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Climate variability and climate change: implications for chronic poverty.

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What is Chronic Poverty?

The distinguishing feature of chronic poverty is extended duration in absolute poverty.

Therefore, chronically poor people always, or usually, live below a poverty line, which is normally defined in terms of a money indicator (e.g. consumption, income, etc.), but could also be defined in terms of wider or subjective aspects of deprivation.

This is different from the transitorily poor, who move in and out of poverty, or only occasionally fall below the poverty line.

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Abstract

This paper follows the principles of the 'bottom-up' approach to adaptation. It believes that one of the starting points for adaptation to climate change should be the present. The focus should not just be on scenarios of the future; combined with this should be analysis of present vulnerability in the face of current climate variability. Adaptation does not have to start from scratch; people have been coping with climate variability and extremes for centuries and continue to cope with it now. At the same time, though, it acknowledges that future climate changes will probably be beyond the current capacities of the poor to adapt to successfully. This is one reason why climate change requires special consideration within the development agenda.

The focus of the paper is on India. It looks at projections of climate change under different climate models and at how these changes will alter India's vulnerability to the climate. In particular it notes that it is not necessarily those poorest states which are the most vulnerable to future projected changes.

The paper then focuses on the current coping strategies for climate variability by the chronically poor and highlights some of the barriers to and opportunities for successful adaptation. Potential responses include livelihood diversification through migration; employment generated by the National Rural Employment Guarantee Act and the potential to expand the area of land under irrigation. These are discussed in greater detail.

Keywords: climate change, India, adaptation, coping strategies, migration, livelihoods.

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1 Introduction

'Climate change will make it impossible for the world to achieve the Millennium Development Goals. Poverty is bound to increase. Food security is bound to get worse.'

Professor Richard Odingo, vice-chairman of the IPCC

'The evidence that human induced climate change will affect many parts of the developing world is now scientifically accepted.'

IPCC, 2001; cited in Huq *et al.* 2005

When looking at the problems posed by climate change, Christian Aid argues that the environment is 'too important to be left to environmentalists' (2006). It believes that if climate change remains unchecked it is difficult to see how the first Millennium Development Goal, which aims to halve world poverty by 2015, can ever be met. Climate change, in other words, is not just an environmental problem; it is a current development problem. Africa and Asia are thought to be the two continents most vulnerable to climate change, with sub-Saharan Africa having the highest levels of chronic poverty in the world and South Asia containing the majority of the world's chronically poor (CPRC, 2004).

Recent 'warming of the climate system is unequivocal' (IPCC, 2007a; page 5) and the impacts of this warming are already being felt. However, they are not yet severe. There needs to be a balance between making policy too quickly and thus making the wrong decisions, while also following through on the need for anticipatory action (Burton *et al.* 2002). While the scientific knowledge of the impacts of human-induced climate change is not certain (Huq *et al.* 2006) there are many places where present day climate variability and extremes are impeding development. One starting point is to assess and reduce people's vulnerability to today's climate (DFID, 2004) while also taking into account how this relationship may change in the future. This is the approach adopted by this paper.

Climate Variability: naturally occurring variability in the climate

Climate Change: a change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (United Nations Framework Convention on Climate Change, 1992).
The distinction between climate variability and climate change would not be significant but for the fact that the United Nations Framework Convention on Climate Change (UNFCCC) funds the latter but not the former (Huq and Reid, 2004).

In reality, signals of variability and change are impossible to distinguish from one another (Downing, Olsthoorn and Tol, 1999; cited in Schipper and Pelling, 2006). Neither the Intergovernmental Panel on Climate Change (IPCC) in 2007, nor this paper, make any distinction.

2 Climate variability: the current threat

The climate is one aspect of the vulnerability context, framing the external setting in which people exist, containing the aspects which are furthest outside their control (DFID, 1999). Vulnerability to the climate combines exposure to the event and change with sensitivity to the adverse consequences (Devereux, 2001). Poor people are both particularly exposed to climate variability, often living in marginal areas, and also have lower sensitivity and resilience – the 'capacity to absorb shocks whilst retaining function' (Folke *et al* 2002). During the Indian heat wave of 2003, for instance, it was poor labourers and rickshaw drivers who formed the highest proportion of the 1,400 people who died (DFID, 2004a). Poor people in Bolangir District, India, also report how it is impossible to recover from the 5 year cycles of drought; due to extreme losses of crops, indebtedness, starvation, land-alienation, sale of assets and irreparable damage to nearby forest resources (Narayan *et al*. 1999, Voices of the Poor, India, 1997 and 98).

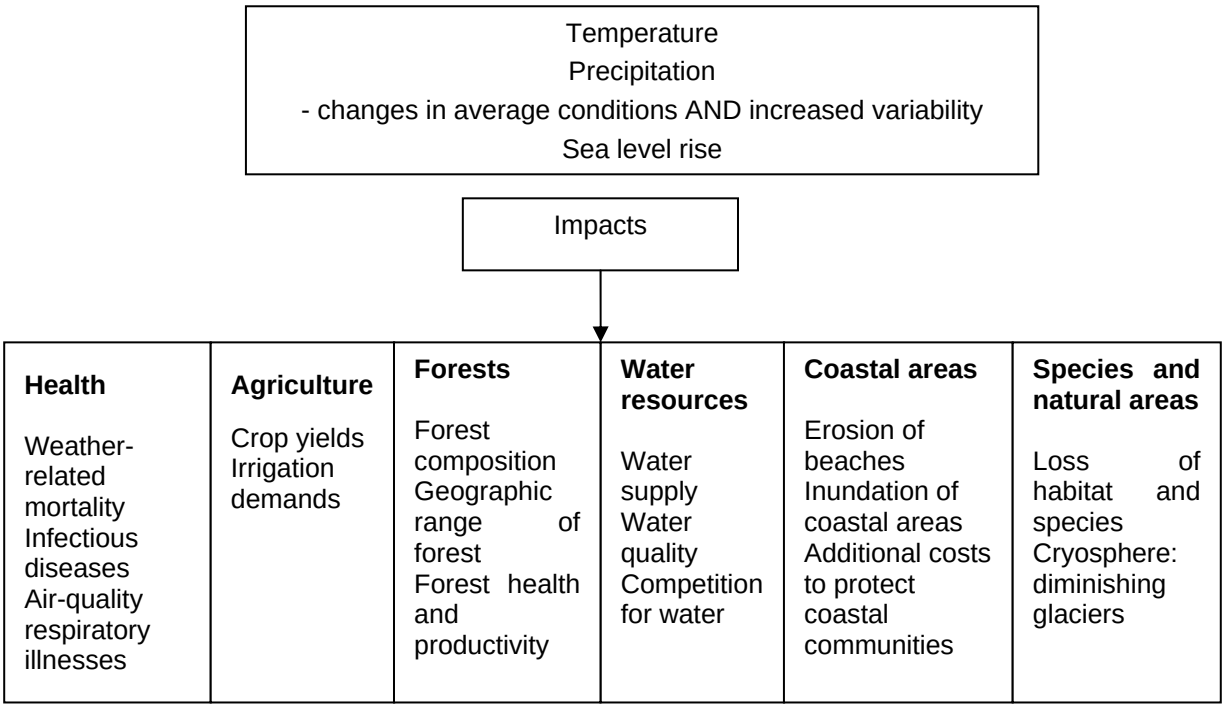
Climate extremes are already resulting in significant economic impacts and climate variability is considerably impeding Africa's development (DFID, 2004). The drought in Malawi in 1991/2 resulted in cereal losses valued at US $1 billion (DFID, 2004). Under climate change it is expected that climate variability will increase and climate extremes will become more intense or more frequent (DFID, 2004). This has serious implications for poor people; especially for the chronically poor who are typically exposed to many stressors as well as the climate, particularly to political, economic and social factors (O'Brien *et al.* 2004).

