Where Have All the Seasons Gone?

Current Impacts of Climate Change in Gujarat

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Summary of the Report

Global warming has finally begun to get the attention of the world in the last few years, though a sense of urgency and a commensurate response is still lacking where it is needed most. With that, there has been a plethora of attempts to study and analyze it at the macro level. However, there has been a relative lack of detailed studies of the impacts on the ground, particularly in India. We need to understand better how people across gender, caste and class divides in different regions and ecosystems are being impacted by climate change; if and how they are responding; and which responses are effective and which are not. Many players need to take part in efforts in this direction, because to address the issues meaningfully, participatory response, at the local, regional, as well as the global level, is essential.

This report reveals the already considerable impacts of global warming on small and marginal farmers, and on agricultural labour in northern and eastern Gujarat. A joint team comprising activists of Delhi Platform, of the International Union of Foodworkers (IUF), along with the Gujarat Agricultural Labour Union (GALU), Bandhkaam Mazdoor Sanghatan and Disha, visited villages in Banaskantha and Sabarkantha districts in northern Gujarat and the predominantly adivasi Dahod and Panchmahal districts in eastern Gujarat in late-November, early December 2010. This report is based on our conversations with residents in villages there; discussions with activists; interactions with those knowledgeable about Gujarat's social structure, agriculture and water systems; and on relevant primary data and secondary literature.

Residents in villages told us about a range of climate change effects in recent years (presented in chapter 1). These date back from about half a decade to a slightly longer 15-20 years. They include a rise in winter temperature and a consequent loss of dew (atmospheric moisture) for the winter crops; irregularity in rainfall; delays in the main southwest monsoon and a decline in rains in June; more intense rainfall events, a lot of rain in fewer days; patchiness in rainfall over a region; and a rise in summer temperatures and heat. Many of these reported changes are in keeping with changes elsewhere in India; some, such as the loss of dew, we were hearing for the first time. Secondly, whereas people in villages had expectedly a clear idea of changes in rainfall and other climatic patterns, there was very little awareness about why it was happening or that global warming caused by human activity was to blame.

The **impacts** of climate change on small and marginal farmers (chapter 3) have been varied:

a. Warmer winters have meant reduced moisture for their winter crops, maize, wheat, tuar dal, etc, due to the absence of dew, resulting in sharply reduced yields or farmers even having to leave their lands fallow. Those without access to well water in eastern Gujarat are particularly hard-hit by this, and they typically tend to be from the poorest households.
b. Warmer winters are also resulting in the increased incidence of pest attacks in both regions. Consequently, farmers are being forced to incur a further burden of higher input/pesticide costs.
c. Irregular rainfall events are harming agriculture in different ways. For instance, the production of cotton and other crops such as groundnut and potato was devastated in 2010-2011 due to excessively and unprecedented rains until late November. These extensive rains, very likely caused by climate change, extended for hundreds of kilometres beyond Gujarat, to southern Karnataka, Andhra Pradesh, Maharashtra, Rajasthan, etc.
d. The extraction of groundwater by farmers has accentuated greatly with the increasing cultivation of market-driven cash and water-intensive crops, and by climate change. This has resulted in a sharp fall in the water table, particularly in northern Gujarat. As this intensifies, it has serious implications for the farm economy generally, and in particular for poorer farmers directly and landless labour indirectly through the reduced demand for labour.
e. Milk production – which is central to household economies, particularly among poor households, both in eastern Gujarat but particularly in Banaskantha and Sabarkantha – is getting hit due to thermal heat stress faced by local and hybrid cow breeds. The availability of fodder, free or at least inexpensively, has diminished, putting more pressure on households least able to cope with it. This also affects the fat content in the milk, thereby reducing the price at which milk can be sold.
f. Food security of the poorest households have begun to get hit as yields of food crops such as maize, wheat and pulses have begun to suffer, wiping out possible short-term gains from Green Revolution strategies.

