbon sequestration is a function of biomass accumulation, the simplest way to expand carbon tocks is to plant trees.

Recent green house gas emission estimates (INCCA Report-2010)[83] for LULUCF sector showed that LULUCF sector in 2007 was a net sink. It sequestered approximately 177.03 million tons of CO_2. Assessment includes emission by sources and or removal by sinks from changes in forest land, crop land, grassland, and settlements. Estimation for wet lands has not been done due to paucity of data. According to the estimates forest land, which includes emissions and removal from above and below ground biomass in very dense, moderately dense, open forests, and scrub lands, sequestered 67.8 million tons of CO_2 in 2007. However, fuel wood extracted non-sustainably from forests lead to an emission of 67.80 million tons of CO_2 in 2007. Changes in grassland resulted in the emission of 10.49 million tons of CO_2 due to decrease in grass land area by 3.4 million ha between the two periods. The crop land sequestered 207.52 million tons of CO_2 in 2007. Land converted to settlements though increased by 0.01 million ha during the period, however, the conversions did not lead to an emission but a net removal of 0.04 million tons.

India has undertaken numerous measures as a response to reduce current and potential future impacts of climate change and is already on a sustainable development path. These measures have targeted a significant increase in the capacity of renewable energy installations, afforestation and watershed development prorammes. Other similar measures have been implemented by committing additional resources and realigning new investments, thus steering economic development onto a climate-friendly path. In the XIth five year plan the need for incorporating adaptation response needs in the relevant programmes, including those relating to watershed management, coastal zone planning and regulation, forestry management, agricultural technologies and practices, and health has been clearly indicated.

One such initiative, which not only has huge potential of generating carbon benefits but also will help in adaptation to climate change in long run, is National Afforestation Programme. The National Afforestation

83 Climate Change and India: A 4X4 Assessment. A sectoral and regional analysis for 2030s. Indian Network for Climate Change Assessment (INCCA), Nov 2010, Government of India

Programme (NAP) Scheme was initiated by scaling-up the Samnavit Gram Vanikaran Samridhi Yojana (SGVSY) project experience and converging all afforestation schemes of the 9th Plan period. The overall objective of the scheme is to develop the forest resources with people's participation, with focus on improvement in livelihoods of the forest-fringe communities, especially the poor. Year-wise progress of National Afforestation Programme in the Tenth Five Year Plan (2002-2007) is given in the table 6 below.

Table 6: NAP Progress made so far

Year	No. of new FDA projects operationalised	No. of JFMCs	Project Area (ha)	Release (Rs. Crores)
2002-03	237	8,209	40,5631	151.26
2003-04	231	7,850	28,3272	207.98
2004-05	105	3,474	10,7963	233.00
2005-06 (up to 31.3.2006)	95	2,391	55,232	248.58

Source: National Afforestation Programme (NAP) Scheme: At A Glance

Box 10: Reducing Emission from Deforestation and Forest Degradation (REDD) +

The concept of "Reducing Emission from Deforestation and Forest Degradation" (REDD) was first discussed in COP 11. In the context of climate change and REDD, India has been in favour of an umbrella approach comprising different policy options, approaches and activities including conservation, sustainable forest management (SFM), and increase in forest cover. India favors a comprehensive REDD plus (REDD+) mechanism, and seek financial incentives of compensation for enhancement of carbon stock as a consequence of following the policy options of conservation and sustainable management of forests. For the purpose of REDD, SFM can be understood as improvement in existing cover and increase in forest/ tree cover (FTC), i.e. (harvest < increment) = net addition. SFM includes maintenance as well as increment of forest carbon stocks by means of improvement in the quality of existing stocks and expression in forest area with activities like afforestation and reforestation (AR). Government of India is promoting Afforestation and Reforestation (AR) projects under Clean Development Mechanism (CDM) of the Kyoto Protocol. Indian Forest Act, Forest Conservation Act, Wildlife (Protection) Act are for the effective conservation of Forests and Wildlife resources in the country. As stipulated in the legislation and Action Plans, establishment of Reserved Forests & Protected Areas (PAs) form the core of India's conservation strategy.

Another similar kind initiative is Joint Forest Management Programme which comes under National Afforestation Programme. Initiated on 1 June 1990, Joint Forest Management (JFM) has emerged as an important intervention in management of forest resources in India. It recognizes the livelihood and sustenance needs of the people through the principle of 'care and share'. The concept of JFM has been interpreted in various ways but the basic element in this concept is to establish grassroots community based institutions for protection and management of forests. The programme aims at empowering local people for their active participation as partners in the management of forest resources and sharing the benefits derived from its protection and management. The JFM programme has led to several positive outcomes. The major ones are: (i)

84 Available at http://envfor.nic.in/naeb/sch/NAP_glance.doc (as on 15 June 2010)

change in the attitude and relationships of local communities and forest officials towards each other and the forests; (ii) improvement in the condition of forests; (iii) reduction in encroachments; (iv) increase in the income of local people; and (v) involvement of NGOs. JFM regime has evolved gradually and at present 10,6479 committees (22 million participants) are functioning in 28 States covering 22.02 million ha of forests. This participatory regime is seen as a potential strength of forest management for the forest fringes. The challenge now is to effectively empower the local communities with appropriate rights and responsibilities, and ensure that substantial benefits from forest conservation accrue to them.

In India, an estimated 146.82 Mha. area suffers from various forms of land degradation due to water and wind erosion and other complex problems like alkalinity/salinity and soil acidity due to water logging (SoE India 2009)[85] . To deal with this Government of India has undertaken number of steps under the broader concept of Area Development Programmes. One such initiative is Integrated Wastes Land Development Programme (IWDP). IWDP started in 1989-90 seeks to develop government wastelands and Common Property Resources (CPRs), based on village/micro watershed plans. IWDP is a Centrally Sponsored Programme for the development of wastelands including private wastelands in the country.

Table 7: Statement of Outlays and Achievement under Integrated Wasteland Development Programme (IWDP)

Sl. No.	Year	Outlay (Rs. In Crores)	Amount released for ongoing projects (Rs. In Crores)	Project Completed	Area treated (Mha)
1	2007-2008	1114.54*	516.53	40	0.94
2	2008-2009	1825*	670.83	98	1.22
Note: *An outlay of Rs.1114.54 crore had been provided for IWMP (DPAP, DDP & IWDP) during 2007-08. : *An outlay of Rs.1545 crore (RE) had been provided for IWMP (DPAP, DDP, IWDP and Professional Support) during 2008 -09.					

Source: Outcome Budget 2009-2010, Department of Land Resources, Ministry of Rural Development

Table 8: Statement of Outlays & Achievement for 2007-08 to 2008 -09 under Integrated Watershed Management Programme (IWMP)

Sl. No.	Year	Outlay (Rs. In Crores)	Amount released for ongoing projects (Rs. In Crores)	Project Completed	Area treated (Mha)
1	2007-2008	1114.54*	1164.54	1,221	2.39
2	2008-2009	1825*	1544.40	2,465 (1044 DPAP, 1,323 DDP and 98 IWDP)	3.11
Note: *An outlay of Rs.1114.54 crore had been provided for IWMP (DPAP, DDP & IWDP) during 2007-08. *An outlay of Rs.1545 crore (RE) had been provided for IWMP (DPAP, DDP, IWDP and Professional Support) during 2008 -09.					