3 Climate change: altering the vulnerability context

Much is made of the scientific uncertainty surrounding climate change. Sometimes this is used to argue that climate change is not happening (though less so now than previously); and at other times to express concern about the imprecise knowledge of its projected impacts, particularly in specific locations. There is though, increasing recognition that climate change is occurring; there is 'no doubt about it, the world is warming' (Kerr, 2006). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) released this year gives more specific information than was previously available about the nature of this climate change and its impacts on specific sectors and different global regions. It states not only that average global temperatures will increase, but also that the incidence of heat waves and extreme precipitation events is very likely to increase. Looking at the sub-global level, while the overall amount of precipitation is very likely to increase in high latitudes, it is likely to decrease in most sub-tropical land regions (IPCC, 2007a).

As the previous sentence highlights, different areas will be exposed to different changes and these will result in different impacts. The projected types of climate change impacts are shown in Figure 1.

Figure 1: Projected types of climate change impacts



Adapted from GRID-Arendal (2000)

Even if concentrations of all greenhouse gases and aerosols are kept constant at 2000 levels, because of lags in the climate system, temperatures are still expected to rise over the next two decades by 0.2^{o}C per decade (IPCC, 2007a; page 12). It is in this context that the role of adaptation – increasing the capacity to cope with the potential impacts of climate change - as a legitimate response has emerged.

Boxes 1 and 2 highlight key potential types of climate change impacts in Bangladesh and Ghana, if there were no adaptation. Precise and quantified impacts, though, do depend on the emissions scenarios used to form the climate projections and thus the expected changes in temperature and precipitation.

Box 1: Projected climate change impacts in Bangladesh

Water related impacts of climate change and sea level rise are likely to be critical issues. Both inland (from river/ rain water) and coastal (sea and river) flooding are predicted to increase. There will also be changes to the river bed and increased riverbank erosion due to seasonal variations in river flow.
Under a moderate climate change scenario the crop losses due to salinity intrusion could be 0.3Mt annually (Habibullah *et al.* 1999). These anticipated losses in agricultural production severely threaten food security.
Warmer temperatures may also increase the occurrence of pests affecting both crops and livestock as well as having impacts for human health.

Allam and Murray (2005)

Box 2: Projected climate change impacts in Ghana

A 1^{o}C rise in temperature will lead to reductions in runoff of between 10 percent and 23 percent leading to an increase in the demand for irrigation.

Under these temperature increases, yields of maize are predicted to decrease by nearly 7 percent of current levels by 2020. Yields of millet, a drought tolerant crop, though, are not expected to be affected.
At the moment one dam provides 80 percent of the countries' electricity supply. Under climate change it is predicted that there will be a decline in hydropower output of around 59 percent as a result of reduced precipitation.
25 percent of the population currently live in the coastal zone. A rise in sea levels of 1 metre will result in over 132 000 people being displaced and the loss of important wetlands areas.

Ghana, First National Communication on Climate Change (2001)

4 Approaches to adaptation

The standard approach to adaptation research, as outlined by the 2001 IPCC Guidelines, relies on climate change scenarios and so focuses on the impacts of future climate change and away from current impacts, variability and vulnerability to these (Burton *et al.* 2002, page 151). This approach is also known as a top-down approach – the starting point is to understand how dangerous future climate change will be (Huq and Reid, 2004).

In contrast to this top-down or scenario approach; recently developed bottom-up or systems approaches 'asses current vulnerabilities to the climate, starting at the community level' (Huq and Reid, 2004, page 16). This is then built into an analysis of different policy environments and how these provide barriers to, and opportunities for, successful adaptation (Burton *et al.* 2002). There is a role here for the CPRC to look at the current coping and adaptation strategies of poor people and to link these to different policy, institutional and technological environments. This would involve looking at the recent experiences of the chronically poor with climate variability and extremes; including assessing whether having access to information about the climate is a useful asset.

Adaptation, then, does not have to be started from scratch. Bottom-up approaches acknowledge that people have adapted to climate variability in the past and continue to do so (Adger *et al.* 2003). The idea is that helping people to respond to existing climate variability, and learning how they have coped with it in the past, will help initiate responses to climate change (Burton and van Aalst, 1999; cited in Schipper and Pelling, 2006). This needs to be combined with a realisation that many of these traditional coping strategies may be insufficient to deal with the new challenges of climate change. Without the knowledge or resources, poor people may have to rely on *ad hoc* and unsustainable responses, potentially reducing their resilience to a range of shocks and stresses (DFID, 2004).

Generic Adaptation
The inherent ability of a country or community to cope with climate impacts; a function of the levels of income, education and development.

Specific Adaptation
The capacity of a community to cope with the impacts of climate change based on an understanding of the projected impacts of human-induced climate change.

5 Climate change: a case of 'development as usual'?

The links between climate change and development are two-fold; 'unsustainable development is the underlying cause of climate change and development pathways will determine the degree to which social systems are vulnerable to climate change' (Huq *et al*. 2006, page 4). Development then, can either increase or diminish the vulnerability of households and communities to climate change. In many instances, climate change adaptation and development share the same means to reduce social and environmental vulnerability; as through improving infrastructure, education and institutional strength (Huq *et al.* 2006). These goals are tied in with the notion of generic adaptive capacity which remains important in the face of climate change. Winchester (2000) argues, for instance, that the best way to reduce vulnerability to cyclones and flooding in South India is to improve people's socio-economic standing by ensuring they have an assured income based on assets, which will enable them to acquire credit worthiness in the local economy.