Our visit reconfirmed our long-held view that the impacts of global warming are being felt most by those least responsible for it. For small and marginal farmers, crop failure due to climate change can be a disaster and can plunge them into a cycle of debt, or into forced migration to factories or construction work in western and south Gujarat. For sharecroppers (*bataidars*) and agricultural workers in Gujarat (and elsewhere in India), the impacts of climate change (discussed in chapter 4) means a serious loss of work and wages. In North Gujarat for instance, the damage to the cotton crop meant a loss of about 30-40 days' work

per agricultural worker, or about Rs 4,000 per worker, a big setback to households in which more than one member engages in agricultural labour. It meant migration, but thousands of workers made that journey to find no work at the end of it because the crop had been damaged there too. To the best of our knowledge, this is the first time that impacts of climate change on agricultural workers in India are being presented in a published report.

Climate change cannot be viewed in isolation from social processes. The capacity to absorb the impacts of climate change is crucially dependent on two factors in any agrarian setting: land ownership and access to water. A third factor, in parts of Gujarat, is animal husbandry, given its centrality for household economies. The social structure and land ownership, the extensive tapping of groundwater in northern Gujarat and its relative absence in adivasi areas of eastern Gujarat; the development of milk cooperatives and the interconnections between these three elements of the agrarian economy are discussed in chapter 2, along with some recent developments, such as the decline in groundwater, policy variations in electrical supply over the last 20 years, the development of contract farming more recently, and how north and eastern Gujarat differ in many of these.

What might be the way ahead? A concluding chapter (chapter 5) suggests that our responses would need to be at different levels. It mentions specifics such as compensation for workers due to loss of work, and to farmers for loss in crop yields, and possible sources for such compensatory payments. Regarding cushioning the impacts of, and adapting to climate change, NREGA has a considerable role to play in the better distribution of water and electricity, in developing and maintaining ponds; check dams; development of grasslands, revival of forests, water harvesting, etc.

The chapter also discusses crucial wider questions that the issue of global warming revives, without which no meaningful long term solution is possible. Two such central questions are equity, and, connected to it, reviving the notion of the commons. Land reforms are central to any notion of equity in an agrarian setting. But what would equity mean in the context of access to water, and more specifically, groundwater? It would include snapping the link between access to land, capital and technology, and access to water. How does one have arrangements in place at the community level that ensure that even the landless and the poor have a right to water? To understand better these and related questions, we briefly discuss some earlier struggles in Maharashtra and elsewhere around equitable distribution of water.

Climate change is only one among a range of ecological crises that humanity has created and needs to tackle with urgency. Global warming draws our attention, once again, to man's relations with nature and relations within human society. It forces us to rethink our entire development trajectory itself. The need to tackle global warming hence needs to be made part of a larger struggle for equity. In that longer struggle, reports such as the one that follows below, can at best, but we hope, play a small part.

Introduction

Global warming needs to be located within a larger context, of man's relation with nature, and relations within human society. With the establishment of capitalist relations, human society has appeared to function more and more autonomously of nature. Most people, urban elites in particular, tend to forget that human society is deeply embedded in nature, and that each social structure was built on top of preceding layers. Settled agriculture was based on the knowledge of plants acquired in the gathering period of human history and on the domestication of animals. In turn, urban industrial society would be unable to sustain itself without dependence on agriculture, for the need for energy through food has not changed, and on forests for wood, medicines, and river waters. In the growing fascination with 'growth', and 'progress', it is easy to forget this relationship to history.

Three issues lie at the core of global warming: industrial capitalism and its dependence on fossil fuels; class; and equity and sustainability. Part of the inherent logic of capitalist development is the pursuit of profit, regardless of the wider consequences. It encourages the pursuit of wealth by an elite class, both urban and rural, based on the destructive extraction and processing of minerals, and in particular fossil fuels — coal, oil and gas – on which much of the affluence and complexity of modern society depends. It fosters the neglect and unsustainable overexploitation of resources, present and past — in Gujarat, we encountered the overexploitation of groundwater in the north, the destruction of forests over time in eastern regions, and depletion of soil nutrients in both places. The waste products from this exploitative process are dumped — in the soil, groundwater, rivers, oceans and the air — contributing to ecological disasters at many levels, local, regional, and global.