Source: Outcome Budget 2009-2010, Department of Land Resources, Ministry of Rural Development

85 State of the Environment Report 2009, Ministry of Environment and Forests, Government of India

Three area development programmes i.e. Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWDP) are being implemented by the Department of Land Resources. While DPAP and DDP are implemented in the identified blocks of identified districts, based on moisture index and availability of irrigation, IWDP is implemented in blocks not covered under DPAP and DDP. It has been decided to have a single 'Integrated Watershed Management Programme' (IWMP) from 2007-08 by consolidating IWDP, DPAP and DDP.

Technology support is extremely vital for success of land based programme, specially in the development of Wastelands. Proper area specific strategy has to be developed keeping in view the Agro-Climatic conditions and capability of land. Realizing this, a Central Sector Scheme of Technology Development Extrusion Training (TDET) was launched during 1993-94 to develop suitable technologies for the reclamation of Wastelands for sustained production of food, fuel wood, fodder etc.

Honorable Supreme Court of India recently passed a directive to create of a Compensatory Afforestation Fund in which all money received from user agencies towards compensatory afforestation, calculated as Net Present Value (NPV), shall be deposited. Out of the received amounts of approximately 13,000 crore in the ad hoc Compensatory Afforestation Fund Management & Planning Authority (CAMPA) the State CAMPAs have so far been allocated approximately Rs. 1,000 crore.

Table9: Degraded lands developed under various programmes since inception upto the Tenth Five Year Plan

(Area in Lakh Hectares and Expenditure in Rs Crore)

S. No.	Ministry/Scheme and Year of Start	Progress since Inception up to Ninth Plan		Progress in Tenth Plan (2002-07)		Total since Inception up to Tenth Plan*	
		Area	Expr.	Area	Expr.	Area	Expr.
(A) Ministry of Agriculture (Department of Agriculture and Co-operation)							
	NWDPRA (1990-91)	69.79	1877.74	23.30	1147.82	93.09	3025.56
	RVP and FPR (1962 and 1981)	54.88	1516.26	9.98	727.98	64.86	2244.24
	WDPSCA (1974-75)	2.58	166.27	1.35	129.31	3.93	295.58
	RAS (1985-86)	5.81	76.39	1.30	45.35	7.11	121.74
	WDF (1999-2000)	0.00	0.00	0.59	26.02	0.59	26.02
	EAPs	13.35	2039.81	4.80	1927.54	18.15	3967.35
Subtotal		146.41	5676.47	41.32	4004.02	187.73	9680.49
(B) Ministry of Rural Development (Department of Land Resources)							
	DPAP (1973-74)	68.95	3284.74	68.32	1557.76	137.27	4842.50
	DDP (1977-78)	33.56	797.38	47.17	1152.50	78.73	1949.88
	IWDP (1988-89)	37.34	616.51	62.22	1821.64	99.56	2438.15
	EAPs	1.40	18.39	3.60	274.28	5.00	292.67
Subtotal		141.25	4717.02	179.31	4806.18	320.56	9523.20
(C) Ministry of Environment and Forest							
	NAEP (1989-90)	0.70	47.53	0.00	0.00	0.70	47.53
Total (A+B+C)		288.36	10441.02	220.63	8810.20	508.99	19251.22

Note: * Includes tentative achievement of 2006-07.
Source: Report of the Working Group on Natural Resources Management for the Eleventh Five Year Plan (2007-12) Planning Commission Government of India (February 2007).

Source: Eleventh Five Year Plan (2007–2012) Planning Commission, Government of India

Below given table 9 highlight some of the initiatives of the Government of India which has the potential to reduce GHG emissions from the waste sector.

Table 10: Brief on Government's Initiative

Responses Forest (Conservation) Act, 1980	Salient Feature
National Forest Policy	To check further deforestation, the Forest (Conservation) Act was enacted by Government of India. National Forest Policy 1988 acknowledges the importance and primacy of local communities and provided for a sustainable management approach with maintenance of environmental stability as the prime objective
Participatory Forest Management / Joint Forest Management Programme (JFM)	Initiated on 1 June 1990, Joint Forest Management (JFM) has emerged as an important intervention in management of forest resources in India. The JFM approach optimizes the returns, minimizes conflicts and links the forestry development works with the overall development of land based resources. It also aims at building technical and managerial capability at the grassroots level
National Afforestation Programme (NAP)	The National Afforestation Programme (NAP) Scheme was initiated by scaling-up the Samnavit Gram Vanikaran Samridhi Yojana (SGVSY) project experience and converging all afforestation schemes of the 9th Plan period. The overall objective of the scheme is to develop the forest resources with people's participation, with focus on improvement in livelihoods of the forest-fringe communities, especially the poor
National Watershed Development Project for Rainfed Areas (NWDPRA)	The programme was initiated in 1990-91 has the twin objectives of improving agricultural production in rainfed areas and to restore ecological balance

Alliance with National Action Plan on Climate Change (NAPCC): The Green India Mission (GIM), as one of the eight Missions under the National Action Plan on Climate Change (NAPCC) focuses on enhancing ecosystem services and carbon sinks through afforestation on degraded forest land, in line with the National Forest Policy 1988 of expanding the forest and tree cover to 33 per cent of the total land area of the country. The Mission acknowledges the influences that the forestry sector has on environmental amelioration through climate mitigation, food security, water security, biodiversity conservation and livelihood security of forest dependant communities. GIM puts the "greening" in the context of climate change adaptation and mitigation meant to enhance ecosystem services like carbon sequestration and storage (in forests and other ecosystems), hydrological services and biodiversity; along with provisioning services like fuel, fodder, small timber and NTFPs.

Box 11: Forest Certification

Forest Certification has emerged as a market-driven mechanism in support of Sustainable Forest Management (SFM). Certification initiatives rely on consumers exercising purchasing choice in favour of products labelled as originating from forests certified as being sustainably managed. Certification and Eco-labelling are the new mantras to enhance the product positioning for a premium price on one hand and ensuring better forest management practices on the other hand.The Ministry has constituted a National Working Group/Governing Body to frame the policy guidelines for forest certification for timber and Non-timber forest products. Three Committees were constituted to prepare a road map and the necessary criteria and processes for the development of National Certification mechanism in the country, which were subsequently, merged into single committee namely the 'National Forest Certification Committee' for the development of Certification Criteria, Certification Process and Accreditation Criteria & Process towards Forest Certification of timber, Non-timber Forest Products. It has also been proposed to constitute an independent Forest Certification Council. National Forest Certification Committee, in consultation with various stakeholders, is in the process of preparing a road map for operationalsing the certification process. The long term strategy involves defining the structure of the National Forest Certification Council including its framework, composition, terms of reference, setting of standards, process for chain of custody and procedures for accreditation. The short term goal for 2010-11 involves formulating policy and guidelines on Forest Certification which can be circulated to all the States and UTs to deal with the issue till long term strategy is put in place. In order to operationalise certification process in forestry, Criteria & Indicators of sustainable forest management developed by IIFM (Bhopal-India Process) would need to be approved & notified in 2010-11 after getting endorsed by an International Certification Agencies (like FSC and PEFC). To strengthen the database on forestry sector, the Ministry plans to collect, compile and disseminate forestry statistics by strengthening mechanism at ICFRE in 2010-11.