There are also more specific 'win-win' approaches – those which give immediate benefits to poor people while also providing a long-term reduction in vulnerability to climate change. These include the conservation of mangrove belts, coral reefs, wetlands and forests through community-based sustainable management (IISD, IUCN and SEI, 2003). It is the identification of these approaches that will ensure adaptation to climate change is more firmly aligned with poverty reduction. One of the starting points for identifying these approaches is an analysis of the livelihoods of poor people; here the CPRC can play an important role.

Development pathways, however, are not always a win-win for both development and climate change. In Rajasthan, population increase combined with a change in the patterns of land holding and a decline in benevolent attitudes is making it more difficult for communities to cope with drought – their resilience has declined (Chatterjee *et al.* 2005). Also, many African countries, influenced by donors, are reforming their water sector and water rights. These reforms could reduce access to water by poor people, leaving them more vulnerable to droughts (Huq *et al.* 2006). Conflicting interests between the development and climate change agendas need to be identified and addressed.

Another aspect which will require more attention by the development community is Disaster Risk Reduction (DRR). This approach signals a shift from disaster management to disaster preparedness. The Bangladesh Comprehensive Disaster Management Programme, for instance, is incorporating risk reduction, particularly to cyclones and flooding, in an effort to mainstream climate change (Tanner, cited in Huq *et al.* 2006). The programme recognises that climate change impacts will include an increased risk of disasters.

The unpredictability generated by climate change means that hazard-specific capacity needs to be supported alongside developing generic adaptive capacity (Schipper and Pelling, 2006). Enhancing capacity involves more than identifying win-win approaches and

incorporating DRR. It also involves research on the social and institutional issues of ensuring effective adaptation responses, learning from those successes and replicating them on a larger scale (Huq *et al.* 2005). As with development, adaptation responses will result in winners and losers (Kates, 2000; cited in Adger *et al.* 2003). Particularly in the case of the chronically poor, who are often marginalised groups, it is likely that national governments will not put forward their interests equally. How can they be included in adaptation responses?

This paper will now look at the chronically poor in India; at their current vulnerability to the climate and how this may change under different climate scenarios. It will then assess different responses to this variability; both in terms of local coping and adaptation strategies and also state and national policies.

6 India: sensitivity and resilience - the adaptation baseline

Due to the summer monsoon circulation, which contributes 78 percent of annual rainfall, the climate in India is dominated by the largest seasonal mode of precipitation in the world. As well as the monsoon, precipitation variability has interannual and inter-seasonal components leading to extremes in seasonal anomalies, often resulting in large-scale floods and droughts. Temperature variability also causes cold waves during winter in the north and heat waves during the pre-monsoon season in most of the country. About six cyclonic storms occur each year in the northern Indian Ocean, often leaving behind widespread destruction and loss of life in coastal regions (National Communication on Climate Change, 2004). People in India, then, have had to adapt to climate variability and extremes. They already use a range of strategies to cope with the seasonality of monsoon rains, including income diversification, use of communal resources, relying on social networks and relationships and reserving household stores and assets (DFID, 2004a).

India, though, is particularly concerned about climate change due to the importance of climate-sensitive sectors – notably agriculture, forestry and fisheries (Chatterjee *et al.* 2005) – and also because around two-thirds of the population are rural and depend on climate sensitive natural resources (National Communication on Climate Change, 2004). Agriculture represents 35 percent of India's GNP and sustains the livelihoods of nearly 75 percent of the population (Naveen Kalra *et al.* 2003). This sector is also highly dependent on the South West monsoon (June-September), while 60 percent of the crop area under rainfed agriculture is in areas highly vulnerable to climate variability and change (National Communication on Climate Change, 2004). The share of agriculture in the GNP has, though, been declining over time.

Forests, meanwhile, meet around 40 percent of India's energy requirements and 30 percent of fodder needs, with around 200 million people depending, directly or indirectly, on forests for their livelihoods (Ravindranath *et al.* 2003). Forests provide people not only with timber, but also non-timber forest products (NTFPs), which form an important component of livelihood strategies (Maithani, 1994; cited in Ravindranath *et al.* 2003).

This dependence on climate-sensitive sectors, both for the national economy and for people's livelihoods, is combined with population growth leading to greater pressure on these resources, while more than a third of the world's chronically poor people already live in India (CPRC, 2004). 71.65 percent of India's poor and over half the population are located in the six states of Uttar Pradesh, Bihar, Madhya Pradesh, Maharashtra, West Bengal and Orissa (Kapur Mehta and Shepherd, 2004). This spatial concentration of poor people is one of the reasons behind the regional variation in adaptive capacity (Bhatt and Sharma, 2002; cited in Shukla *et al.* 2003). This is combined with the fact that different regions of the country will be

exposed to varied degrees of change in the mean state of the climate and also in climatic variability.

7 India: exposure to climate change – the data

Predictions of changes in climate over India used to be viewed at the horizontal scale of a few hundred kilometres; the scale offered by global climate models (GCMs) and which DFID (2004) argues is of little practical use to decision makers. Recently, however, Regional Climate Models (RCMs), developed by the UK's Hadley Centre, have been run for the Indian sub-continent. These are able to simulate the climate down to a scale of fifty kilometres and provide a more realistic representation of summer monsoon rainfall (IITM, 2004). The results from an RCM simulation will be used alongside those of the larger horizontal-scale GCMs.

The Joint Indo-UK Programme, a DEFRA-funded initiative, assessed the results of eight GCMs[1]. The simulation experiments were set up for;

- an IS92a scenario of Greenhouse Gas Increase (for 1990-2099 the forcing is increased at a compounded rate of 1 percent per year relative to 1990 values);
- an A2 scenario ('Medium-High' emissions – cumulative global carbon emissions between 2000 and 2100 are 1862GtC);
- a B2 scenario ('Medium-Low emissions – cumulative global carbon emissions between 2000 and 2100 are 1164GtC); and
- a control simulation.

Under all the simulations all the models indicate widespread warming into the future (for the time periods 2041-2060 and 2061-2080). This increase is expected to be in the order of 2-5^{o}C across the country, with the most pronounced warming being over northern parts of India. For climate variability though, the evidence is less conclusive. Most of the models in the IS92a scenario show enhanced precipitation during the monsoon season and so increasing variance into the future. However, only a few of the models in the A2 and B2 scenarios show this trend. This uncertainty means IITM argues that 'there is as yet no conclusive evidence or a general consensus among models in the future changes of enhanced variability in monsoon rainfall' (2004).

Under an RCM simulation (HadRM2, under IS92a scenario for the 2050s) the results show an;

- Overall decrease in the number of rainy days over the major part of the country. However, in Uttaranchal and in northeast India the number of rainy days is found to increase by 5-10 days.
- Overall increase in rainy day intensity by 1-4 mm/day, except for in small areas of northwest India

[1] The evaluation of the climate scenarios was undertaken by the Indian Institute of Tropical Meteorology (IITM). The main centres of development of these models are; Canadian Center for Climate Modelling; Center for Climate System Research, Japan; Commonwealth Scientific and Industrial Research Organization, Australia; Deutsches Kilma Rechen Zentrum, Germany; Geophysical Fluid Dynamics Laboratory, USA; Hadley Centre for Climate Prediction and Research, UK; Max-Planck Institute, Germany and National Center for Atmospheric Research, USA.

