

Title:

Mainstreaming Adaptation to Climate Change in Indian Policy Planning

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Abstract:

Climate change affects the balance of natural and socio-economic systems. In the recent years, literature has accumulated on the potentially large-scale impacts of climate change on India. India has emerged as one of the most vulnerable countries in the world, with a high-dependence on climate sensitive sectors such as agriculture, water resources, natural ecosystems and forestry, health, sanitation, infrastructure and energy. This necessitates a rapid response by the government, especially in light of recent global negotiations. In this context, an attempt is made to present findings thus far on the potential vulnerability to the effects of climate change in India's key sectors. This paves the way for an argument to ensure current and future policy development in India incorporate climate change adaptation. We argue that currently available scientific knowledge is adequate to plan and implement adaptation practices in India. A strategy for adaptation to be mainstreamed into the planning process is also presented.

1. Introduction

Climate change is now recognised as one of the most pressing global issues of our planet (El Sioufi (2010)). A review of climate science by the US National Academy of Sciences (NAS, 2010) concludes that “the Earth system is warming and that much of this warming is very likely due to human activities” and describes this conclusion as a “settled fact”. Newer studies in 2011 report even higher levels of GHG emissions in the last decade (Peters et al., 2011). Also new observations at the global and regional levels show higher observed impacts of climate change on many key production systems, natural resources and communities (Rahmstorf, Stefane, 2010, Beaumonta et al., 2011; Tedesco et al., 2011; Wang et al., 2009; Harley D.G. Christopher., 2011; Bálint et al., 2011, Rignot et al., 2011). For example, the IPCC projected a global average temperature rise of 4.2°C under the BAU emissions scenario (A1B) towards the end of the 21st century, while new studies project a warming of more than 6°C under the current BAU emissions scenario over the same period (IEA, 2011). Thus studies based on new observations and models clearly suggest that the threats from climate change are much more immediate and severe than anticipated earlier in the decade.

The current concern is on the extent and magnitude of climate change. Climate change affects the balance of natural eco-systems (i.e. forests, river basins, sea level) and socio-economic systems (i.e. agriculture, fisheries, irrigation and power projects). The impacts arise through changing temperature patterns, rising sea-levels, and the intensification of natural disasters, affecting livelihood systems including agriculture, water resources and sanitation, forests and biodiversity. It is widely accepted that the poorest are disproportionately vulnerable to climate change and the least able to adapt (Parry et al., 2007; Black et al., 2011). This can be largely attributed to their reliance on the natural resource base for their livelihood. Developing countries such as India are thus more likely to be vulnerable to the effects of climate change. Severe changes affecting the natural resource base will impact livelihoods of the poor in these countries. IPCC studies indicate that the vulnerability of a region depends to a great extent on its wealth, and that poverty and inequality limit adaptive capabilities (IPCC, 2011). Patnaik and Narayanan (2005) argue that socio-economic systems “typically are more vulnerable in developing countries where economic and institutional circumstances are less favourable”.

Furthermore, due to its effects on livelihoods, climate change is predicted to impose significant aggregate costs for society (House of Commons, 2008; Parry et al, 2007; Stern, 2007). For example, the total cost of adaptation to climate change was estimated at over \$100 billion in the run-up to the Copenhagen Climate Change Conference (Black et al., 2011).

Therefore policies promoting adaptation to climate change are critical in the coming years. Thus far, studies have mostly concentrated on assessing the impacts of scenarios without climate policy. The most important reason is that detailed descriptions of climate change, needed as input to assess the impacts, are predominantly available for scenarios that explore the consequences of different socio-economic development pathways in the absence of climate policy (Moss et al., 2010).

In addressing this gap, an important debate currently is the incorporation of climate change into mainstream developmental policy. Mainstreaming in this context refers to the incorporation of climate change considerations into established or on-going policies, development programmes, policies or management strategies, rather than developing climate adaptation and mitigation initiatives separately. The idea is explained best by the FAO; “in order for climate change adaptation and mitigation to be sustainable and applicable on a wide scale, it must be incorporated, integrated or “mainstreamed” into the policy apparatus of governments” (FAO, 2009).

In this paper, an attempt is made to highlight the need for and rationale for mainstreaming adaptation in planning developmental policies and programmes. We also present an approach for mainstreaming adaptation in developmental programmes. This is particularly highlighted in the context of India and its five-year development plan – the 12th plan for the period 2012-2017. Additionally, the paper considers adaptation in the larger global context, through global agreements such as the Kyoto Protocol and most recently the Durban Climate agreements (2011).

2. Climate change projections for India

India's economy is tied to crucial sectors such as agriculture, water resources, natural ecosystems and forestry, health, sanitation, infrastructure and energy. A 2004 study by National Communications (NATCOM) highlights these sectors as most vulnerable to the projected changes in surface temperature, precipitation patterns and rising sea levels. NATCOM assessed and reported impacts of climate change on these sectors for the 2050s and 2080s. The study underscored the need for more comprehensive studies and information at regional and sub-regional levels.

The Indian Network for Climate Change Assessment (INCCA) launched in 2010 by the Ministry of Environment and Forests (MoEF) published its first study in the same year. The study projects the climate and impacts on four eco-sensitive zones to 2030's, covering the Himalayan region, the North-Eastern region, the Western Ghats and the Coastal region. The sectors covered are agriculture, forests and biodiversity, water resources and coastal zones (INCCA, 2010). This study presents the most recent information on modelling of climate impacts in India.

The assessment examines the implications of climate change for India using the model HadRM3 (Hadley centre Regional Model Version 3). The A1B scenario is used as it provides a good mid-line scenario for carbon dioxide output and economic growth. The 2030s are taken as the average of the period 2021–2050. All the changes in the 2030s are measured with respect to the period 1961–1990, also referred to as ‘1970s’ or ‘baseline’.

The key findings are indicated in table 1 below, and highlight the impacts of climate change with regard to the following climate variables:

- Temperature variability,
- Precipitation variability,
- Rising sea-levels,
- Extreme events (drought and flooding), and

- Risk to environmental health.