In some villages, we sensed disbelief from people there that man had the power to alter nature, to affect something as powerful as rainfall patterns. Nature is remarkably resilient, but it has its limits. Fossil fuels are finite, as is the capacity of the Earth to absorb the primary waste from their use — carbon dioxide. The Earth can currently absorb 16-17 billion tonnes of carbon dioxide (CO_2) a year; we are emitting over 34 billion tonnes annually from burning fuels and deforestation. This excess CO_2 over the years has raised the Earth's temperature, to which all life is sensitive. Through this upsetting of the carbon cycle, one of Nature's critical regenerating and sustaining cycles, we have altered climate itself, the underlying basis for agriculture and food. In our shortsightedness, we have quickly pushed it to a point where it can be called nothing but a severe, deepening and widening climate crisis.

Some people elsewhere are sceptical of the link between global warming and changing climate. This is at least partly understandable, as there are cycles and natural variation in climate and weather. However, as soon as we understand the consequences of the mounting accumulation of CO_2 with the tapping of energy of first coal, later oil and gas, and the Industrial Revolution it made possible, the link and correlation is obvious. It's something widely accepted by well-established climate science.

Alongside this overexploitation of nature as the basis for the accumulation of wealth is the exploitation of the vast majority of the poor by the elites. The forms may vary, its mechanisms may get more nuanced, but this basic fact remains. Now, further damage is being inflicted on them through the climate crisis. Our visit reinforced our long-held view that those most affected by the climate crisis belong to social classes least responsible for it.

The only way forward is to push for a pattern of development that is sustainable: such a trajectory can be viable only if it has equity at its core, not only because it is just, but because of the all-encompassing support necessary for many hard decisions that society needs to make. This struggle for equity needs to include many elements — in addition to equity between peoples, genders and castes, we need to pursue equity between species, and between generations, to accept that future generations have as much a right to the commons as we do.

Climate Change in Gujarat and Climate Science

"*We are at a planetary tipping point. If we go over the edge, we will transition to an environment far outside the range that has been experienced by humanity, and there will be no return within any foreseeable future generation.*"

— James Hansen, Director, Goddard Institute for Space Studies, NASA

"*Earlier, the rain used to be regular. Now it rains at any time. We can't make out any season any more.*"

— An old woman in Sonagadh tola, Banaskantha district, north Gujarat

In most villages we visited in Banaskantha and Sabarkantha districts, in northern Gujarat, uppermost on people's minds were the **unusual rains beyond Diwali** (5 November 2010). These rains persisted until late November, just before our team's visit. The rain itself was sometimes light but persistent, lasting for over 15 days. In Sonasangh village in Prantij taluk of Sabarkantha district, we were told it had never rained like this. The principal of a local agricultural research college said he had never seen rain of this nature at this time in his 35 years of adulthood. In Kanepur village in Himmatnagar taluk, they said it used to rain sometimes, for 2-3 days only, never like this. This unseasonal rain also occurred in western Gujarat, such as in Junagadh district. In Panchmahal and Dahod districts, to the east, it did not so much rain, as remained consistently overcast and cloudy, affecting crops, small farmers, agricultural labour, and livestock in ways that are discussed in chapter 3. This unusual weather extended well over a thousand kilometres in western India, beyond Gujarat, both north and south, damaging the onion crop in Rajasthan (*Rajasthan Patrika*, 2 December 2010) and rice and other crops in southern Karnataka (personal communication).

With what certainty, though, can one link these irregular rains with climate change? Climate change, it could be argued, is not an event but a process of change over time. One highly respected climate scientist recently argued that rather than trying to link extreme events with climate change, another way of posing the question would be: what is the likelihood of such an event happening had atmospheric CO_2 levels stayed at what they were at the time of the Industrial Revolution (276 parts per million) rather than what they are now (390 ppm). His answer: very, very unlikely. Though he was making this argument in the context of the 2010

floods in Pakistan and the forest fires in Russia (*www.realclimate.org*), his interesting logic can easily be extended to these irregular rainfall events.

It could also be argued that these irregular rains are linked to the ongoing La Nina. La Nina is the reverse of the El Nino phenomenon. By the movement of ocean currents, winds and heat, El Ninos tend to adversely affect the Indian monsoons, whereas La Ninas that follow them tend to contribute to excessive rains in parts of India. After a year of El Nino — which contributed to the drought in India in 2009 and ended in April 2010 — we had entered a La Nina phase in June 2010, a phase expected to continue until the first quarter of 2011 (*www.wmo.org*).