- Increase in 1-day extreme rainfall over the majority of India
- Increase in extreme daily maximum temperature over the majority of the country. This will be highest in the northern regions where this may increase by over 4^{o}C.
- Increase in extreme daily minimum temperature of up to 4^{o}C but over the southern peninsula, northeast India and some parts of Punjab, Haryana and Bihar, the increase may exceed 4^{o}C.

IITM (2004)

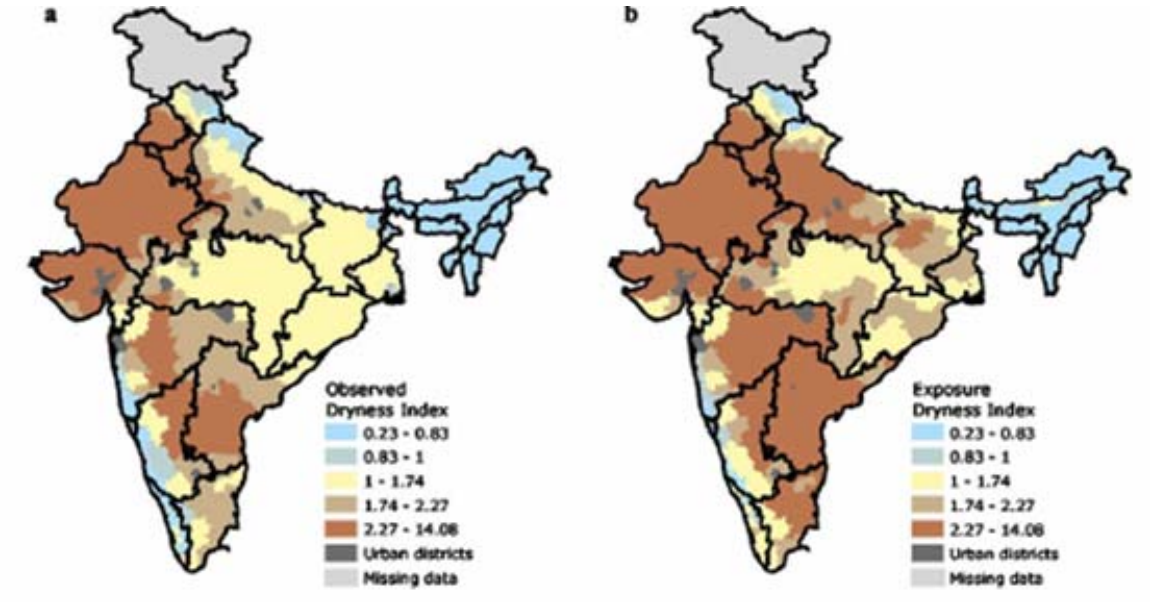
Tendency for an increase in rainfall intensity to be combined with greater variability is reported in other studies (IITM, 2004). Clearly, an increase in the frequency and intensity of rainstorm events will have a profound effect on water resources, particularly in terms of flooding (IITM, 2004). However, an increase in rainfall intensity and extreme rainfall does not equate to greater surface water availability, for it is thought that potential evapotranspiration rates in India are 'uniformly set to increase' as temperatures also rise (Chattopadhyay and Hulme, 1997).

Using the results of HadRM2 (Leichenko, O'Brien, Aandahl, Tompkins, and Javed 2004) develop two indices to determine climate sensitivity;

- Monsoon dependency index – the percentage of the total annual rainfall received in the top four consecutive months of precipitation. This index thus reflects reliance on the monsoon rains and can be used as a proxy for extreme rainfall events.
- Dryness index – the ratio of the ratio of annual potential evapotranspiration to precipitation. A value of less than 1 indicates a humid climate while a value greater than 1 indicates an arid climate.

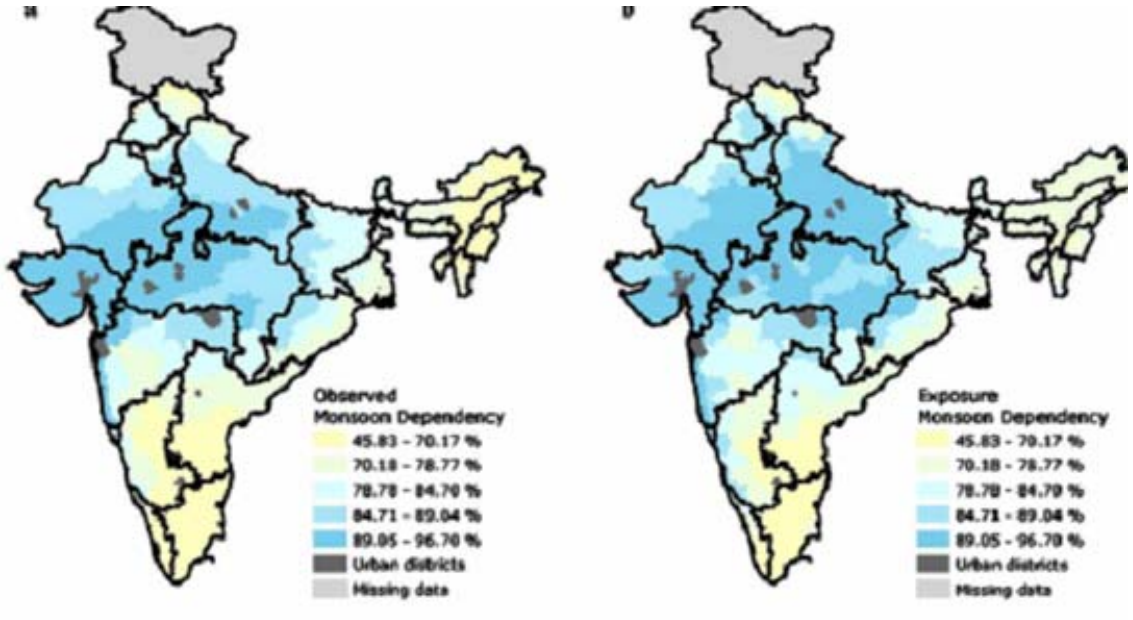
They construct both these indices at the district level for 1961-1990 (observed) and for the future climate scenario period of 2041-2059 (exposure) (Figures 2 and 3). The districts are ranked as quintiles.