Table 1: Summary of climate change projections for India

Indicator	Climate Change Projections
Temperature variability	<ul style="list-style-type: none"> • An overall warming for all the four regions in focus, with a net increase in annual temperatures in the 2030s ranging between 1.7°C and 2.2°C, with extreme temperatures increasing by 1–4°C, with maximum increase in coastal regions. • Seasons may be warmer by around 2°C towards the 2030s. • The extreme maximum and minimum temperatures are also projected to increase in the 2030s • The variability of seasonal mean temperature may be more in winter months
Precipitation Variability	<ul style="list-style-type: none"> • All the regions are projected to experience an increase in precipitation in the 2030s and the increase is highest in the Himalayan region and lowest in the North Eastern region. • A mean increase of 7–20% in annual precipitation • A 10–15% increase in monsoon precipitation in many regions • Extreme precipitation events are likely to increase by 5–10 days in all the four regions. • The number of rainy days are projected to decrease, in most parts of the country, except in the Himalayas, the North-western region and the Southern plateau, however intensity is set to increase
Extreme Events – Drought	A sharp drop in groundwater tables across the entire Indo–Gangetic plain. The Ganga, Narmada, Krishna and Kaveri rivers are expected to experience seasonal or regular water stress, impacting western, northern and eastern India.
Extreme Events – Flooding	<ul style="list-style-type: none"> • All the regions are likely to experience flooding exceeding the existing magnitude by 10–30%. • A sea surface temperature rise of 2–4°C, as anticipated in the Indian Ocean is expected to induce a 10–20% increase in cyclone intensity. The East Coast is likely to face more intensity. • Further projections indicate that the frequency of cyclones is likely to decrease in the 2030s, with increase in cyclonic intensity.
Rising Sea-Level	<ul style="list-style-type: none"> • Sea level along the Indian coast has been rising at the rate of 1.3mm/year and is likely to rise in consonance with the global sea level rise (SLR). • Significant coastal inundation seen with a 1m sea

	level rise, especially in low-lying areas.
Environmental Health Risk	Increased occurrences of environment-related health risks, due to extreme temperatures, flooding and SLR.

Source: Information derived from INCCA (2010); IIED (2009); Parry et al (2007)

In another recent study, Krishna Kumar et al., (2011), examined the impact of global warming on Indian summer monsoon using Hadley Centre's high-resolution regional climate model, PRECIS (Providing Regional Climates for Impact Studies). The PRECIS simulations corresponding to the IPCCSRES A1B emission scenario were carried out for a continuous period of 1961–2098. The climate projections were studied over three time periods - short-term (i.e. 2020s), medium-term (i.e. 2050s) and long-term (i.e. 2080s). The findings are comparable to recent projections of climate change from the INCCA assessment. Krishna Kumar et al (2011) also suggest that the annual mean temperature over India rose by 0.051°C / decade over the last century while the pace of temperature rise increased considerably since 1970s when annual mean temperature rose by 0.21°C / decade.

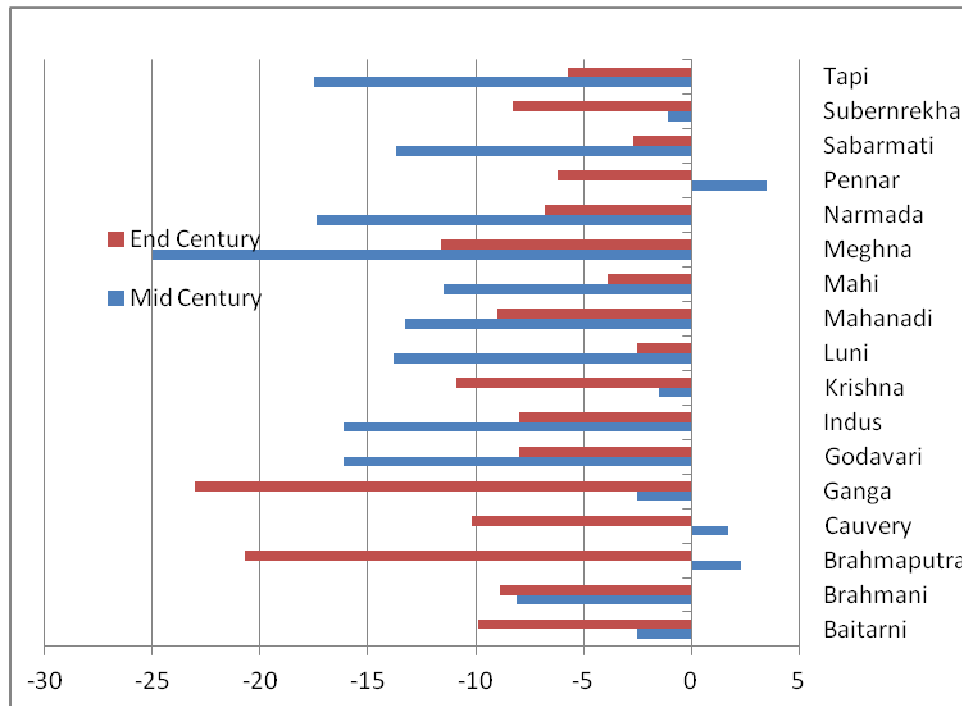
It must be noted that the level of uncertainty in all these studies is high (Krishna Kumar et al., 2011 & INCCA, 2010). This is in part due to the scale of analysis. Global averages can be projected with much more certainty than projections for specific locations. The level of uncertainty also differs across different aspects of climate change, with more accurate projections available for temperature than for precipitation (GIZ 2011). Despite the uncertainty involved, and whilst knowledge in the subject is developing, it is crucial to understand that the science, through the projections is indicative of what might happen and enable policy makers to identify and counteract possible impacts. Projected impacts of climate change on key sectors are discussed below.