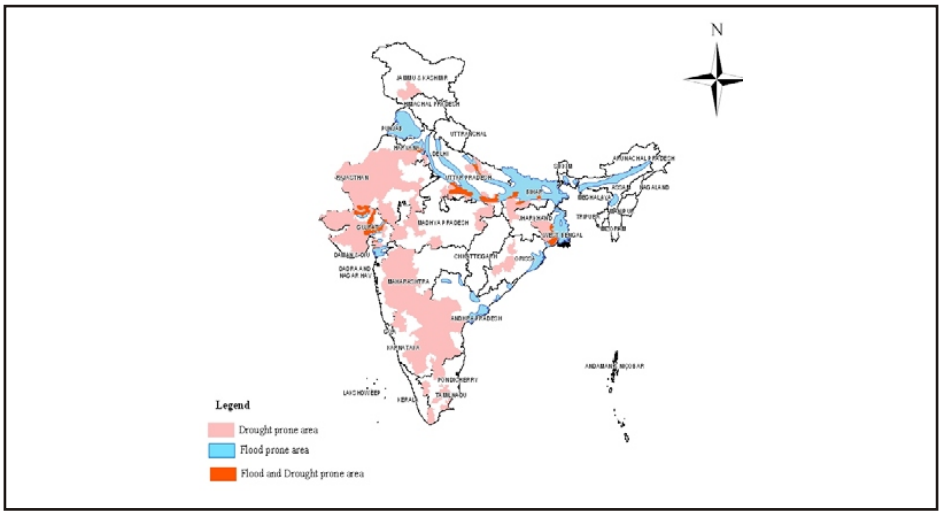
3.3.5 Disaster Management- *From Rehabilitation to Preparedness*

Floods, droughts, earthquakes, landslides, cyclones, avalanches, forest fires are some of the natural disasters frequently experienced in the country. The National Institute of Disaster Management (NIDM), Government of India's apex body dealing with disaster control, reports an average disaster leads to an annual loss of 4,350 human lives, 1.42 million hectare of crop loss, and 2.36 million damaged houses. [86]

According to the OFDA/CRED disasters database[87], over 1.5 billion people have been affected by major disaster events since 1900, more than 4.5 million human lives have been lost, and damage in excess of USD 40 billion suffered over 1900-2007 period.

86 ORCHID, 2006, Adaptation to Climate Variability and Change, Proceedings of the International Conference on Adaptation to Climate Variability and Change, New Delhi.
87 CRED, International Disaster Database, Universite Catholique de Louvain, Belgium

Figure 12: Flood & Drought prone areas in India



Source: Climate Risk Screening in DFID India, Technical Appendix, TERI, India, IDS

Table 11 : Major Categories of Natural Disasters in India (1900-2007)

Category	No. of Events	People Killed	People Affected (Million)	Damage (USD (Million)
Drought	11	4,250,300	711.84	942
Extreme Temperatures	41	13,148	--	544
Flood	198	55,243	747.93	21,355
Wind Storm	141	163,318	87.67	12,719
Wave/Surge	2	16,789	0.65	1,022
Earthquake	25	61,705	27.26	4,147

Source: Climate Risk Screening in DFID India, Technical Appendix, TERI, India, IDS

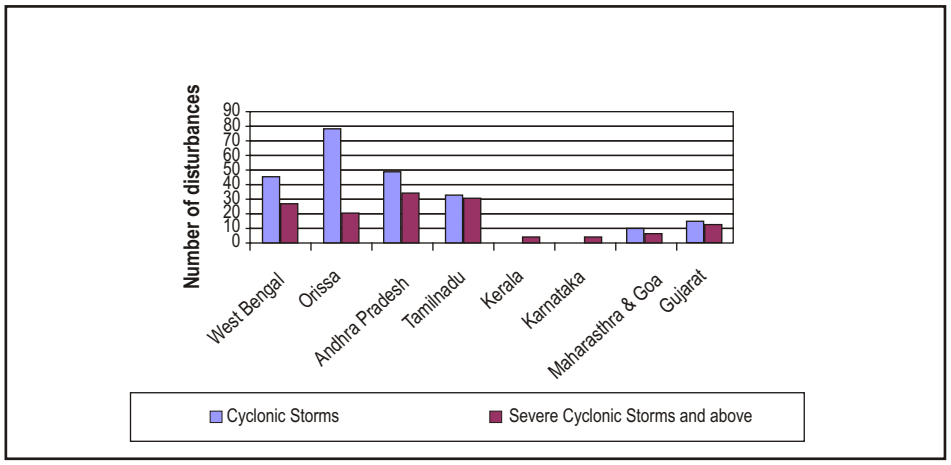
Around 68 per cent of the country is prone to drought in varying degrees. Of the entire area, 35 per cent of the area, which receives rainfall between 750 mm and 1,125 mm, is considered drought prone, while another 33 per cent, which receives less than 750 mm of rainfall, is called chronically drought-prone.[88] The Emergency Database (EM-DAT) of Centre for Research on the Epidemiology of Disasters (CRED) reports the impact of drought in India. According to this database, droughts have affected nearly 1,061 million people and killed 4.25 million people in India during 19002006 (CRED, 2006).[89]

Nearly 40 million hectares of land in the country is vulnerable to floods and the average area affected by floods annually is about 8 million hectares (UNEP, 2002).[90] Floods cause the bulk of the damage to property and

88 Manual for Drought Management, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi, 2009
89 Center for Research on Epidemiology of Disasters (2006) India country profile of natural disasters, EM-DAT: The International Disaster Database.
90 Technical Report of Project (GT /1010-00-04), UNEP- Division of Early Warning and Assessment, 2002, pp 46

infrastructure, with OFDA/CRED placing estimates in excess of USD 21 billion over the last century or so. Of India's annual rainfall of 400 million-hectare meters, 75 per cent is received in just four months.[91] Nearly 40 million hectares of land is vulnerable to floods, with about eight million hectares flooded annually. In the last four decades, the country has lost about INR 9,720 million in damages to crops, public utilities and houses.[92] The graph below shows history of cyclonic Storms over Indian States during 1891-2006. Orissa, Andhra Pradesh, West Bengal and Tamil Nadu have experienced large no. of cyclones in the past.

Figure 13: Cyclonic storms & severe cyclonic storms in Indian States (1891-2006)



Source: Climate Risk Screening in DFID India, Technical Appendix, TERI, India, IDS

Figure 14: Top ten natural disasters in India

Top Ten Natural Disasters in India

By People Affected

DISASTER	DATE	PEOPLE AFFECTED
Drought	May 1987	300,000,000
Drought	1972	200,000,000
Flood	July 1993	128,000,000
Drought	June 1982	100,000,000
Drought	1965	100,000,000
Flood	June 2002	42,000,000
Flood	June 1975	34,000,000
Flood	Aug 1982	33,500,000
Flood	June 2004	33,000,000
Flood	Sep 1995	32,704,000

By Total Damages

DISASTER	DATE	DAMAGE (USD000's)
Flood	July 2006	3,390,000
Flood	July 2005	3,330,000
Earthquake	Jan 2001	2,623,000
Find Storm	Oct 1999	2,500,000
Flood	June 2004	2,500,000
Flood	June 2005	2,300,000
Wind Storm	Aug 1990	2,200,000
Wind Storm	Nov 1996	1,500,000
Wind Storm	May 1990	1,300,000
Wave/Surge	Dec 2004	1,022,000

Source: Climate Risk Screening in DFID India, Technical Appendix, TERI, India, IDS