Figure 2: Dryness Index for the periods 1961-1990 (observed) and 2041-2059 (exposure)



(Leichenko, O'Brien, Aandahl, Tompkins and Javed 2004)

Figure 3: Monsoon Dependency Index for the periods 1961-1990 (observed) and 2041-2059 (exposure)



(Leichenko, O'Brien, Aandahl, Tompkins and Javed 2004)

The dryness index noticeably increases in all of Uttar Pradesh, eastern Maharashtra, south-eastern Madhya Pradesh, central Bihar and Tamil Nadu indicating a more arid climate in the future. Monsoon dependency increases in north and central Uttar Pradesh and east Madhya Pradesh. O'Brien *et al.* (2004) point out that the overall climate sensitivity index, an average of these two indices, noticeably increases in Uttar Pradesh, Madhya Pradesh and Maharashtra. Clearly, the degree of change in climate into the future, as well as the actual climatic state influences the vulnerability of an area to climate change. Spatial analogues can be used where detailed case studies of responses to the climate in one area are used to inform adaptation policy in areas where a similar climate may develop (Adger *et al.* 2003).

8 India: vulnerability to climate change

Vulnerability is a function of exposure, sensitivity and resilience. At the national scale India is particularly concerned about its vulnerability to climate change in terms of;

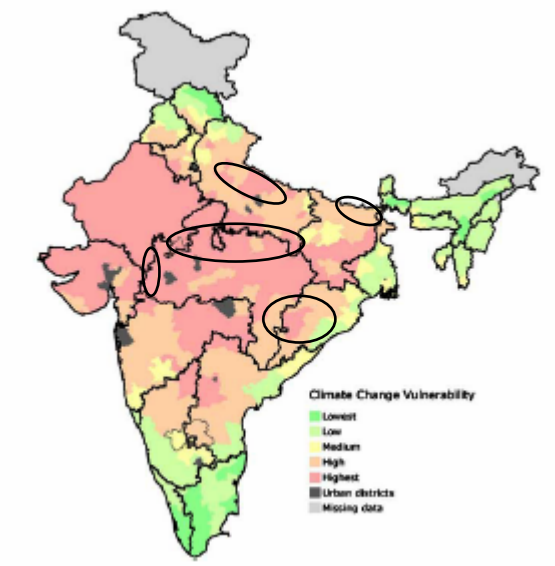
- Inadequate water availability due to a decrease in rainfall in certain areas of the country and recession of glaciers
- Threats to agriculture and food security
- Adverse impacts on human health due to an increase in vector and water-borne diseases and thermal stress
- Die-back of natural ecosystems such as forests on which the energy consumption of rural households depends
- Adverse impacts on coastal ecosystems due to sea-level rise
- Increased energy requirements and impacts on climate sensitive industry and infrastructure

(Shukla *et al. 2003*)

As already mentioned, vulnerability to climate change is not uniform across the country. O'Brien *et al.* (2004) use their indices to produce a district-level map of climate change vulnerability; a composite of climate sensitivity (index constructed using Figures 2 and 3) and adaptive capacity[1] under-exposure to climate change (Figure 4). This climate vulnerability map, then, shows *current* vulnerability to *future* climate change at the district level. The districts are ranked and presented as quintiles.

[1] This index was constructed using biophysical, socioeconomic and technological factors that influence agricultural production. Biophysical indicators – areas with more productive soil and greater groundwater availability should be more adaptable to adverse climatic conditions. Indicators for soil productivity – quality, depth and level of degradation; for groundwater – estimates of total amount of replenishable groundwater available annually. Socioeconomic factors – levels of human and social capital provide basic indicators of the economic endowments of a district and of the capacity for the community to engage in collective social and economic activities - represented by adult literacy rates and degree of gender equity. Also indicators on the percentage of the district workforce employed in agriculture and percentage of landless labourers in the agricultural workforce – used to show the ability of farmers to shift to other economic activities in response to reduced agricultural income as a result of adverse climatic conditions. Technological factors – availability of irrigation (net irrigated area as a percentage of net sown area) and quality of infrastructure – would expect districts with higher irrigation rates/ better infrastructure to have higher capacity to adapt to climate fluctuations.

Figure 4: District level map of climate change vulnerability



Areas with high concentrations of chronically poor; based on proxies used in Kapur Mehta and Shah (2004).

O'Brien *et al.* (2004)

8.1 Districts with concentrations of the chronically poor

Unsurprisingly, many of the districts which are the most vulnerable to climate change include those with high numbers of the chronically poor. Shah and Sah (2004) point to certain districts having the disadvantages characteristic of 'remote rural areas' which has lead to their high incidence of chronic poverty. These characteristics have resulted from 'logjams of disadvantage' in the forms of low levels of irrigation, low agricultural growth, forests, hilly terrain, tribal communities, feudal agrarian relations and low political representation.

They cite three sets of forces which have played an important role in re-enforcing the alienation of certain districts from mainstream local economic development;

- the commercialisation of forest by bringing the resources under state monopoly
- encouraging non-tribals to undertake settled agriculture and thereby marginalising other tribes
- a centrally planned economy with higher priorities given to rapid industrialisation and technology based agricultural growth in regions with better agricultural infrastructure.

The Indian development strategy, then, has mostly by-passed agriculturally less-favourable areas. This means that the districts with high concentrations of the chronically poor can essentially be divided into two types of less-favoured areas;

- drylands - characterised by frequent crop failure and sporadic opportunities for employment
- forested areas - especially in hilly regions with a predominance of tribal populations, and with limited access to natural resources, information and markets (Mehta and Shah, 2003; cited in CPRC, 2004).

Agriculture in the drylands

The areas particularly vulnerable to climate change are those where crops (other than rice and wheat) are rain fed or un-irrigated (Shukla *et al*. 2003). In India it is the poorest farmers who practice rainfed agriculture. In the poor state of Orissa, for instance, irrigation coverage accounts for less than ¼ of total cultivated area, compared to irrigation coverage of above ¾ of the total cultivated area of the richer Punjab (Shukla *et al.* 2003). Interestingly, though, figure 4 shows only a few districts in Orissa which are considered to have the highest vulnerability to climate change.

Vulnerability of forest areas

Even in the relatively short span of about 50 years, most of the forest biomes in India appear to be highly vulnerable to climate change. The prevailing biome type is thought to change in 70 percent of the country. While the climate is changing there is likely to be large-scale forest die-back, affecting the supply of non-forest timber products. As well as this, forest die-back will result in an increased supply of timber, leading to a decline in timber prices (National Communication on Climate Change, 2004). These projections raise questions about how forests should best be conserved and, particularly for the CPRC, increase the importance of the promotion of non forest-based livelihoods for the chronically poor.

8.2 Relatively wealthy areas

There are areas which, despite being relatively wealthy and so having a high generic adaptive capacity, appear as highly vulnerable to climate change in Figure 4. While these areas don't include the wealthiest states of Punjab and Haryana in the north-west, they do include the western, arid states of Gujarat and Rajasthan; which are not viewed as being among the poorest areas in India.