However, even if these excessive rains were helped by the ongoing La Nina, it raises a question: is there any link between El Ninos-La Ninas and global warming? Though this connection has yet to be conclusively proven, an increasing number of scientists worldwide feel there is, that the higher frequency of El Ninos since the mid-1970s is due to global warming. For 5,500 years before that, El Ninos used to happen once every 6 years on average. Since the mid-1970s, they have been happening more frequently, once every three-and-a-half years on average. The mid-1970s is also the time when the effects of global warming first began to be felt in different parts of the world; it would be too much of a coincidence, they argue, for El Ninos to increase in frequency from exactly the same period. Global warming, after all, is about the excessive absorption of (heat) energy due to greenhouses gases, and scientists feel that more frequent or more intense El Ninos are one way the climate system is letting go or passing on some of the excess energy it is being forced to absorb. And in the likelihood that there is a link between El Ninos-La Ninas and global warming, it has seriously worrying consequences for the Indian monsoon and for marginal farmers and agricultural labour everywhere.

Other changes we were told about fit more easily with accepted patterns of climate change. They are both consistent with the climate change scientific literature, and in keeping with impacts of global warming we have heard over the last few years from small farmers and activists elsewhere in India.

These included a **rise in winter temperatures**. At a meeting in Umaria village, in Khanpur taluk, Panchmahal district, people from Umaria and Jer Umaria villages said, "Earlier, we simply could not sit in the cold, like we are now." In Prantiya Falia in Sabarkantha, they said the size of grain of wheat has reduced because of the warmer winters. At Matwa village and many other places in Dahod and Panchmahal districts, we were told that the dew (*os*), essential for soil moisture and crop growth on non-irrigated lands, had either lessened or stopped in recent years because of warmer winters. Dew forms and falls at a particular temperature and gets affected if the temperature rises above it. In Khandol village, they said that over the last 4-5 years the weather has been much less cold than necessary for proper growth of the wheat crop. Scientific studies confirm that night-time temperatures and maximum winter temperatures are rising. This phenomenon is more accentuated in northern India but overall the winters are getting shorter.

A second and obvious effect is the **rise in summer temperatures and heat overall**. A study by the Indian Meteorological Department, Ahmedabad, has revealed a rise in night-time temperatures in Gujarat's towns over the last decade, in Bhavnagar, Surat, Dwarka, Veraval and Okha. If sceptics feel that such data is skewed by measurements being taken in cities, a warming caused by more cars and concrete structures — referred to as 'the urban heat island effect' — then one needs to emphasise that we were repeatedly told about it getting hotter in recent years in villages with no industry in sight, with few or any concrete structures, and only the occasional passing car, such as in Chitroda village in Banaskantha district. Some told us that 2010 was a particularly bad year. Schools and offices had to be closed for a few days in some places as deaths from heatstroke began. In a recent press release, the Indian Meteorological Department has declared 2010 as the warmest year on record [in India] since 1901, as much as 0.93 deg Celsius above the 1961-1990 average, their benchmark 'normal' (*www.imd.gov.in/section/nhac/ dynamic/pressrelease.pdf*, 13 January 2011). Areas in eastern and north Gujarat we visited were in the range of 1-2 deg Celsius above the average (Press Release, figure 2). And the pre-monsoon months (March-May) were also the hottest since 1901, as much as 1.8 deg C above the 1961-1990 average. The year 2010 has been an exceptionally hot year not only in Gujarat and India, but worldwide. The Goddard Institute for Space Studies, NASA, and NOAA have worldwide temperature data going back 130 years. Their data indicates that "temperatures for 2010 tied with 2005 as the warmest such period on record, 1.12 deg F (0.62 deg C) above the 20th century average". It was not an aberration — 2010 was "the 34th consecutive year with global temperatures above the 20th century average" (*www.noaa.gov*, 12 January 2011).