3. Impact of climate change in India

Impact on water resources

Gosain et al (2011) projected the impact of climate change on the 17 most important river basins in India up to mid-century and towards the end of the century. They estimated a decline in rainfall in 14 out of the 17 river basins towards the 2030s (mid century) and the 2080s (end century). In almost all river basins rainfall declines from 4% to 23%, following changes in precipitation (figure 1). As a result of the decline in basin level rainfall, water yield in most of the river basins will decline by the 2030s and almost all (except the Krishna and Cauvery basins) by the 2080s.

Figure 1: Projected change in precipitation in major river basins in India (%)



Source: Gosain et al (2011)

Impact on agricultural systems

The agriculture sector in India is already threatened by existing factors such as land use changes, scarcity of water resources, increasing air pollution and loss of biodiversity. In a tropical country such as India, even minimal warming will lead to loss in crop yields (Parry et al., 2007). Further studies conducted by the Indian Agricultural Research Institute (IARI) indicate the possibility of loss of 4-5 million tons in wheat production with every rise of 1 degree C temperature throughout the growing period even after considering carbon fertilization. Losses for other crops are still uncertain but are expected to be smaller, especially for kharif crops (Aggarwal, 2008).

Research also suggests that erratic monsoons will have serious effects on rain-fed agriculture with projected decreases in the productivity of crops including rice, maize and sorghum (especially in the Western Ghats, Coastal region and North eastern regions), apples (in the Himalayan region) (Kumar et al, 2011). Studies indicate that increased droughts and floods are likely to increase production variability and lead to considerable effects on microbes, pathogens, and insects needed for the upkeep of healthy agricultural systems. The UNFCCC (2007) have indicated that increasing sea and river water temperatures are likely to affect fish breeding, migration, and harvests. Increasing glacier melt in Himalayas could affect availability of irrigation

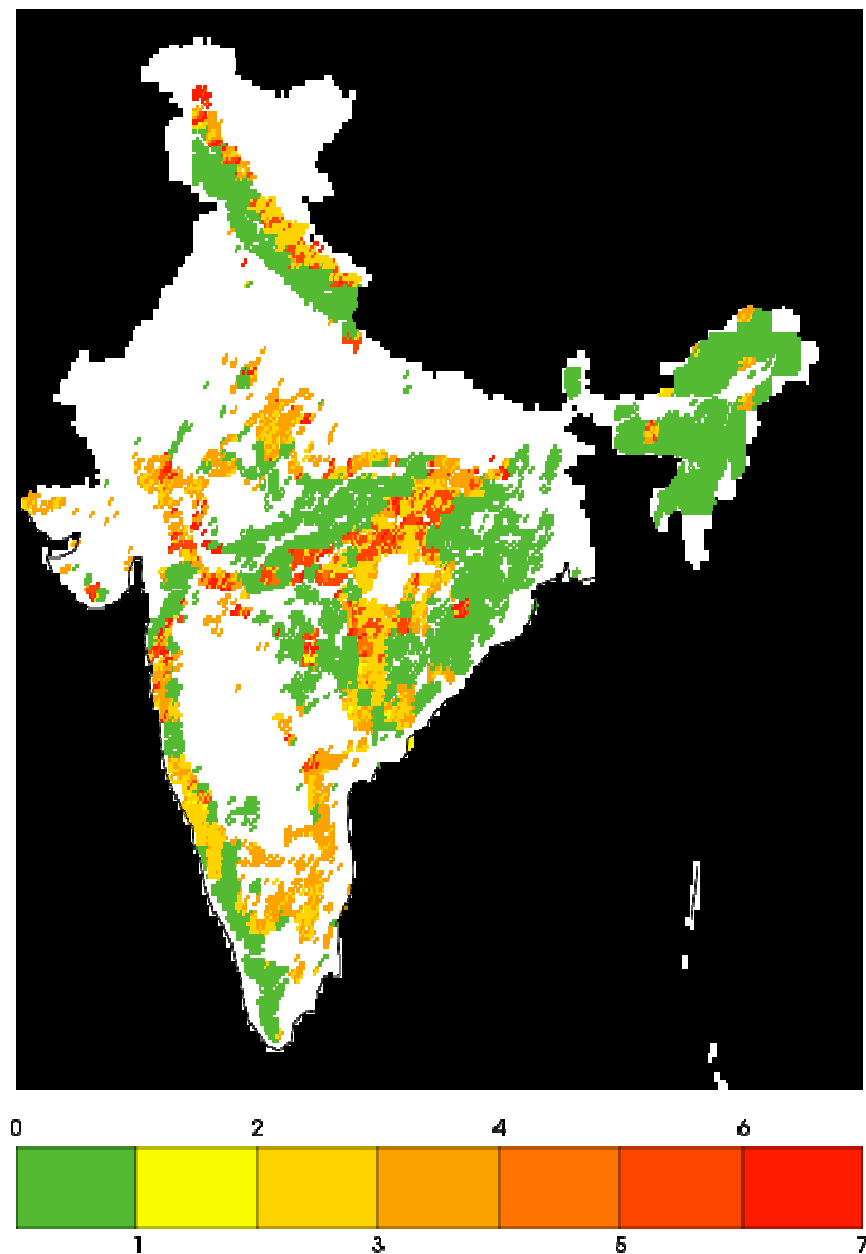
especially in the Indo-Gangetic plains, which, in turn, would have consequences on food production.

Aggarwal et al (2009) estimated the impact of climate change on livestock and conclude that animal distress could lead to effects on reproduction and subsequently loss of 1.5 million tons of milk by 2020.

Impact on forests and biodiversity

Chaturvedi et al (2011) projects the impact of climate change on Indian forests and conclude that 39% and 35% of the forests grids in India will likely undergo change under the A2 and B2 scenarios respectively. Figure 2 shows the vulnerable forest grids in India (under the A2 scenario of climate change).

Figure 2: Distribution of forest vulnerability in India (for FSI grids).



Green indicates a vulnerability index of 1 (least vulnerable), while yellow to red indicate increasing levels of vulnerability.

Source: Chaturvedi et al (2011)

The vulnerability map suggests that the concentration of vulnerable forest grid is higher in the upper Himalayan stretches, parts of central India, northern Western Ghats and Eastern Ghats. The upper Himalayan stretches and parts of central India currently have low development indicators, so that they will struggle to cope with any impacts they might be faced with.