91 Technical Report of Project (GT /1010-00-04), UNEP- Division of Early Warning and Assessment, 2002, pp 46
92 Technical Report of Project (GT /1010-00-04), UNEP- Division of Early Warning and Assessment, 2002, pp 46

There is growing evidence that the climate change do has implications for drought vulnerable India with studies projecting future possible reductions in monsoon related rainfall in the country. In the 21st century over the past three decades, climate related natural disasters occurred five times as frequently, killed or affected seventy times as many people, and caused twice as much damage worldwide as did earthquakes and volcanoes. In the past decade, weather-related natural hazards have been the cause of 90 per cent of natural disasters and 60 per cent of related deaths, and have been responsible for 98 per cent of the impacts on disaster-affected populations, the majority in areas of developing countries (IFRC, 2005).[92] Between 2000 and 2004 an average of 326 climate disasters was reported each year. Some 262 million people were affected annually for 2000-2004, more than double the level in the first half of the 1980's (UNDP, 2007a)[93]. According to the April 2007 report of the Intergovernmental Panel on Climate Change (IPCC), farming and fishing communities in developing countries will suffer some of the worst impacts of climate change, including more frequent droughts and floods, more crop damage and falling yields, water shortages, and more disease[90].

Disaster and climate change are increasingly being considered as a development constraint; hence, mainstreaming them into the development policy is all the more pertinent in the current context. Both natural and manmade disasters are becoming frequent causing huge socioeconomic and environmental losses.

Disaster management has therefore emerged as a high priority for the country and is getting mainstreamed into the process of development planning at all levels. The Tenth Plan set into motion the process of shift in focus from response-centric disaster management covering rescue, relief, rehabilitation, and reconstruction to laying greater emphasis on the other elements of disaster management cycleprevention, mitigation, and preparednessas a means to avert or soften the impact of future emergencies. The Eleventh Plan aims at consolidating the process by giving impetus to projects and programmes that develop and nurture the culture of safety and the integration of disaster prevention and mitigation into the development process. (11th FYP). Two main planks of the new approach are mainstreaming disaster risk reduction into infra-structural project design and strengthening communication networks and disaster management facilities at all levels (NAPCC).

Table 12: Government Responses to Disaster Management

Responses to Disaster Management	Salient Feature
National Disaster Mitigation Programme (NDMP)	Scheme for capacity building of government functionaries and other stakeholders to manage disasters in an effective manner.
National Policy on Disaster Management (NPDM)	Formulated with a vision to build a safe and disaster resilient India by developing a holistic, proactive, multi-disaster oriented and technology driven strategy through a culture of prevention, mitigation, preparedness and response

Responses to Disaster Management	Salient Feature
National Disaster Management Authority (NDMA)	NDMA has the responsibility for laying down policies, plans and guidelines for DM (and coordinating their enforcement and implementation for ensuring timely and effective response to disasters.
Disaster Risk Management Programme	Under this programme Disaster Management Plans have been prepared for 8643 villages, 1046 Gram Panchayat, 188 blocks and 82 districts.
Disaster Management Act, 2005	Lays down the institutional and coordination mechanisms at the national, state, district and local level for disaster management

Alliance with National Action Plan on Climate Change (NAPCC): The National Mission on Sustainable habitat addresses the need to adapt to future climate change by improving the resilience of infrastructure, community based disaster management, and measures for improving the warning system for extreme weather events. Capacity building in this area is also an important component of this Mission. The National Mission on Himalayan Ecosystem aims to maintain two-thirds of the area under forest cover in order to prevent erosion and land degradation and ensure the stability of the fragile eco-system of Himalayas which is prone to natural disasters. NAPCC highlights that under the coastal zone management programmes the main focus is on coastal protection and early warning systems.

Annexes

A.1 Monitorable Targets in the 11th FYP

Monitorable targets reflect the multi-dimensional economic and social objectives of inclusive growth. The Twenty-seven targets at the national level fall in six major categories. The targets in each of these categories are given below.

Income and Poverty

- Average GDP growth rate of 9% per year in the Eleventh Plan period.
- Agricultural GDP growth rate at 4% per year on the average.
- Generation of 58 million new work opportunities.
- Reduction of unemployment among the educated to less than 5 per cent.
- 20 per cent rise in the real wage rate of unskilled workers.
- Reduction in the head-count ratio of consumption poverty by 10 per cent age points.

Education

- Reduction in the dropout rates of children at the elementary level from 52.2 per cent in 2003-04 to 20 per cent by 2011-12.
- Developing minimum standards of educational attainment in elementary schools, to ensure quality education.
- Increasing the literacy rate for persons of age 7 years or more to 85 per cent by 2011-12.
- Reducing the gender gap in literacy to 10 percentage points by 2011-12.
- Increasing the percentage of each cohort going to higher education from the present 10% to 15% by 2011-12.

Health

- Infant mortality rate (IMR) to be reduced to 28 and maternal mortality ratio (MMR) to 1 per 1000 live births by the end of the Eleventh Plan.
- Total Fertility Rate to be reduced to 2.1 by the end of the Eleventh Plan.
- Clean drinking water to be available for all by 2009, ensuring that there are no slip-backs by the end of the Eleventh Plan.
- Malnutrition among children of age group 03 to be reduced to half its present level by the end of the Eleventh Plan.
- Anemia among women and girls to be reduced to half its present level by the end of the Eleventh Plan.

Women and Children

- Sex ratio for age group 0-6 to be raised to 935 by 2011 12 and to 950 by 2016-17.

- Ensuring that at least 33 per cent of the direct and indirect beneficiaries of all government schemes are women and girl children.
- Ensuring that all children enjoy a safe childhood, without any compulsion to work.

Infrastructure

- To ensure electricity connection to all villages and BPL households by 2009 and reliable power by the end of the Plan.
- To ensure all-weather road connection to all habitations with population 1000 and above (500 and above in hilly and tribal areas) by 2009, and all significant habitations by 2015.
- To connect every village by telephone and provide broadband connectivity to all villages by 2012.
- To provide homestead sites to all by 2012 and step up the pace of house construction for rural poor to cover all the poor by 2016-17.

Environment

- To increase forest and tree cover by 5 percentage points.
- To attain WHO standards of air quality in all major cities by 2011-12.
- To treat all urban waste water by 2011-12 to clean river waters.
- To increase energy efficiency by 20 per cent by 2016-17.

The Eleventh Plan has been formulated in a manner whereby 13 of the 27 monitorable national targets have been disaggregated into appropriate targets for individual States. These are: GDP growth rate, Agricultural growth rate, New work opportunities, Poverty ratio, Drop out rate in elementary schools, Literacy rate, Gender gap in literacy rate, Infant mortality rate (IMR), Maternal mortality ratio (MMR), Total Fertility Rate (TFR), Child malnutrition, Anemia among women and girls:-

A.2 Overview of National Programmes & Policies

National Policy on Agriculture:

The first ever National Agriculture Policy was announced on 28th July, 2000. The National Policy on Agriculture seeks to actualize the vast untapped growth potential of Indian agriculture, strengthen rural infrastructure to support faster agricultural development, promote value addition, accelerate the growth of agro business, create employment in rural areas, secure a fair standard of living for the farmers and agricultural workers and their families, discourage migration to urban areas and face the challenges arising out of economic liberalization and globalization. Some salient feature of the policy includes-

- Growth that is based on efficient use of resources and conserves our soil, water and bio-diversity;
- The policy seeks to promote technically sound, economically viable, environmentally non-degrading, and socially acceptable use of country's natural resources - land, water and genetic endowment to promote sustainable development of agriculture.
- The use of bio-technologies will be promoted for evolving plants which consume less water, are drought resistant, pest resistant, contain more nutrition, give higher yields and are environmentally safe. Conservation of bio-resources through their ex situ preservation in Gene Banks, as also in situ

conservation in their natural habitats through bio-diversity parks, etc., will receive a high priority to prevent depletion of bio-diversity.