Crop simulation models, however, show that it is precisely the agriculturally rich, winter wheat growing sub-tropical northern states of Haryana, Punjab and parts of western Uttar Pradesh which will experience the most negative effects, particularly in terms of impacts on crop yields (Kavi Kumar and Parikh, 2001). A 0.5^{o}C increase in winter temperature, for instance, would translate into a 10 percent reduction in wheat production in the high yield states including Uttar Pradesh (Shukla *et al.* 2003). In contrast, in terms of crop yields, the poorer eastern districts of West Bengal, Orissa and parts of Bihar seem to benefit from the projected changes in climate (Kavi Kumar and Parikh, 2001).

Certainly, the rice-wheat system in north-western India is already showing signs of stagnation/ decline in its productivity. A crop simulation study, with weather as the only varying factor, indicates that a significant part of the yield decline/ stagnation trend can be ascribed to rising temperatures during the crop season. These changes are not statistically significant but they do indicate a warming trend and their possible effects on crop production (National Communication on Climate Change, 2004).

It is also the north-west of the country where forests are likely to be the most vulnerable to climate change, with this region experiencing large temperature increases along with decreasing precipitation (National Communication on Climate Change, 2004). This is anticipated to result in a shift towards drier forest types in the north-west, in contrast to an expected shift towards wetter forest types in the north-east region (Ravindranath, 2006).

Figure 4, however, shows current vulnerability to future climate change. Have these wealthier areas a greater capacity to respond to future changes in climate, as a result of better governance (a factor not considered in the adaptive capacity index used in Figure 4), or perhaps because their wealth enables them to secure external assistance? This response, however, has to be appropriate. There is a danger of adopting unsuitable technologies which increase vulnerability to the climate – 'maladaptation' (Huq *et al.* 2006). Already in Haryana the introduction of canal irrigation has resulted in almost 0.5Mha of land being affected by soil salinity (National Communication on Climate Change, 2004).

When looking at vulnerability to climate change, there may be a tendency solely to focus on states and districts which are currently very poor. Spatial patterns of vulnerability to the climate, though, will be different in the future. It also cannot be assumed that regional-level wealth will necessarily result in either successful or equitable adaptation. To illustrate this point in the context of present-day efforts to reduce poverty Box 3 looks at the situation in Gujarat, a state which is relatively well governed and experiencing high levels of economic growth. These characteristics of a state with high 'generic adaptive capacity' though, have not translated into widespread poverty reduction.

Box 3: Gujarat - economic growth is not enough for poverty reduction

GDP growth rates in Gujarat exceeded 9 percent per year over the 1990s. Many people believed that this would be accompanied by poverty reduction and in some cases thought that growth alone would lead to a reduction in levels of poverty. A study covering 5 871 households in 36 villages in northeastern Gujarat, though, shows a different story. It concludes that over the past 25 years 56 percent of households remained poor, 9.5 percent of households escaped from poverty and 6.3 percent of households became poor; with poverty being defined by community groups. The failure of economic growth to lead to poverty reduction is due to the inability or unwillingness of the government of Gujarat to invest funds derived from growth into healthcare provision. Ill health and health related expenses remain the main reasons for both descent into poverty and remaining poor. Large initial inequality also keeps the benefits of economic growth beyond the reach of most households. Means of escaping poverty, for 32 percent of the households which escaped poverty, was gaining a private sector job, while for another 39 percent, this job was in the government sector. Other means of escape came through the expansion of minor irrigation facilities and diversification of income sources due to informal sector activities, especially dairying.

Krishna *et al.* (2005)

9 India: responses to climate variability and change

Possible adaptation responses are not always known; many come about through trial-and-error. For this reason, the identification of current best-practices by communities and the potential for them to be scaled-up is important. Conway (2006) identifies five categories of measures for building resilient livelihoods and environments:

Livelihood: diversifying sources of income, rural-urban linkages
Institutional: early warning systems, improvements in communications, land use zoning
Environmental: mangrove belts, soil and water conservation
Agricultural: crop and livestock diversity, developing flood and drought resistant varieties
Physical: cyclone shelters, embankments, irrigation canals, structural flood control

The strengths of the CPRC lie particularly in identifying appropriate livelihood and institutional responses and identifying ways of ensuring their successful implementation and adoption. In terms of bottom-up approaches to adaptation, the starting-point should be the livelihoods of poor people. Box 4 illustrates the livelihoods of chronically poor people in two towns in Badwani district in south-west Madhya Pradesh; an area likely to become both drier and warmer in the future.

Box 4: **Chronic poverty in a remote rural district of South West Madhya Pradesh**

Badwani district of Madhya Pradesh has relatively low levels of irrigation and at 17 percent forest cover, has a higher proportion of forest area and tribal population than other districts in the area.

The average land holding is far below 5 acres – the economically viable size for dryland conditions - particularly when only 45 percent of landed households have access to irrigation. Households with little or no land supplement their livelihoods by engaging in poultry farming and keeping a few sheep or goats. Ideally, forest-based activities, including the collection of NTFPs, should provide supplementary income but the depletion of forests and other common property resources in the villages limits these activities.

Given the meagre resource base, availability of food grains from your own land or from wage income within the villages remains very limited. The cost of foodgrains makes up about 30 percent of total expenditure and borrowing for consumption is common, particularly during the monsoon. Due to high interest rates under the private money lending system, migration becomes almost inevitable for many poor households. However, hostile conditions at the migration destination and the low availability of long-term employment means that, in this instance, people won't migrate if it is possible first to borrow. High incidence of drought worsens the situation and out-migration, combined with perpetual indebtedness, is a way of life for many households.

Shah and Sah (2004)

In this instance, the dependence of the chronically poor on climate-sensitive natural resources, the increasing pressure on these resources and in many cases their already degraded state, makes them highly vulnerable to climate change. Three barriers to successful adaptation in Badwani district are the limited off-farm employment and income opportunities; high-interest rates under the private money lending system, and the low availability of employment and poor conditions at destinations of migration.

Areas with high concentrations of chronic poverty though, do have different characteristics, depending on whether they are predominantly forest-based or dryland areas, on their agro-climatic conditions and on access to markets. In different areas there will be different barriers to and opportunities for adaptation. This is acknowledged in the following section which, while not intended to be comprehensive, highlights different types of adaptation response.

9.1 Livelihood responses: income diversification - migration

Migration has mainly been viewed as a response to shocks; as a politically and socially destabilising process. Evidence though, is increasingly suggesting that internal voluntary migration can play an important role in poverty reduction (Deshingkar and Grimm, 2004). In several regions of India, migration for poor households is a significant livelihood strategy (PRAXIS, 2002; cited in Srivastava and Sasikumar, 2003); it is not merely a coping strategy in the aftermath of environmental and social shocks and stresses.