The forests of northeast, southern Western Ghats and eastern parts of India are projected to be least vulnerable. This is on account of their high biodiversity, low fragmentation, high tree density as well as low rates of vegetation change (as these regions experience lower levels of temperature increase and gain substantially in terms of precipitation). Chaturvedi et al (2011) suggest that low vegetation vulnerability in North-eastern India means these regions are suitable especially for forest conservation projects.

An earlier study by O' Brien et al (2004) estimated the vulnerability of India under multiple stressors (e.g climate change, globalization etc). O' Brien et al (2004) suggest North-western and central parts of India to be highly vulnerable and Southern India to be relatively low on vulnerability.

Impact on infrastructure systems

In India, investments worth US\$ 120 billion have been planned for infrastructure asset creation during 2011-2012 (Naswa and Garg, 2011). Climate change induced natural disasters could put serious pressure on these investments. The critical climate parameters of temperature, precipitation, sea-level rise and extreme events pose direct and indirect threats to India's infrastructure assets. Enhanced landslides, vegetation cover, excessive siltation in rivers, and soil erosion could be direct impacts. Ground-water table depletion, energy demand changes, and migratory traffic could be the possible indirect impacts. The risks could be physical, technological, supply-chain or regulatory in nature (Naswa and Garg, 2011). A study on the adverse impact of climate change on the Konkan Railways (a 760 kilometre line connecting Maharashtra, Goa and Karnataka – a region of criss-crossing rivers, deep valleys and mountains) leading to both direct and indirect risks in the railway sector has indicated key impacts such as infrastructure damages, disruption to services, repair and reconstruction costs, changes in both agricultural freight traffic and passenger traffic as a result of climate change. For instance, the study identified that 20% of repair and maintenance expenses on tracks, tunnels and bridges were due to climatic reasons (IIM, 2007).

4. Understanding India's vulnerability to climate change

Understanding vulnerability is central to any analysis on incorporating climate change into mainstream policy mechanisms. 'Vulnerability' to climate change is subject to varying interpretations. Vulnerability can occur on many levels and can include a

range of biophysical, socioeconomic, institutional and technological factors. Vulnerability is also subject to a number of external influences. The IPCC (2007) provides one useful typology of vulnerability and identifies it as encompassing three key elements - adaptive capacity, sensitivity, and exposure. Adaptive capacity describes the ability of a system to adjust to actual or expected climate stresses, or to cope with the consequences. McCarthy et al (2001) refer to vulnerability as ‘‘a function of wealth, technology, education, information, skills infrastructure, access to resources, and stability and management capabilities’. Sensitivity refers to the degree to which a system will respond to a change in climate, either positively or negatively. Exposure relates to the degree of climate stress upon a particular unit of analysis; it may be represented as either long-term change in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events.

Wheeler (2011) attempted a comprehensive account of climate change vulnerability for 233 countries, including India. The study developed risk indicators for three critical problems: increasing weather-related disasters, sea-level rise, and loss of agricultural productivity. With about 2,600 persons per 100,000 population at risk to weather related disasters, India is assessed as the 7th most vulnerable nation for the year 2008. Further it is projected that, the proportion of its vulnerable population will increase to 11,704 persons per 100.000 population by 2015 leading India to be the 3rd most vulnerable nation in the world (Table 2).

Table 2: Top 10 countries to weather risk in 2015

	Vulnerability: Probability of Extreme Weather Impact (Per 100,000 Population)					
Country	Rank 2008	Rank 2015	2008	2015- Climate only	2015-Climate + Income	2015 -Climate + Income + Urbanization + Regulation
China	3	1	6,772	25,072	19,933	17,720
Djibouti	1	2	13,709	14,281	14,167	14,331
India	7	3	2,599	11,704	9,531	9,153
Kenya	2	4	6,807	7,752	7,620	7,617
Somalia	8	5	2,382	4,011	3,807	5,482
Mozambique	4	6	4,576	5,133	5,028	5,269
Philippines	10	7	2,134	5,161	4,607	5,102
Bangladesh	19	8	823	5,487	4,611	4,844
Sri Lanka	6	9	3,458	4,304	4,072	4,558
Ethiopia	5	10	3,791	4,892	4,747	4,540

Source: Wheeler (2011)

Table 3: Top 10 countries vulnerable to sea level rise over 2008 to 2050

	Rank		Vulnerable population (Mn)	
Country	2008	2050	2008	2050
India	1	1	20.6	37.2
Bangladesh	3	2	13.2	27
China	2	3	16.2	22.3
Indonesia	4	4	13	20.9

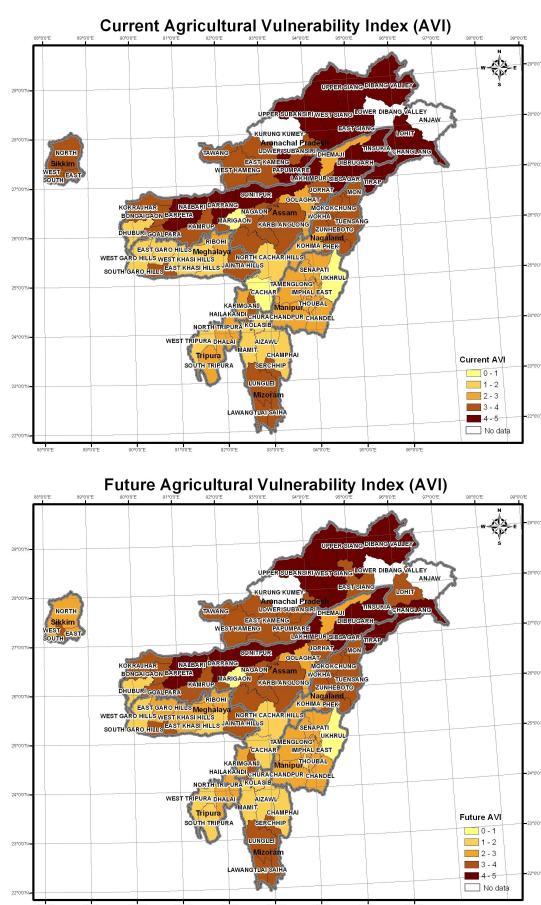
Philippines	6	5	6.5	13.6
Nigeria	9	6	4.3	9.7
Vietnam	7	7	5.7	9.5
Japan	5	8	9.8	9.1
United States	10	9	3.8	8.3
Egypt	17	10	2.1	6.3

Source: Wheeler (2011)

While a number of global vulnerability studies are available, very few vulnerability assessments are available at the country level in India. At the national level there is a lack of studies assessing multi-sectoral vulnerabilities.