A third change has been an **overall increase in annual rainfall**, going by official government data of the last decade. In Vadgam taluk that we visited in Banaskantha, average annual rainfall over 2001-2009 was 775 mm compared to 586 mm for the period 1980-2002. In Prantij taluk, it has been 937 mm compared to 775 mm for the earlier period. In Himmatnagar taluk, also in Sabarkantha district, the recent average is 893 mm compared to 734 mm for the period 1980-2002. The rise in Sabarkantha as a whole has been roughly the same — about 162 mm higher in recent years. The comparison for Panchmahal district is trickier because the erstwhile Panchmahal included Dahod district, formed more recently. But here again, the overall data hints at a slight increase, in Panchmahal but not in Dahod. Within this increase there is a fair amount of inter-annual variability. The period 1999-2002 saw severe drought in most of these places, but otherwise, the rain seems to have been swinging wildly between very good rain years to drought, to low rains.

Yet most residents of various villages told us rainfall has been declining. Why? Because this increase in overall rainfall has been masked by a fourth, most significant change in climate, — and the most common complaint — **irregularity in rainfall**. In both Chitroda and Sonasangh villages in Banaskantha district, they said that these irregularities in rainfall patterns go back 20-25 years. Assuming that the data mentioned above and the people's

reporting is correct, a most likely explanation is the increasing irregularity. The rain is not falling when they want it to.

There are kinds and kinds of irregularity. One, **when the southwest monsoon begins**. Three-fourths of annual rainfall in Gujarat and in the country as a whole falls in these four months; hence erratic rainfall behaviour at this time has even weightier consequences. The southwest monsoon used to start on 20 June or thereabouts with reasonable punctuality during years it used to rain well. The Gujarati term itself for the period of the southwest monsoon rains, *chaumasu*, reflects rains over a four-month period. In more recent years, we were told, there is no saying when it will begin. It could be early July; it could even be mid-July, a month behind schedule. The Indian Meteorological Dept's (IMD) monthly data bears them out (monthly rainfall data for each district in the country for the last 5 years 2005-2009 can be accessed at *http://imd.gov.in/section/hydro/distrainfall/districtrain.html*). Interestingly, for Sabarkantha, Banaskantha and Panchmahal districts, the data for the period 2005-2010 reveals less rain in the month of June compared to the long period average in five of the last six years. This decline ranged from -13% to -84% for both Sabarkantha and Banaskantha, and -11% to -87% for Panchmahal. In Dahod district, June rainfall was less in every single year, ranging from -15% to -80% (*see Table 1*). Since sowing begins only after the first rains, it implies that only the larger farmers, who own borewells, or those who can access groundwater by buying it from those who may have excess of it, can sow at the right time. Those who cannot afford it are forced to look at the heavens and wait.

Table 1. Rainfall in the month of June, Last 6 Years (2005-2010)

Year	June Rain(mm)	% Deviation	Year	June Rain(mm)	% Deviation
BANAS '05	68.0	+7%	**SABAR** '05	71.1	-13%
2006	55.0	-13%	2006	120.7	+47%
2007	38.6	-41%	2007	55.8	-32%
2008	27.5	-57%	2008	39.2	-52%
2009	9.9	-84%	2009	13.0	-84%
2010	40.0	-37%	2010	39.0	-52%
PANCH '05	146.1	+28%	**DAHOD**'05	39.3	-61%
2006	102.1	-11%	2006	85.9	-15%
2007	36.3	-68%	2007	41.3	-59%
2008	34.0	-70%	2008	35.7	-65%
2009	14.4	-87%	2009	20.0	-80%
2010	42.0	-63%	2010	52.0	-48%

Sources*: http://imd.gov.in/section/hydro/distrainfall/districtrain.html),* Indian Meteorological Department; for 2010 data, *http://www.gsdma.org/rf_data.htm*

This erratic behaviour is made worse by a second kind of irregularity, **a lot of rain in fewer days**. In a meeting with mostly older farmers in Prantij taluk in Sabarkantha district, they said the pattern has become one of few days of too much rain, often the entire season's rain in a few

days. In a village in Himmatnagar taluk of Sabarkantha district, they said this first began ten years ago — it rains intensely for short periods and then does not rain at all for weeks, a pattern typically associated with climate change, and an effect we have heard often elsewhere. A 2008 study published in *Geophysical Research Letters* by scientists at the National Atmospheric Research Laboratory, Tirupati, says that, for India as a whole, there has been a 6% increase in incidents of extreme rain every decade for the last 50 years, while moderate rain incidents are reducing at 2.3 incidents a year. Significantly, this study found a link between rising sea surface temperatures and extreme rainfall events over the last five decades.