- A regionally differentiated strategy will be pursued, taking into account the agronomic, climatic and environmental conditions to realize the full growth potential of every region. Special attention will be given to development of new crop varieties, particularly of food crops, with higher nutritional value.
- An integrated approach to marine and inland fisheries, designed to promote sustainable aquaculture practices, will be adopted.
- The regionalization of agricultural research based on identified agro-climatic zones will be accorded high priority. Application of frontier sciences like bio-technology, remote sensing technologies, pre and post-harvest technologies, energy saving technologies, technology for environmental protection through national research system as well as proprietary research will be encouraged.
- Bridging the gap between irrigation potential created and utilized, completion of all on-going projects, restoration and modernization of irrigation infrastructure including drainage, evolving and implementing an integrated plan of augmentation and management of national water resources will receive special attention for augmenting the availability and use of irrigation water.

Rashtriya Krishi Vikas Yojana:

National Development Council (NDC), in its meeting held on 29th May, 2007 resolved that aspecial Additional Central Assistance Scheme (RKVY) be launched. The NDC resolved that agricultural development strategies must be reoriented to meet the needs of farmers and called upon the Central and State governments to evolve a strategy to rejuvenate agriculture. The NDC reaffirmed its commitment to achieve 4 per cent annual growth in the agricultural sector during the 11th plan. The Resolution with respect to the Additional Central New Additional Central Assistance scheme to incentivise States to draw up plans for their agriculture sector more comprehensively, taking agro-climatic conditions, natural resource issues and technology into account, and integrating livestock, poultry and fisheries more fully. This will involve a new scheme for Additional Central Assistance to State Plans, administered by the Union Ministry of Agriculture over and above its existing Centrally Sponsored schemes, to supplement the State-specific strategies including special schemes for beneficiaries of land reforms. The RKVY aims at achieving 4 per cent annual growth in the agriculture sector during the XIth Plan period, by ensuring a holistic development of Agriculture and allied sectors. The main objectives of the scheme are:

- To incentivize the states so as to increase public investment in Agriculture and allied sectors.
- To provide flexibility and autonomy to states in the process of planning and executing Agriculture and allied sector schemes.
- To ensure the preparation of agriculture plans for the districts and the states based on agro-climatic conditions, availability of technology and natural resources.
- To ensure that the local needs/crops/priorities are better reflected in the agricultural plans of the states.
- To achieve the goal of reducing the yield gaps in important crops, through focussed interventions.
- To maximize returns to the farmers in Agriculture and allied sectors.
- To bring about quantifiable changes in the production and productivity of various components of agriculture and allied sectors by addressing them in a holistic manner.

Integrated Watershed Management Programme:

Integrated Wasteland Development Programme, Drought Prone Areas Programme, and Desert Development Programme were been brought under a comprehensive programme called Integrated Watershed Development Programme. This was initialized in the year 2008 and is placed under Ministry of Rural Development and Department of Land Resources. This programme is intended to be taken up in rain-fed and drought-prone areas especially predominated by SC/ST population and preponderance of wasteland. The watershed Development Programmes like DDP, Drought-Prone-Area-Programme (DPAP) and Integrated Wasteland Development Programme (IWDP) are implemented by the Zilla Panchayats through Watershed Associations. The main objective of this programme is to develop wastelands/degraded lands, drought-prone and desert areas on watershed basis, keeping in view the capability of land, site-conditions and local needs, promoting the overall economic development and improving the socio-economic condition of the resource poor and disadvantaged sections inhabiting the programme areas, mitigating the adverse effects of extreme climatic conditions such as drought and desertification on crops, human and livestock population for their overall improvement, restoring ecological balance by harnessing, conserving and developing natural resources.

National watershed development project for rainfed areas:

Rainfed Farming is complex, diverse and risk prone and is characterised by low levels of productivity and low input uses. The Government of India has accorded high priority to the holistic and sustainable development of rainfed areas through integrated watershed development approach. The key attributes of the watershed approach are conservation of rain water and optimization of soil and water resources in a sustainable and cost-effective mode. Improved moisture management increases the productivity of improved seeds and fertiliser. So conservation and productivity enhancing measures become complementary.

Participatory Irrigation Management (PIM):

Participatory Irrigation Management comes under the National Water Policy of 1987. It includes making efforts to involve farmers progressively in various aspects of management of irrigation systems, particularly in water distribution and collection of water rates, and assistance of voluntary agencies in educating the farmers in efficient water-use and water management. Following are the objectives of PIM:

- To create a sense of ownership of water resources and the irrigation system among the users, so as to promote economy in water use and preservation of the system.
- To improve service deliveries through better operation and maintenance.
- To achieve optimum utilization of available resources through sophisticated deliveries, precisely as per crop needs.
- To achieve equity in water distribution.
- To increase production per unit of water, where water is scarce and to increase production per unit of land where water is adequate.
- To make best use of natural precipitation and ground water in conjunction with flow irrigation for increasing irrigation and cropping intensity.
- To facilitate the users to have a choice of crops, cropping sequence, timing of water supply, period of supply and also frequency of supply, depending on soils, climate and other infrastructure facilities

available in the commands such as roads, markets cold storages, etc., so as to maximize the incomes and returns.

- To encourage collective and community responsibility on the farmers to collect water charges and payment to Irrigation Agency.
- To create healthy atmosphere between the Irrigation Agency personnel and the users

National Food Security Mission (NFSM)[93]:

The national food security mission (NFSM) is being implemented in 312 identified districts of 17 states of the country. Under the purview of larger mission sub-missions on rice, wheat and pulses also ply. The interventions covered under these include:

- demonstrations on improved practices;
- system of rice intensification;
- promotion of hybrid rice-production and distribution;
- distribution of High Yield Verities (HYV) seeds;
- seed minikits; micro-nutrients; liming; zero till seed drills; multi-crop planters; seed drills; rotavators, diesel pump sets, power weeders, knap sack sprayers;
- plant protection chemicals and bio-pesticides;
- Farmers' Field Schools (FFS);
- mass media campaign;
- International exposures for technical knowledge enrichment and project management team.;
- sprinkler sets;
- pilot projects on community generators;
- distribution of certified seeds; strengthening of seeds certification agencies; demonstration of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) technologies

National Project on Management of Soil Health and Fertility:

The scheme is being launched with the following broad objectives:

- To facilitate and promote Integrated Nutrient Management (INM) through judicious use of chemical fertilizers, including secondary and micro nutrients, in conjunction with organic manures and bio-fertilizers, for improving soil health and its productivity.
- To strengthen soil testing facilities and provide soil test based recommendations to farmers for improving soil fertility and economic return to farmers.
- To improve soil health through green manuring.
- To facilitate and promote use of soil amendments for reclamation of acidic/alkaline soils for improving their fertility and crop productivity.