A study by Ravindranath et al (2011) presents one of the best efforts to quantify vulnerability to climate change at the regional level. Ravindranath and colleagues (2011) assess the district level vulnerability profiles of agriculture, water and forest sectors for North-eastern India. The study estimates that a majority of grids (areas covering roughly 50 by 50 kilometres boxes on the map) in North Eastern India are vulnerable to climate change even under the current climate. Projected climate change increases the vulnerability even further. The current and future vulnerabilities of the agriculture and water sector in North-eastern India are shown in the figures below.

Figure 3: Distribution of Current and future Agricultural Vulnerability over the Districts of North East India



5. Adaptation Strategies

Adaptation is needed to prepare communities, regions, countries and societies for the consequences of climate change. Adaptation is an expansive subject covering many sectors and socio-economic frameworks. The United Nations Framework Convention on Climate Change (UNFCCC) defines adaptation as “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation” (UNFCCC, 2011).

Adaptation as a concept has developed very slowly under the UNFCCC, although it has been given higher priority since the Bali Action Plan in 2008. At CoP 15 Copenhagen (2009), it was agreed that “enhanced action and international cooperation on adaptation is urgently required to ensure the implementation of the Convention by enabling and supporting the implementation of adaptation actions aimed at reducing vulnerability and building resilience in developing countries, especially in those that are particularly vulnerable, especially least developed countries, small island developing States and Africa” (UNFCCC, CoP 15, 2009).

The need for adaptation

The immense vulnerability of a country such as India, to the potential effects of climate change, as explored above, necessitates the need for national policy to be intensified to address climate change. India is home to a third of the world’s poor. The poor are most vulnerable to the effects of climate change. India is set to be the most populous nation in the world by 2045, and the economic, social and ecological cost due to climate change is likely to be enormous. Also keeping in mind, global negotiations, strategies promoting adaptation to the projected effects of climate change are crucial.

The development of a strategy to ensure its populace is protected from as much of the effects of climate change as possible is of utmost importance. Development strategies in India have generally followed a growth-centric pattern. Similarly, the climate change agenda in India has largely followed a fairly straight-laced approach. The Indian government has been working toward reducing GHG emissions and developing adaptive capacity, with bespoke policies and programmes.

This approach will need to be overhauled by more innovative strategies, that look to incorporating climate change into existing developmental programmes whilst also continuing separate policies on low carbon energy and adaptation. In a transition country such as India, there is a need to analyse the potential of rights-based, equity oriented developmental programmes to consociate between:

- Generating livelihoods and employment for poor;
- Promoting infrastructure growth;
- Generating environmental services;
- Conserving natural resources; and

- Reducing vulnerability to climate risks.

6. Current climate change adaptation efforts in India

It is important to note that programmes targeting sound macro-economic intentions can spill over into climate-related impacts that need to be addressed. Thus, adaptation options should not be isolated from other decisions, but occur in the context of demographic, cultural and economic changes as well as transformations in global governance, social conventions, and the globalising flows of capital and to a lesser extent labour (O'Brien and Leichenko, 2000). Impacts on natural resources; including soil and water conservation, land development, irrigation systems and afforestation; which are critical for sustained livelihoods and long-term employment to the poor (in particular the landless), appear to not be sufficiently addressed within development programmes.

It is in this context that developmental programmes can offer an opportunity to address the duality of the issue i.e. developmental programmes targeting the most vulnerable in a society as climate change affects the most vulnerable in a society. Box 1 gives an example the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) programme in India. The study described in the box provides evidence of the importance of mainstreaming climate considerations into developmental programmes.

Box 1: Climate Change in Developmental Programmes

MNREGA and Climate Change

The Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) is a large pioneering rights-based programme. Introduced by Indian legislation in August 2005, the scheme aims at enhancing the livelihood security of the poorest in rural areas by guaranteeing one hundred days of wage-employment in a financial year to a rural household whose adult members volunteer to do unskilled manual work.

The MNREGA is one of the largest single rights-based social protection initiatives in the world. The national budget for the financial year 2010-2011 was Rs 40,000 crores (US \$8.8 billion). The programme has had its successes, essentially relating to its prime objective of employment provision.

Despite the potential for ecological restoration and vulnerability reduction, a key criticism facing MNREGA is the insufficient attention given to the sustainability of the employment opportunities generated. In view of the target-based approach, implementation of the act emphasizes easily executable works such as road building. Currently, activities related to tree plantation and drought proofing account for around 8 percent of the funding, but forestry could be included more fully to help trigger real economic growth. The National Forest Commission has recommended a substantial increase in the allocation of funds to forestry and watershed operations, to reach 20 percent of Rural Development Programme funding (Matta, 2009).

Furthermore, a study by Tiwari et al (2010) assessed the potential of the activities undertaken by the MNREGA to enhance and provide environmental services. Using an indicator approach, an analysis of environmental services such as water for irrigation and improvement in soil quality was conducted, before and after the implementation of the activity. Vulnerability indices were constructed and compared. The results found that the activities under MNREGA reduced the vulnerability of agricultural production, water resources and livelihoods to uncertain climate parameters such as rainfall, water scarcity and poor soil fertility.