A third kind of irregularity is **patchiness in rain over a region**. Earlier, when the rains came, one would be assured it would rain evenly over a region. In parts of Dahod district, we heard that in recent years it has become quite common for it to rain a lot in one village and rain quite poorly or not at all in a village not far away. For instance, according to Roopsi Chauhan of the NGO Disha, who knows the area around Dhanpur taluk in Dahod very well, the rains came to Limkheda on 1 June. In Kamboi village, 20 kms to the east of Limkheda, there were no rains until 15 June. And in Jekot village, only 5 kms away from Kamboi, there was almost no rain at all until 15 July! In Jhalod and Fatehpura taluks, it rains a lot in one place, and scantily in others. In a village of Garbada taluk of Dahod district, we were told that last year there was very little rain here, while it rained well in Chilagota village only 3 kms away.

In all the villages we went to, without exception, there was the appreciation that the climate had changed but limited understanding about why it had changed. The common refrain was: '*Prakruti ki baat hai*'. That humans had the power to alter nature's patterns was something that was not grasped, perhaps not imaginable. Even beyond the villages of Gujarat, in cities and elsewhere outside Gujarat, it is not adequately appreciated that the era of relatively stable climate is over, effectively forever. This is because of the longevity of the main greenhouse gas, carbon dioxide (CO_2), in the atmosphere and the continually increasing stock of CO_2 as the years go on. The only certainty left is uncertainty.

The lag between CO_2 emissions and warming (see box '*Global Warming, its Impacts and Urgency*') implies that the climate impacts described above will not just continue to be with us for very, very long, they will intensify and become more frequent. This has alarming consequences in particular for small and marginal farmers and for agricultural labour.

However, before trying to understand the specific impacts already unfolding from a changing climate in parts of north and eastern Gujarat, one would need a broad sense of the social structure and agrarian relations in these regions. Climate change impacts in any agrarian context cannot be viewed in isolation. They need to be located and linked with other issues such as land distribution, caste inequalities, adivasi/non-adivasi disparities, access to irrigation and groundwater, livelihoods, terms of wage and of tenancy relations, developments in agricultural practices, sources of employment other than agriculture, migration, etc. These issues are touched upon in the next chapter, some of them in those that follow.

Global Warming, its Impacts and Urgency

Global warming happens from any human activity — from cars, planes, industry, power generation, agriculture — that emits greenhouse gases, of which the main ones are carbon dioxide (CO_2), methane (CH4) and nitrous oxide (N2O). Greenhouse gases (GHGs) act like a blanket; they trap outgoing solar radiation — heat energy — just as a blanket traps our body's heat.

Of the greenhouse gases, carbon dioxide from the burning of coal, oil or gas is the most significant, because it has a long lifespan; once emitted, a significant portion of CO_2 stays in the atmosphere for hundreds of years, and a quarter of it effectively forever, contributing to warming. The world is currently emitting about 30 billion tonnes of CO_2 every year, and another 4-5 billion tonnes from deforestation (because trees emit carbon when they die). About half of that is currently absorbed by the Earth's oceans mainly and forests and grasslands, leaving an excess 17 billion tonnes or so in the atmosphere. About 8 billion tonnes equals one part per million by volume (ppm) of CO_2, so we are rising now by over 2 ppm a year, which is a staggeringly fast rate compared to long-term planetary trends. From 276 ppm at the time of the Industrial Revolution in the 18th century, we have reached 390 ppm in 2011.

This excess CO_2 is what causes warming. The Earth has warmed by an average of 0.9 degrees Celsius since the Industrial Revolution, but has been speeding up in recent times to about 0.2 degrees a decade. And this is only an average. Some regions — such as the Himalayan ecosystem and the Arctic — are warming much more.

The impacts of global warming first began to be perceived worldwide in the mid-1970s, but they have intensified in recent years. There is no region in India immune anymore. It is causing reduced snow at mid- to high altitudes and receding of glaciers in the Himalayan states; droughts in Bundelkhand in central India; sea level rise along the Gujarat coast and in the Sunderbans; irregular and more intense rains all over the country; storm surges in Orissa and other parts of the east coast; greater incidents of pests, spread of mosquitoes to new areas; growth of weeds and frequency of fires in forest areas; migration of fish stocks northwards in the Arabian Sea as the sea water gets warmer. And on, and on.