However, while for some poor and non-poor people migration is an accumulative strategy (Deshingkar and Start, 2003) for others it remains a coping strategy. Boxes 5 and 6 illustrate this by outlining two migration streams from the same village in Madhya Pradesh; one is an accumulative migration pathway, while the other is a coping migration stream.

Box 5: **Accumulative migration by Havelli workers from Mandla, Madhya Pradesh**

Traditionally the livelihoods of tribals in this region involved gathering forest products and low productivity agriculture in the forest. They used to depend on being hired by forest contractors from outside the area as sawmill labourers. This work ended after the forests came under the 1980 Forest Conservation Act.

Another migration stream emerged with the establishment of the paper mill at Chanda district in Maharashtra. Here, labourers worked as bamboo cutters. However, in the last 10-20 years, as green revolution agriculture took off in the nearby 'Havelli' areas leading to an increase in labour demand, tribals started to migrate there.

Initially landlords from this area would visit specific tribal villages to make contact with a potential labour force. They offered to pay transport costs and in time designated a trusted contact person from the village who acted as an agent. After several years stable relationships with employers were established; offering security. Now, the labourers go to the destination at a certain time of the year without waiting for a call from the employer. The employers may provide an advance to be paid off through work. Earlier only men went; but now women and children also migrate. It was also mainly the poor and landless Pradhan scheduled caste who migrated. Recently though, other castes and large farming households have started to migrate to supplement their incomes.

Deshingkar and Start (2003)

Box 6: Migration as a coping strategy: construction workers from Mandla, Madhya Pradesh

For a certain section of society the migration scheme to the Havelli areas is not an option and instead they must migrate to urban areas for construction work. These are mainly the Baiga (Scheduled Tribe) people who have very poor or no land and/ or very high dependency ratios. Unlike Havelli migration, there is no established relationship between the labourers and employers. Workers are dependent on the contractor for information and wages. The work is road and building construction, telephone trench digging, rickshaw pulling and house/ shop painting. This pays better than work available in the village, but there is a high risk of not getting work every day. Generally only men use this migration route as the work and living conditions are too difficult for women.

Deshingkar and Start (2003)

Deshingkar and Start (2003) argue that caste is an important determinant of being excluded from an accumulative migration stream. This is because of the correlation between belonging to a Scheduled Caste and being poor, illiterate and assetless and also being discriminated against by employers. At the same time, though, the very poorest usually don't have a chance to migrate, even as a coping strategy, for 'the poorest of the poor cannot afford either risk or movement and the majority starve in situ' (Skeldon, 2002; cited in Deshingkar and Start, 2003, page 4).

In terms of the chronically poor the role of migration as a means of poverty reduction raises interesting questions. Clearly, migration is not an option for the chronically dependent poor – the elderly and disabled. With these exceptions though, is it possible for some sections of the chronically poor to enter accumulative migration streams, or does their position within society deny them this option?

The existence of accumulative migration means that rural development programmes should not automatically, however implicitly, aim to control voluntary internal migration (Deshingkar, 2004). In some instances migration should be encouraged and incorporated into government policies; these instances need to be identified. In some areas, particularly those where pressures on natural resources are already high and their quality is likely to change as a result of climate change, facilitating migration, and so non natural-resource based livelihoods, is an option which should be investigated.

If migration were to be facilitated in some areas though, this needs to be accompanied by mechanisms to improve both the rights and living conditions of migrants. At the moment migrant households are unable to access the benefits of public programmes meant for poor households and migrant labourer's children often don't have access to education (Srivastava and Sasikumar, 2003). Many of the labour laws, designed to protect the rights of workers to decent working conditions and wages, continue to be disregarded (Deshingkar, 2004); these laws need simplified and enforced (Srivastava and Sasikumar, 2003). Accompanying this,

people need to know their rights under the laws and also have knowledge of wage rates. Does this knowledge enable the most vulnerable to enter accumulative migration streams?

Under climate change there is also the possibility that migration patterns will alter. The Ghanaian National Communication on Climate Change notes that there may be a natural migration of people from areas which become more water-stressed to those where a relatively good water supply remains.

9.2 Institutional responses: employment guarantee schemes

As shown in Boxes 4 and 6, migrants often have difficulties in finding long-term employment at the migration destination. This is combined with low opportunities for off-farm employment in villages. One means to build resilience in the face of climate change, is to guarantee employment through state schemes. Srivastava and Sasikumar (2003) argue that in rainfed areas the scope for an Employment Guarantee type of scheme, linked with the need for the building of physical and social infrastructure should be explored. This type of scheme has been operating in Maharashtra since 1974.

In 2005, with the passing of the National Rural Employment Guarantee Act (NREGA), this approach to poverty alleviation became enshrined in an Act of Parliament. Beginning in two hundred of the four hundred poorest rural districts in February 2006, the Act means that, by law, people have the right to at least 100 days employment per year. Their wage is fixed at state level, usually at state minimum wage rate, though the Government retains the right to impose a wage rate. These rates are converted to piece-work rates for many jobs. Job cards are issued on a household basis and when received people can demand work which must be provided in 15 days. These jobs are available to anyone residing in a particular district; for poor people and non-poor alike, but their relatively low wage rates means they are unlikely to be attractive for anyone but the most needy. Exceptions to this though, are under 18s and over 60s, who are not eligible. When a disabled person applies for work, efforts are made to give them sedentary tasks (Harper, 2006).

Linking in with seasonal variations in on-farm employment, the major demand for work is expected to be in the April to June summer season and between November and March, when crops are ripening but not yet harvesting. As most employment opportunities are created locally (workers have to be paid 10 percent more if they have to travel over 5 kilometres), they should benefit these poorest districts. With a few exceptions, projects have to be for public benefit and over half of them must be implemented through the Panchayati Raj institutions; the lowest level of elected government, which is being revived due this new area of responsibility. There are already detailed lists of the jobs available in each village, including de-silting irrigation channels, strengthening embankments and digging ditches (Harper, 2006). Many of these measures, then, may be used as physical responses for building resilience against projected climate changes.