With growing interest in incorporation of adaptation into developmental programmes, two viewpoints have to be considered, adaptation to current climate variability and future climate variability. Parry et al (2007) suggest various types of adaptation measures, which are described below:

- **Anticipatory adaptation:** It is the form of adaptation that takes place before impacts of climate change are observed. It is also referred to as proactive adaptation.
- **Autonomous adaptation:** It is the form of adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. It is also referred to as spontaneous adaptation. It is essentially planning that

should have taken place already but has not. For instance, traditional water harvesting systems to supplement household water supply.

- **Planned adaptation:** Is to plan for changes in the medium and long-term. It is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

India has already incorporated adaptation to climate change at various policy levels. For example India has included for adaptation in its National Action Plan on Climate Change, State level Action plans, Union budgets and India's five-year plans.

National Action Plan on Climate Change

India has a good start on its climate change programme through the National Action Plan on Climate Change (NAPCC, 2008), and its subsequent eight missions. The NAPCC, released in June 2008, outlines a strategy by which India will adapt to and mitigate, challenges of climate change, while maintaining a high growth rate, protecting poor and vulnerable sections of society and achieving national growth objectives. The government's proposals, whilst void of specific targets and details, put forward action plans, that could be easily developed through regional and state level strategies as well as to incorporate into current and future developmental plans, for example MNREGA (Box 1).

The NAPCC has identified eight missions to address climate change, of these five missions solely deal with adaptation. These are:

1. **National Water Mission:** The mission aims to optimize water use by increasing water use efficiency by 20%, recycling of waste water and implementation of IWRM
2. **National Mission for Sustaining the Himalayan Ecosystem:** The plan aims to conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers that are a major source of India's water supply are projected to recede as a result of global warming;
3. **National Mission for a "Green India":** Goals include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India's territory;
4. **National Mission for Sustainable Agriculture:** The plan aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, agricultural practices and improving productivity of rain-fed agriculture; and
5. **National Mission on Strategic Knowledge for Climate Change:** To gain a better understanding of climate science, impacts and challenges, the plan envisions a new Climate Science Research Fund, improved climate modelling, and increased international collaboration. It also encourages private sector initiatives to develop M&A technologies through venture capital funds.

According to the NAPCC, existing government efforts are directed mainly in the following development areas: crop improvement, drought proofing, forestry, water, coastal regions, health, risk financing and disaster management

State Action Plans

Following in the heels of the NAPCC missions, all Indian states and union territories have been urged to prepare a state action plan on climate change (SCAP), detailing sector specific plans to adapt and mitigate climate change at the state level. A few states (Delhi, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Arunachal Pradesh, Karnataka among others) have already completed climate action plans. Though many states have prepared preliminary climate change action plans, they are not yet available for assessing the scientific or economic validity. It is not clear if most vulnerable regions, sectors and populations are identified and if appropriate adaptation strategies are prioritised.

11th Five Year Plan

The 11th five-year plan (FYP) of India (2007-2012) recognised the urgent need to balance the trade-off between economic growth and environmental stability. The 11th plan also recognised the dangers posed by India's large population, economic growth and increasing demand on natural resources including water. The plan developed a number of policy targets such as, to reach 33% forest and tree cover requiring an additional coverage of about 10–11 million ha of forestland; to achieve WHO targets of air quality in all major cities by 2011–12.

With regard to adaptation to climate change, the strategy stated that, since a substantial adverse change in climate appears unavoidable even with the optimal mitigation response, the process of adaptation to climate change must have priority. The plan also recognised the need to incorporate adaptation responses in the relevant programmes, including those relating to watershed management, coastal zone planning and regulation, forestry management, agricultural technologies and practices, and health. However in this plan there was no systematic or scientific effort to incorporate climate change in planning developmental projects, probably due to lack of scientific knowledge on climate change impacts and economic vulnerabilities.

12th Five Year Plan

Most recently, the Planning Commission has prepared "Twelve Strategy Challenges" to initiate the consultations in preparation for the 12th five-year plan (covering the period 2012-2017). The strategy challenges refer to some core areas that require new approaches for climate change adaptation and mitigation. Challenges of relevance include:

- Managing the environment
- Markets for efficiency and inclusion
- Decentralisation, empowerment and knowledge for sustainable development
- Technology and innovation
- Rural Transformation and Sustained Growth of Agriculture
- Improved Access to Quality Education
- Managing Urbanisation

The 12th plan is being centred on the theme of 'inclusive growth'. The Planning Commission has outlined the challenge of climate change in its Approach Paper for

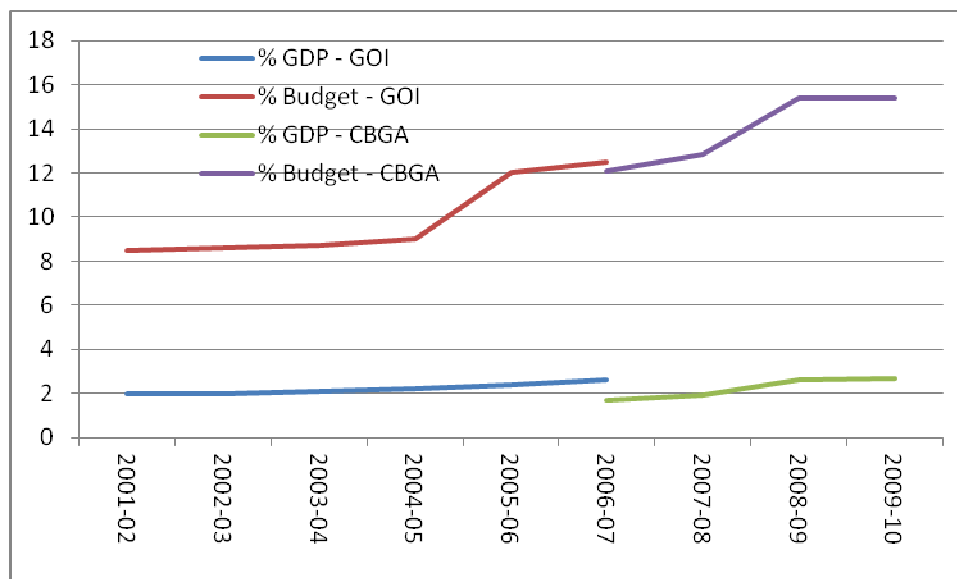
the 12th FYP (Planning Commission, 2011). The Approach Paper calls for implementing the activities outlined under various Missions of the National Action Plan on Climate Change and a low carbon mitigation strategy.