These impacts, or those discussed in this report, are not from current emissions but from emissions in the past. There is a lag between CO_2 emissions and warming, because much of the CO_2 and excess heat energy get absorbed by the oceans. Which means that further warming and impacts are unavoidable. It is widely accepted that a further 0.6 degrees of average warming is in the pipeline, but recent science suggests that this 'committed warming' may be a lot more, may be more than twice that.

Which will take us close to dangerous levels of warming. It is now accepted that were the planet to cross 2 degrees Celsius of average warming, it would trigger off feedbacks in ecosystems, ice melt and forest dieback on a scale that would make it very difficult for us to intervene and prevent further warming. Some scientists now argue that given the scale of impacts at merely 0.8 deg C, setting 2 deg Celsius as a safe level may be too risky. Others — supported by numerous activists worldwide — now argue that we need to be cutting CO_2 back drastically to 350 ppm, not adding more each passing year. One respected scientist wrote: "Since there are already threshold changes in ecosystems and ocean acidification … dangerous change is likely to appear before 2 deg Celsius". Therein lies the urgency of the issue.

2 | Understanding the Agrarian Structure

The capacity to absorb the impacts of climate change — discussed later, in chapter 3 — is dependent crucially on two factors in any agrarian setting: land ownership, and access to water. The patterns of both factors are different in northern and eastern Gujarat, the two regions in the state we visited.

As elsewhere in the country, current land ownership in Gujarat is still heavily influenced by the incomplete land reforms of half a century ago. Via a series of legislations in the late 1940s, through the 1950s and early 1960s, governments in Saurashtra, Bombay, and later, Gujarat state, passed laws that sought to grant occupancy rights to tenant cultivators, halt arbitrary eviction of tenants, and abolish intermediaries in land. The government passed the Land Ceiling Act in 1960, to provide some land to the landless. This Act was amended in 1974 to lower the ceiling further. As Ghanshyam Shah argues in a seminal volume of collected essays, land reforms in Gujarat (also as elsewhere) were far from perfect. It was bitterly resisted by the rich sections among the dominant castes; the tenant cultivators who acquired lands were largely the better-off among them; and the lands acquired after the land ceiling acts were often of inferior quality (Ghanshyam Shah, 'Caste Sentiments and Class Formation in Gujarat', in Francine Frankel and M.S.A. Rao [eds], *Dominance and State Power in Modern India*, vol. 2, OUP, 1990, pp. 59-114).

There were, however, undeniable gains for sections of the tenantry. If one were to name one caste grouping that benefited from land reforms in Gujarat, it would be the Patel community. This they did at the cost of the upper caste landlords, Brahman and Rajput. However, whereas upper caste hegemony was irretrievably dented by land reforms (and later, the accumulation of money among certain sections made possible by the modern Indian economy and NRI links), four points are relevant to understand the current caste and class structure in rural Gujarat. One, upper castes — Brahman, Vania and Rajput — continued to dominate landholdings, now along with the Patels. Two, most scheduled castes (SC) and scheduled tribes (ST) benefited little and remained at the bottom of the caste and class structure. According to a survey of 100 villages in Gujarat in 1983-84 by the Centre of Social Studies, Surat, by the 1980s, 27% of Brahman, 21% Vania and 23% Rajput households owned over 15 acres of land. By then, the highest proportion was of the Patels/ Patidars, of whom 33% did. Contrast this with the scheduled castes (5%) and the scheduled tribes (2%).