93 Economic Survey of India 2009, Government of India

- To promote use of micro nutrients for improving efficiency of fertilizer use.
- To upgrade the skill and knowledge of STL/ extension staff and farmers and their capacity building through training and demonstration including demonstration on farmers fields regarding benefits of balanced use of fertilizers.
- To ensure quality control of fertilizers through strengthening of fertilizer quality control facility including training to enforcement.

Environment Protection Act (1986) :

The Government of India enacted the Environment (Protection) Act, 1986 (EPA) with the purpose to act as an "umbrella" legislation designed to provide a frame work for Central government co-ordination of the activities of various central and state authorities established under previous laws, such as Water Act & Air Act. The potential scope of the Act is broad, with "environment" defined to include water, air and land and the inter-relationships which exist among water, air and land, and human beings and other living creatures, plants, micro-organisms and property.

Forest (Conservation) Act, 1980:

To check further deforestation, the Forest (Conservation) Act was enacted by Government of India. The salient features of the Act are as follows:

- This Act prohibits de-reservation of any reserved forest land, using of forest land for any non-forestry purpose, leasing out of forest land to any private person or authority or any organization not owned, managed or controlled by the government and felling of trees growing naturally over any forest land without the prior approval of the Central Government.
- However work relating or ancillary to conservation, development and management of forest and wildlife like establishment of checkpost, construction of fencing, culvert, boundary marks etc. are not prohibited, under this Act.
- The Hon'ble Supreme Court in its order dated 12/12/1996 in the WP(C) 202/95 has directed that the provisions of this Act will apply to any land which looks like a forest as per the dictionary meaning of the word “forest” or to any land which is recorded as forest land in government records.
- The Act prescribes the procedure and the forms for obtaining the approval of the Central Government for any non-forestry activity in the forest land.
- The Act also prescribes that compensatory afforestation needs to be raised as per the guidelines circulated by the Central Government at the cost of the user agency in lieu of the forest land diverted for non forestry purpose.

The National Forest Policy:

National Forest Policy 1988 acknowledges the importance and primacy of local communities and provided for a sustainable management approach with maintenance of environmental stability as the prime objective. Commitment to conservation of nature is highlighted by the targets of maintaining one-third of land under the forest/tree cover. The social concerns are targeted through increasing productivity to meet local and national needs and creating a people's movement for afforestation. Industries have been advised to network with farmers for industrial raw material.

Biological Diversity Act, 2002:

India is party to the Convention on Biological Diversity (CBD) 1992 which recognizes the sovereign rights of states to use their own Biological Resources. In order to help in realizing the objectives of CBD, India has enacted an umbrella legislation called the Biological Diversity Act 2002 with the following salient features:-

- to regulate access to biological resources of the country with the purpose of securing equitable share in benefits arising out of the use of biological resources; and associated knowledge relating to biological resources;
- to conserve and sustainably use biological diversity;
- to respect and protect knowledge of local communities related to biodiversity;
- to secure sharing of benefits with local people as conservers of biological resources and holders of knowledge and information relating to the use of biological resources;
- conservation and development of areas of importance from the standpoint of biological diversity by declaring them as biological diversity heritage sites;
- protection and rehabilitation of threatened species;
- Involvement of institutions of state governments in the broad scheme of the implementation of the Biological Diversity Act through constitution of committees.

The National Biodiversity Authority (NBA) set up on 1st October 2003 as per the provisions of the Biological Diversity Act, 2002 is mandated to facilitate implementation of the Act.

Participatory Forest Management / Joint Forest Management Programme (JFM):

Initiated on 1 June 1990, Joint Forest Management (JFM) has emerged as an important intervention in management of forest resources in India. The concept of JFM has been interpreted in various ways but the basic element in this concept is to establish grassroots community based institutions for protection and management of forests. The programme aims at empowering local people for their active participation as partners in the management of forest resources and sharing the benefits derived from its protection and management. The JFM approach optimizes the returns, minimizes conflicts and links the forestry development works with the overall development of land based resources. It also aims at building technical and managerial capability at the grassroots level. The JFM programme has led to several positive outcomes. The major ones are: (i) change in the attitude and relationships of local communities and forest officials towards each other and the forests; (ii) improvement in the condition of forests; (iii) reduction in encroachments; (iv) increase in the income of local people; and (v) involvement of NGOs. JFM regime has evolved gradually and at present 106479 committees (22 million participants) are functioning in 28 States covering 22.02 million ha of forests. This participatory regime is seen as a potential strength of forest management for the forest fringes.

National Afforestation Programme (NAP):

The National Afforestation Programme (NAP) Scheme was initiated by scaling-up the Samnavit Gram Vanikaran Samridhi Yojana (SGVSY) project experience and converging all afforestation schemes of the 9th Plan period to avoid duplicity or redundancy, and at the same time keeping in focus the decentralization agenda of the government. The National Afforestation Programme of National Afforestation and Eco-

development Board (NAEB) is a centrally sponsored scheme (CSS). The goal of NAP is to promote improvement or increase in forest and tree cover. The overall objective of the scheme is to develop the forest resources with people's participation, with focus on improvement in livelihoods of the forest-fringe communities, especially the poor. NAP Scheme aims to support and accelerate the process of devolving forest protection, management and development functions to decentralized institutions of Joint Forest Management Committee (JFMC) at the village level, and Forest Development Agency (FDA) at the forest division level. NAP has been the epicenter of the JFM movement. Financial support under NAP Scheme is available for:

- Mobilization of village JFMC, and micro-planning in project villages
- Afforestation through: aided natural regeneration, artificial regeneration, bamboo plantation, cane plantation, mixed plantation of trees having medicinal value, regeneration of perennial herbs & shrubs of medicine value, pasture development / silvipasture
- Soil & Moisture Conservation
- Fencing, Monitoring & Evaluation, Training, Awareness raising, Overheads

Centrally Sponsored Scheme for Reclamation of Alkali Soils (RAS) :

Scheme was launched in the Seventh Five Year Plan for reclamation of Alkali Soils, which contain Exchangeable Sodium Percentage (ESP) more than 15 and pH more than 8.2. From November, 2000 this scheme was subsumed under Macro Management of Agriculture (MMA) Scheme along with other Centrally Sponsored Schemes of Department of Agriculture & Cooperation and is being implemented as one of the programme of MMA scheme. During the X Five Year Plan, the programme of development of Acid Soils was also initiated by different States under MMA as a new intervention to develop the Acid Soils which are highly leached, generally poor in fertility and water holding capacity, pH value less than 5.5 and with severe deficiencies of phosphorus, calcium, magnesium and molybdenum and toxicities of aluminum and iron. From the XI Five Year Plan, these programmes have been expanded for reclamation and development of both Alkali & Acid Soils and renamed as "Reclamation and Development of Alkali & Acid Soil (RADAS)". The main objectives of the revised programme are to:-

- reclamation and development of the lands affected by alkalinity & Acidity;
- improvement of soil fertility by under taking, appropriate on farm Development, application of soil amendments and growing suitable crops and horticulture crops;
- plantation of suitable fuel wood and fodder trees as per local demand and suiting to soil capability;
- improving capacity of extension personnel and beneficiaries in various aspects of alkali and acid soils reclamation technology and generate employment opportunities & thereby reduce rural urban migration.