The government with the aid of the Planning Commission is therefore revising their overall strategy to respond to these new priorities. Mainstreaming climate considerations into the 12th FYP, particularly in sectors that will impact the long-term development of the country, should be considered vital. Co-ordinating the strategy set out by the NAPCC, together with the development of strong state level actions plans must be integrated with a well defined strategy that can be adopted by the 12th FYP to help in achieving the objective of the various missions toward a more inclusive long-term growth and developmental strategy for India.

Significant adaptation deficit exists in India despite the current adaptation related efforts

A NAPCC report (2008) stated that India spent about 2.6% of its GDP on climate change adaptation and related measures in the financial year 2006-07. Adaptation related spending of Union budget is increasing year on year (see figure 5 below).

Figure 4: Expenditure on Union Govt. Schemes and programmes that promote adaptation



Source: NAPCC(2008) as well as Ganguly and Panda (2010)

Another study by CBGA and Oxfam suggests the actual expenditure on adaptation related activities to be much lower at 1.7% of the GDP per annum in year 2006-07 (Ganguly and Panda, 2010). However Ganguly and Panda (2010) do find that the

budgetary expenditure on adaptation in India has been increasing - from 1.7% in 2006-07 to 2.6% in 2009-2010.

The NAPCC (2008) as well as Ganguly and Panda (2010) consider the following items as adaptation related expenditures.

Table 4: Govt. Programmes and schemes that promote adaption

Sectors	Issues Addressed in Scheme Selection	2009-10	
		% of Budget	% of GDP
Poverty Alleviation	Income security, livelihood security and food security (also includes nutritional support programmes).	11.51	2.01
Health Improvement & Disease Control	Disease surveillance, control of vector-borne diseases, immunisation, provisioning & upscaling of drinking water and sansupply and improvement in	1.03	0.18
Risk Financing	Health insurances, crop insurances and grant to NAFED for MIS/PSS	0.18	0.03
Land development, Drought Proofing & Flood control	Wasteland development, combating desertification, development of watersheds,irrigations and flood control measures.	1.22	0.21
Agriculture & Allied Services	Agricultural innovation, balanced use fertilizer, soil conservation and development of horticulture, fisheries and livestock.	1.16	0.2
Forestry & Biodiversity	Regeneration and conservation of forests, wetlands and mangroves, biodiversity conservation.	0.1	0.02
Water Resources	Groundwater management, major & medium irrigation, prevention of pollution of water bodies.	0.11	0.02
Disaster Management	Institutional support for research, documentation, capacity building and human resource development, programmes on early warning systems and measures to promote disaster preparedness	0.05	0.01
Coastal, Marine & Ocean Management	Protection of coastal environments and livelihood security along coastal stretches. It also involves monitoring, managing and information dissemination on coastal and marine resources.	0.017	0.003
Total Expenditure		15.37	2.68

Source: Information derived from NAPCC (2008) and; Ganguly and Panda (2010)

Although adaptation expenditure in India has improved significantly, the current levels of expenditure on adaptation are inadequate. With current investment levels a significant adaptation deficit/gap remains in the country. India already faces a considerable adaptation deficit for its existing climate vulnerabilities. More than 21,600 people have died in India over the last decade (2000-2010) and property worth USD 21 billion has been damaged over the last decade due to climate related extremes (EMDAT, 2011). It is however important to note that it is not only observed climate change contributing to the adaptation deficit. A high level of poverty, illiteracy and the historical lack of health infrastructure also contribute to this existing adaptation

deficit. Rapid increase in mean temperatures over India and increase in extreme rainfall events have already increased India's exposure to the impacts of climate change. A rapidly growing population and a fast growing economy is increasingly putting more people and assets at risk. Loss of life and assets is far higher in India due to low adaptive capacity of its citizens as only 75% of the population is literate; approximately 15% of the population has no access to safe drinking water, and 26% of population lives below the poverty line. Efforts to reduce the vulnerability of Indian population to climate risks must invest in improving the adaptive capacity of the population. These existing adaptation deficits/ gaps needs to be urgently filled by mainstreaming adaptation strategies in union and state planning processes.

7. Mainstreaming Adaptation in Indian planning

Mainstreaming in the context of climate change refers to the incorporation of climate change considerations into established or on-going development programs, policies or management strategies, in addition to implementing adaptation initiatives separately. In order for climate change adaptation to be sustainable and applicable on a wide scale to enable the people, especially the poor, to cope with the possible risks of climate, it must be incorporated, integrated or "mainstreamed" into the policy apparatus of governments (FAO, 2009).

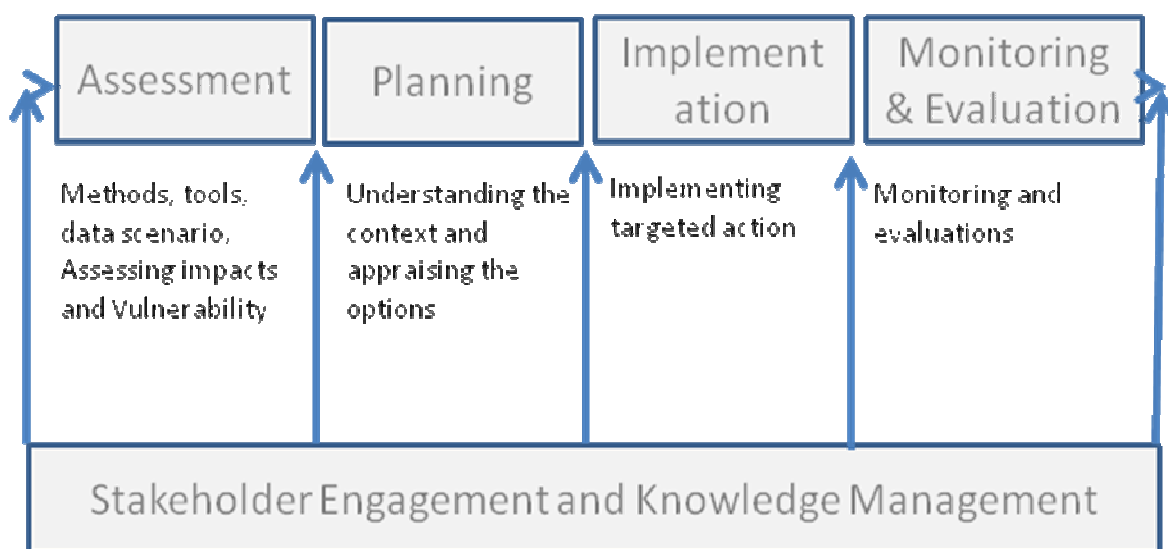
Strategy for mainstreaming adaptation in the planning process