India, though has had a long and generally unsatisfactory experience with rural programmes of this type. The Indian press pointed to the Employment Guarantee Scheme in Maharashtra as being 'synonymous with corruption' (Joshi, 2005). Eligibility requirements under the NREGA are much simpler – residence - meaning there are not the complex rules which have been used in other schemes to deprive those who are already deprived (Harper, 2006). In terms of the chronically poor, this Act is a manifestation of the social protection measures which the CPRC advocates they require. Though there is little data on the scheme so far, important areas to consider include:

- Job cards are issued on a household, rather than individual basis. The chronically poor, though, often have high numbers of dependents – can one job per household enable escape from, or prevent falling into, chronic poverty?
- Linked with this, will the impacts of the scheme be protective effects – preventing the non-poor from slipping into chronic poverty or will it also have promotional effects – helping escape from chronic poverty (Imai, 2003). For instance, will providing the unemployed with work experience under the programme raise their bargaining power with future employers, or is a greater element of training needed? (Sengupta, 2006)
- Looking at corruption in the Employment Guarantee Scheme in Maharastra, Joshi (2005) argues that it has affected the wages offered in the agricultural wage market. If this were the case under the NREGA the impacts for the chronically poor would be severe for real wage rates are one of the factors determining the incidence of chronic poverty (Bhalla *et al.* 2004).
- Villagers are often unaware of the public works schemes which they can enrol with (Shah and Sah, 2004). Low enrolment may mean that there is not a large demand for low-paid employment (as Harper, 2006) or it could be that there are unforeseen barriers to entry.

9.3 Physical responses: irrigation

As mentioned before, farmers reliance on rainfed crops is likely to increase their vulnerability to climate change (Huq *et al.* 2006). Shah and Sah (2004) already point out that having access to better quality land and irrigation facilities are two factors which help people to escape from chronic poverty. Irrigation, in these circumstances, would seem to be a means through which future vulnerability can be reduced.

The agricultural sector plays a critical role in the reduction of poverty in India. Most of the increase in agricultural output over the years has taken place under irrigated conditions while rainfed areas, as a proportion of total cultivated area, has declined over time as more land has been irrigated. In 1956 about 17 percent of the cropped area was irrigated compared to 33 percent in 1996 and 40 percent in 2004 (National Communication on Climate Change). However, the opportunities for continued expansion of irrigated areas are limited (Kerr, 1996). As returns from additional intensification in irrigated areas are declining, the role of rainfed areas in ensuring food security will need to increase (Kerr, 1996).

These hopes for a second revolution in areas of rainfed farming though, need to be viewed with caution; for RCM predictions indicate an overall decrease in the number of rainy days over India, with the exceptions of Uttaranchal and areas of north east India. These concerns should not be confined to rainfed farming areas however, for increasing aridity at district level (figure 2) will reduce the water available for irrigation. Irrigation already accounts for 83 percent of all water usage and India is facing situations of water shortage. Water wastage and efficient usage have to be prioritised through more effective management including linkages with farmers, water conservation techniques, participation management (see Box 7) and institutional reforms (National Communication on Climate Change, 2004). Certainly, with increasing temperatures and associated evapotranspiration rates, preventing water wastage will need to be a primary concern.

9.4 Agricultural responses: developing new crop varieties

There are now real possibilities of developing new varieties of rice which can tolerate drought and submergence (IRRI, 2006). A submergence-tolerant variety of rice has recently been released in Orissa, which is hoped to result in increased productivity in a submergence-prone area (IRRI, 2006).

The National Agricultural Innovation Project, launched in 2006 with the assistance of the World Bank, aims to encourage the sustainable transformation of the Indian agricultural sector to one of greater market orientation; to reduce poverty and improve income. It has a particular emphasis on dryland areas where the possibilities for the large-scale expansion of irrigation infrastructure are very limited. Here productivity can only be increased through advances and innovations in technology, coupled with institutional and policy support. One research and development component is bio-prospecting, using the gene pool for crop and animal improvements and then adopting them with support of communities (NAIP, 2006). This type of alignment between the social and natural sciences is important in the face of climate change.

9.5 Environmental responses: watershed development programmes

One of the great challenges for Indian agriculture is to ensure that an increase in food production is coupled with poverty reduction and environmental preservation (National Communication on Climate Change, 2004). It can be difficult to find the right balance between the three.

Watershed development programmes, Box 7, in contrast with the National Agricultural Innovation Project, start from the perspective of environmental protection, and are criticised for giving insufficient attention to both food production and poverty alleviation. Ratna Reddy *et al.* (2004) argue that pro-poor programmes complementing the other benefits of watershed development programmes need to be introduced, including horticultural and dairy

developments, which would benefit from the improved moisture conditions. They see the present successes of the programmes as being dependent on infrastructure and credit support systems in certain areas. They believe that in order to achieve sustainable livelihoods the watershed development programmes need to be expanded to include these areas. This would make the programmes more aligned to the 'win-win' approaches which are needed to reduce both present vulnerability and future vulnerability to any changes in climate.

Box 7: Environmental response to changes in water resources: watershed development programmes

This Government programme has been in operation for nearly 40 years. It emphasises the importance of soil and water conservation through using Watershed Associations in its planning and management. However, national objectives of the programme to reduce adverse impacts of droughts to improve/ stabilize the production of important rainfed crops like pulses and oilseeds and to control siltation of reservoirs, have not been satisfactorily achieved. The impact of some of the projects in reducing siltation, expanding cropped areas, increasing cropping intensity and improving biomass yields, though, have been very visible. The emphasis of this programme is on soil and water conservation efforts; not on productivity-linked best agronomic practices.

India: First National Communication on Climate Change, 2004

10 Key questions

The issues highlighted in this paper have been general. The CPRC needs to conduct micro- and macro- studies to capture local and regional dimensions; to identify the current livelihood strategies, coping and adaptation responses to climate variability in its target areas and to identify the barriers to successful adaptation. Specific research and policy questions will include:

- Why, in some areas, have there been moves towards maladaptation?
- How can chronically poor people be included in adaptation responses?
- Identifying whether chronically poor people are able to enter accumulative migration streams. When should migration be encouraged?
- How can migration be effectively incorporated into national policies – particularly in ensuring that migrant's families have access to education?
- Is the National Rural Employment Guarantee Act able to provide an escape-route from chronic poverty? Is it sufficient to be a replacement for other state-run public works schemes? Issuing a job card for a certain number of individuals, rather than for a household, however large or small, would need investigating.
- What are the possibilities for a 'second revolution' in rainfed agriculture, when taking into account climate change projections? In the short term, is the development of rainfed agriculture in remote rural areas essential before long-term solutions for economic development and the promotion of non-natural resource based livelihoods are successfully implemented (as Kerr, 1996)?
- Should there be greater public sector investment in irrigation? How can government responses to increasing water shortages, such as watershed development programmes, be made more pro-poor?

11 Conclusions

Climate change poses a serious threat to development. At the very least the CPRC needs to ask for each project and programme; 'will this increase or decrease people's vulnerability to the climate?' (Simms and Reid, 2005). There remains uncertainty in climate change projections; but the identification and adoption of 'win-win' approaches mean that poor people can see immediate benefits even if those changes occur far into the future or don't occur at all. Climate variability and extremes already impede development. In reality it isn't possible to distinguish the signs of climate variability and the signs of climate change. It is true that work on variability won't always translate for climate change policy (Huq *et al.* 2006), which also needs to incorporate changes in average conditions. It is however, one place to start.

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