Programme on Soil Conservation for Enhancing the Productivity of Degraded Lands in the Catchments of River Valley Project and Flood Prone River (RVP and FPR): The programme is being implemented in 53 catchments having a total catchment area of 110.11 Mha. falling in 27 states. The major objectives of the programme are:

- Prevention of land degradation by adoption of a multidisciplinary integrated approach of soil conservation and watershed management in catchment areas;
- Improvement of land capability and moisture regime in the watersheds;

- Promotion of land use to match the land capability; and
- Prevention of soil loss from the catchments to reduce siltation of multipurpose reservoirs and enhance the in-situ moisture conservation and surface rainwater storage in the catchments to reduce flood peaks and the volume of run-off.

Hariyali (2003):

To involve village communities in the implementation of watershed projects under all the area development programmes namely, Integrated Wastelands Development Programme (IWDP), Drought Prone Areas Programme (DPAP) and Desert Development Programme (DDP), the Guidelines for Watershed Development were adopted w.e.f.1.4.1995, and subsequently revised in August 2001. To further simplify procedures and involve the Panchayat Raj Institutions (PRIs) more meaningfully in planning, implementation and management of economic development activities in rural areas, these new Guidelines are called Guidelines for Hariyali . The objectives of projects under Hariyali are: -

- Harvesting every drop of rainwater for purposes of irrigation, plantations including horticulture and floriculture, pasture development, fisheries etc. to create sustainable sources of income for the village community as well as for drinking water supplies.
- Ensuring overall development of rural areas through the Gram Panchayats and creating regular sources of income for the Panchayats from rainwater harvesting and management.
- Employment generation, poverty alleviation, community empowerment and development of human and other economic resources of the rural areas.
- Mitigating the adverse effects of extreme climatic conditions such as drought and desertification on crops, human and livestock population for the overall improvement of rural areas.
- Restoring ecological balance by harnessing, conserving and developing natural resources i.e. land, water, vegetative cover especially plantations.
- Encouraging village community towards sustained community action for the operation and maintenance of assets created and further development of the potential of the natural resources in the watershed.
- Promoting use of simple, easy and affordable technological solutions and institutional arrangements that make use of, and build upon, local technical knowledge and available materials.

Technology Development, Extension & Training (TDET) schemes:

Technology support is extremely vital for success of land based programme, especially in the development of Wastelands. Proper area specific strategy has to be developed keeping in view the Agro-Climatic conditions and capability of land. Realizing this, a Central Sector Scheme of TDET was launched during 1993-94 to develop suitable technologies for the reclamation of Wastelands for sustained production of food, fuel wood, fodder etc. The objectives of the scheme are,

- development of data base for planning sustainable development of wastelands,
- operationalisation of cost effective and proven technologies for development of various categories of wastelands specially problem lands affected by soil erosion , land degradation, salinity, alkalinity, water logging etc.,

- implementation of location specific pilot projects/ demonstration models including pisciculture, duckery, bee keeping, domesticated animals and birds etc.,
- dissemination of research findings and appropriate technologies for promoting wastelands development,
- evaluation of impact, and replication of these models in larger areas,
- Organizing of publicity, awareness campaign, seminar/ conferences, circulation of handouts/ extension materials.

Important activities undertaken in the Scheme include promotion and testing of various Agro-Forestry Models in different Agro-Climatic Zones of the country, testing of cost effective technologies for increasing productivity of saline and alkaline soils. Development of waterlogged areas through surface, sub surface and bio-drainage technology , promotion of medicinal and herbal plantations in wastelands, composite technologies for water harvesting, treatment of degraded lands through vermi-culture, micorhizae and Bio-Pesticides Food Stock Model techniques and development of technology for Jojoba Plantation in Arid and Semi Arid areas through Israeli collaboration.

A.3 Sectoral Allocation for Public Sector's Resources Tenth Plan (2002-07) Realizations and Eleventh Plan (2007-12) Projections

(Rs crore at 2006-07 prices)

Head of Development	Centre									States and UTs			Centre, States and UTs		
	Budgetary Support			IEBR			Total Qutlay						Total Outlay		
	Tenth Plan Realization	Eleventh Plan Projection	% increase	Tenth Plan Realization	Eleventh Plan Projection	% increase	Tenth Plan Realization	Eleventh Plan Projection	% increase	Tenth Plan Realization	Eleventh Plan Projection	% increase	Tenth Plan Realization	Eleventh Plan Projection	% increase
1. Agriculture and Allied Activities	26108	50924	95.0				26108	50924	95.0	34594	85458	147	60702	136381	124.7
2. Rural Development	79291	190330	140.0				79291	190330	140.0	58419	110739	89.6	137710	301069	118.6
3. Special Area Programmes										16423	26329	60.3	16423	26329	60.3
4. Irrigation & Flood Control	1716	6747	293.3				1716	6747	293.3	110699	203579	83.9	112415	210326	87.1
5. Energy	27262	36912	35.4	238957	591826	147.7	266220	628739	136.2	97415	225385	116.1	363635	854,123	134.9
6. Industry & Minerals	24146	54382	125.2	25108	67196	167.6	49254	121579	146.8	15401	32021	107.9	64655	153600	137.6
7. Transport	97711	120188	23.0	85405	266118	211.6	183116	386306	111.0	80818	186137	130.3	263934	572443	116.9
8. Communications	5312	16133	203.7	77109	79204	2.7	82422	95337	15.7	523	43	-91.8	82945	95380	15
9. Science, Technology & Environment	26667	75421	182.8		25		26667	75446	182.9	2006	12487	522.4	28673	87933	206.7
10. General Economic Service	9972	13920	39.6	456	891	95.3	10428	14811	42.0	19921	47712	139.5	30349	62523	106.0
11. Social Services	183725	524414	185.4	31494	54450	72.9	215219	578864	169.0	221310	523463	136.5	436529	1102327	152.5
12. General Services	4887	7489	53.2				4887	7489	53.2	15602	34794	123	20489	42283	106.4
Total	486798	1096860	125.3	458530	1059711	131.1	945328	2156571	128.1	673132#	1488147	121.1	1618460	3644718	125.2

Note: # Based on the sectoral outlay reported by the States. Totals May not tally due to rounding errors.

Source: Eleventh FYP, Volume I Annexures

A.4 International Agreements in Energy Sector

India & China went into an agreement to establish the India-China Partnership on combating climate change. Some of the focus areas of this agreement includes Energy conservation and energy efficiency; Renewable

energies; Clean coal; Methane recovery and utilization; Afforestation and sustainable management of forests and ecosystems; Transportation; Sustainable habitat.