The UNFCCC has recently detailed a strategy for the incorporation of adaptation into the planning process. It consists of four key components (UNFCCC, 2011):

- (i) The assessment of climate impacts and vulnerability;
- (ii) Planning for adaptation;
- (iii) The implementation of adaptation measures; and
- (iv) The monitoring and evaluation of adaptation actions.

The components are addressed in the figure below.

Figure 5: Adaptation process and its four key elements



Source: UNFCCC (2011)

In Indian context we recommend the following adaptation process for mainstreaming climate change in national/ state policy

Assessment of climate change impacts and its vulnerability

- Projections of the impact of climate change on key production systems such as agriculture, forests and natural resources e.g water are available for India. However the impact of climate change on vulnerable communities such as dryland farmers, forest dependent communities and other such communities is not analyzed. Further there is a need to assess the adaptive capacity of vulnerable communities in India
- Also at national level cross sector vulnerability assessments are not available for India. Ravindranath et al (2011) has presented the district level multi sector vulnerability assessments for the Northeast India, however such assessments are not available for the rest of the country. There is a need for such an integrated vulnerability and risk assessments for the rest of the country as well
- Nevertheless we should not delay urgent adaptation actions as any further delay in implementing urgent mitigation/ adaptation strategies will be counterproductive. We believe that MoEF (2004), Ravindranath et al (2006), Ravindranath et al (2011a) and INCCA (2010) provide adequate scientific knowledge on climate change projections and high resolution projections of the impacts of climate change in India to plan and initiate adaptation practices at the decentralized level.

Adaptation Planning

- Identify and prioritize most vulnerable regions for each sector, for example in agriculture, identification of vulnerable cropping systems; in forest sector,

- identification of vulnerable forest types, and forest areas; water sector, identification of vulnerable river basins and watersheds
- Evaluate the adequacy of current technologies, and practices for their ability to adaptation
- Develop adaptation strategies for each sector, and each region based on scientific studies and participatory approach involving all stakeholders at district and panchayat levels
- The focus should be placed on win-win adaptation practices such as soil water conservation, watershed management, biodiversity conservation, development and use of drought resistant varieties of seeds, development of shelter belts and agro-forestry

Implementation of adaptation practices

- Need for mainstreaming adaptation into developmental programs and projects at decentralized level i.e at district and panchayat levels. In implementation priority must be given to win-win adaptation practices as described in the above paragraph
- Build capacity in developmental departments and panchayats to recognize current and future climate vulnerabilities
- Provide tools and techniques to implementing agencies to identify and incorporate at district and panchayat level

Monitoring and Evaluation of adaptation actions and practices

- There is a need to assess the implementation of current climate change programs and practices for their ability to increase or decrease vulnerability to climate risks of production systems, natural resources and communities. For example Tiwari et al (2011) evaluated the impact of MGNREGA programme on enhancing the environmental services in Chitradurga district of Karnataka. There is a need that monitoring and evaluation is continued over long term– so that the impact of policy could be discerned over long term.

8. Conclusions

India is one of the most vulnerable nations to climate change. Even within India the poorest are especially vulnerable to current climate variability as well as projected climate change. There have been major improvements in India's response to climate change adaptation. However considerable adaptation deficit exists even under the current climate. With greater understanding of India's risk and vulnerability to climate change it is important to accelerate its efforts further. In doing so, the government of India needs to take into consideration the real costs of adaptive measures, the existence of appropriate institutions, availability of resources and access to technology.

Priorities need to be set and followed through in the forthcoming 12th plan. For instance, in India the changing temperature and water regimes create an environment

whereby daily livelihoods of millions are at stake. Therefore, improvement of productivity potential and water use efficiency of agricultural crops, specifically is priority. Furthermore, the plan needs to make space for adaptation responses to be incorporated in relevant programmes, including those relating to watershed management, coastal zone planning and regulation, forestry management, agricultural technologies and practices, and health. Development programmes such as MNREGA have the scope and the resources to incorporate adaptation.

Therefore, in addition to developing adaptation strategies, there needs to be a strong focus on implementing these strategies through mainstream developmental programmes. Developmental programmes are structured so to tend to the vulnerable populations. The vulnerability could be a result of a number of reasons, whether social, physical or environmental and attaching adaptation to climate change to these programmes would ensure tackling these interwoven situations effectively. The 12th five year plan can aid greatly in this regard.

The existing gaps in adaptation funding must be filled so that work on the potential impact, forecasting systems and adaptations in response to climate change will be the addressed for future development through the 12th five year plan.

In summary, adaptation to climate change is still a relatively new field of work. Apart from the high priority of reducing emissions of greenhouse gases through mitigation, the importance of dealing with inevitable impacts of climate variability and change through adaptation is being recognised. However more studies are required for better understanding the impacts of climate change in India. Efforts are being made at the international stage that can provide an understanding for implementing relevant policies at national levels. Integrating, co-ordinating and implementing adaptation to climate change through India's 12th year plan will highlight to the international and national audiences that India is committed to tackling climate change and is willing to take major steps to aid the growing percentage of its population who are exposed to possible risks from climate change.

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