Other **International Bilateral/Multilateral Cooperation Frameworks between India and other countries for cooperation in New and Renewable Energy** during the period 2007 2009:

- MoU between the Ministry of New and Renewable Energy, Government of India and the Department of Energy of the USA on Cooperation in the Development of Bio-fuels.
- MoU on Indo-Denmark New and Renewable Energy Cooperation between Ministry of New and Renewable Energy, Government of the India and the Ministry of Climate and Energy, Government of the Kingdom of the Denmark.
- MoU among the Government of the Republic of South Africa, Government of the Federative Republic of Brazil and the Government of the Republic of India on Cooperation in Wind Resources.
- Protocol on Cooperation in New and Renewable Energy between the Government of the Republic of India and the Government of the Republic of Cuba for the Biennium 2007-2009.
- MoU on Indo-Iceland Renewable Energy Cooperation between the Ministry of New and Renewable Energy, Government of India and the Ministry of Industry of the Republic of Iceland.
- MoU on New and Renewable Energy Cooperation between Ministry of New and Renewable Energy and Department of Resources, Energy & Tourism, Government of Australia.
- Agreement between the Ministry of New and Renewable Energy, Government of India and the University of Saskatchewan, Canada on Indo-Canadian Renewable Energy Cooperation.
- MoU on Indo-Italian Renewable Energy Cooperation between the Ministry of New and Renewable Energy, Government of India and the Ministry for Environment, Land and Sea of Italy.
- MoU on Cooperation in the field of New and Renewable Energy, Government of the India and the Secretariat of Energy of the United Mexican States.
- MoU between the Ministry of New and Renewable Energy, Government of India and the Department of Energy, Republic of The Philippines on Enhanced Cooperation in the Field of Renewable Energy.
- MoU between Ministry of New and Renewable Energy, Government of India and the Ministry of Energy, Government of The Kingdom of Thailand on Enhanced Cooperation in the field of Renewable Energy.
- MoU on Cooperation in the Field of New and Renewable Energy between the Ministry of New and Renewable Energy, the Government of India and the National Energy Commission, Republic of Chile.
- MoU on India-Scotland Renewable Energy Cooperation between the Ministry of New and Renewable Energy and The Government of Scotland.
- MoU between The Ministry of New and Renewable Energy of the Republic of India and The Ministry of Industry, Tourism and Trade of the Kingdom of Spain in the field of Renewable Energy.

In addition, interaction with USA and Japan for cooperation in New and Renewable Energy is pursued under India-US Energy Dialogue and India-Japan Energy Dialogue, respectively. Interaction with EU for cooperation in New and Renewable Energy is pursued under India-EU Energy Panel. A multilateral cooperation framework called Asia-Pacific Partnership on Clean Development and Climate (APPCDC) enables interaction for cooperation with USA, China, South Korea, Japan, Canada and Australia.

A major trans-boundary project for conservation and sustainable development of the Greater Mt Kailash Region, involving India, Nepal and China has been launched, facilitated by (ICIMOD) with support from UNEP. The project is titled as 'Mount Kailash Sacred Landscape Conservation" (Source: MoEF) -India and China Signed Agreement on Climate Change Cooperation on , 21st October, 2009 (Source : MoEF).

A.5 Projects/Schemes Identified by the Working Group/ NDMA to be taken up by for Implementation during the Eleventh Plan

S. No.	Name of the Project/Programme/Scheme	Objective
1	National Cyclone Risk Mitigation Project (with World Bank Assistance)	For mitigating hazard risks in the country & enhancing capabilities at various levels
2	National Earthquake Risk Mitigation Project	Strengthening structural & non-structural earthquake mitigation efforting and reducing risk and vulnerability in high risk districts
3	National Flood Mitigation Project	Multi-objectives including effective preparedness and improved promptness and capability, strengthening community capacity and reduction in consequences of floods
4	National Landside Mitigation Project	Strengthen the structural and non-structural landslide mitigation efforts and reduce the landslide risk and vulnerability in the hilly districts prone to landslides and mudflows
5	Expanded Disaster Risk Mitigation Project	Strengthen the structural and non-structural disaster preparedness and mitigation efforts to reduce the risk and vulnerability in the disaster-prone districts with community participation
6	National Disaster Communication Network (NDCN)	Dedicated communication & IT support for pro-active disaster support functions including for early warning & forecasting
7	Information, education and Communication (IEC) Programme	Disaster risk and vulnerability reduction, disaster preparedness, structural and non structural mitigation efforts and disaster response by developing ICT materials, print and electronic media products, campaigns, exhibitions, etc
8	Micro-zonation of Major cities	To carry out micro-zonation of High Risk Cities in Seismic Zone IV and V to prepare strategies to deduce earthquake risk and vulnerability in the high risk districts
9	Project Preparation Facility/Resarch Programme Studies	Take up mitigation projects for disaster risk reduction and also undertake special studies and research programmes
10	Vulnerability Assessment Schemes	Gujarat has undertaken vulnerability analysts of different parts of the State to different forms of disasters. Such an analysis in urgently required to be carried out by other States too
11	International Co-operation	India needs to adopt a proactive approach for providing necessary support to the neighboring countries through multilateral co-operation and involvement of regional organizations
12	Infrastructure of 8 NDRF Battalions	Completely new infrastructure has to be built for 6 battalions @ Rs. 80 crore per bn and existing infrastructure has to be upgraded for the 3 battalions @ Rs 25 crore per bn
13	Upgradation of NIDM and other Institutes	The institute requires space and equipments for state -of-the-art emergency operations centre, disaster mitigation workshop, mock drill exercise, library, GIS laboratory, etc

Source: Eleventh FYP, Volume I Annexures

A.6 List of Figures

A.7 List of Tables

A.8 List of Boxes

A. 9 Acronyms

AgDSM	Agriculture Demand Side Management
BPL	Below Poverty Line
CAMPA	Compensatory Afforestation Management and Planning Authority
CO2e	Carbon Dioxide equivalent
CSP	Concentrated Solar Power
DFID	Department for International Development
FAO	Food and Agriculture Organization
FSC	Forest Stewardship Council
FYP	Five Year Plan
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GoI	Government of India
GRIHA	Green Rating for Integrated Habitat Assessment
GW	Giga Watt

IARI	Indian Agricultural Research Institute
ICFRE	Indian Council of Forestry Research and Education
IEP	Integrated Energy Policy
IFPRI	International Food Policy Research Institute
IIFM	Indian Institute of Forest Management
IISc	Indian Institute of Science
IITM	Indian Institute of Science
INCCA	Indian Network of Climate Change Assessment
IPCC	Inter-Governmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IWDP	Integrated Wasteland Development Programme
IWMP	Integrated Watershed Management Programme
JFM	Joint Forest Management
JFMCs	Joint Forest Management Committees
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KVK	Krishi Vigyan Kendra
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land-Use Change and Forestry
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MMT	Million Metric Tonnes
MNRE	Ministry of New & Renewable Energy, Government of India
MoEF	Ministry of Environment and Forests, Government of India
MSSRF	MS Swaminathan Research Foundation
MSW	Municipal Solid Waste
Mt	Million tonne
Mtoe	Million Tonnes of Oil equivalent
MW	Mega Watt
NATCOM	National Communication (to UNFCCC)
NIO	National Institute of Oceanography
NPL	National Physical laboratory
NPP	Net Primary Productivity
NRAA	National Rainfed Area Authority
NREP	National Rural Employment Progarmme

NTFPs	Non-Timber Forest Products
OECD	Organisation for Economic-Cooperation & Development
PEFC	Programme for the Endorsement of Forest Certification
PIM	Participatory Irrigation Management
PMGSY	Pradahan Mantri Grameen Sadak Yojana
PPP	Purchasing Power Parity
RE	Renewable Energy
REDD	Reducing Emission from Deforestation and Forest Degradation
RGGVY	Rajeev Gandhi Grameen Vidyutikaran Yojana
RKVY	Rashtriya Krishi Vikas Yojana
SoE	State of Environment
TDET	Technology Development, Extension & Training Scheme
TERI	The Energy and Resources Institute
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	US Dollars
WEDO	Women's Economic Development Outreach
WFP	World Food Programme
WHO	World Health Organization

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