In Banaskantha district, and in northern Gujarat in general, Patels derive from the Kunbi community, and are sometimes referred to interchangeably as Patidars. They were expectedly among the larger landholders in most villages we visited. In Chitroda village, for instance,

the largest owners, Patel households, own about 40-50 acres of land. However, — and this is the third point — there is never a complete overlap between caste and class. Members of the dominant caste community continue to be among the small landowners, a fact accentuated by land fragmentation, which happens as land is passed on to succeeding generations. The CSSS study quoted above found that 41% Brahman and 55% Vania households owned less than 5 acres. Having said that, a much smaller proportion among them tends to be landless or agricultural workers. Roughly 150-200 households in Chitroda are landless, most of them Bhangi, Raval, Valmiki, Chamar and other scheduled castes. In Sonasangh village, in Sabarkantha district, two hundred of the 1,500 households own about 20 acres or more, while 500 households, mainly scheduled caste, are landless. Finally, four, though we did come across occasional mention of joint ownership of land among spouses, that is a rarity and men generally control land ownership and retain it through inheritance laws, and therefore decisions about water.

Between these two ends of the ladder lie the other backward classes (OBCs). The number of OBCs stands at a bewildering 142. As we found in Kenpur village in Sabarkantha, — dominated by Parmar, Makwana, Chavan and Thakore households with holdings of 7-8 bighas, — more often than not, they tend to be small and medium farmers. Pratij taluk in Sabarkantha is similar, populated by predominantly OBC villages — Prajapati, Kumhar, Lohar, Sutar, etc — where most people have 1-2 acres.

To complete this snapshot of the social structure, barring a small landed agrarian elite, a large proportion of Muslims in Gujarat tends to be self-employed. They comprise 9.7% of the poor in Gujarat (Sachar Committee Report, *Social, Economic and Educational Status of the Muslim Community of India*, November 2006, p. 178), and 53% of them in urban areas tend to be self-employed (p. 343). According to a recent study by NCAER's chief economist Dr Abusaleh Shariff, it is increasingly the case that Gujarat's Muslims tend to be involved in informal trade or are self-employed, "running food stalls, pull rickshaws, do manual labour", an outcome, he suggests, of "active discrimination" (*Outlook*, 11 April 2011, p. 26).

The dominance that arises from unequal land ownership gets strengthened by unequal access to sources of irrigation. For our purposes, **private tapping of groundwater** is the most significant, as it has become overwhelmingly the dominant source for irrigation in northern Gujarat, particularly in the non-monsoon seasons, and the source to be tapped in the event of delayed June rains due to climate change.

Though the use of groundwater in northern Gujarat through wells and the deployment of animal power dates back to the 1920s, serious tapping of groundwater in Banaskantha district took off only in the 1970s with the use of diesel pumps and the expansion of rural bank credit. In a village in Vadgam taluk of Banaskantha, they said that the first borewell was installed in the village in 1972 with the introduction of electricity there, but their number

expanded only in 1985. In Banaskantha and Sabarkantha, electrification in agriculture meant that electrical motors — of two kinds — successively replaced diesel engines. In the first, electrical motors are placed along with the pump, usually on the dry well bed; unlike tubewells, they are to be placed a few feet above the water level and are referred to as dug-cum-bores (DCBs). Tubewells followed, particularly as the water level declined; using submersibles, they need to be placed below the water level. Navroz Dubash, who has closely studied the development of tubewell irrigation and its consequences in north Gujarat, points out that with tubewells, it's easier for water to be pumped up since the motor and pump are below water; tubewells are significantly more expensive to install but easier to maintain; and being of greater horsepower, tubewells can water 2-3 fields at the same time (Navroz Dubash, *Tubewell Capitalism: Groundwater Development and Agrarian Change in Gujarat*, OUP, 2002). By 1997, of 1.4 million hectares (ha) irrigated in North Gujarat, over 1.3 million ha were being pumped by 1.5 lakh DCBs or tubewells, less than 0.1 mha by surface water (Jennifer McKay and H. Diwakara, 'Groundwater Irrigation in North Gujarat'). Census data for 2001 suggests that by the turn of the century, the first kind of electrified motors, DCBs, was the dominant technology used in Sabarkantha — 'wells with electricity' account for nearly half the land irrigated. In Banaskantha, on the other hand, tubewell irrigation had overcome all other forms and covered nearly half the total area under irrigation (*see Table 3, page 23*).

In effect, there's little legal constraint on how much groundwater can be extracted; any constraint operates only post-facto when new tubewells are discouraged after extraction rates are deemed too high. Effectively, the right to tap groundwater follows from the ownership of land (also implying that the landless are denied that right). This is important, as 'ownership' of groundwater, by its very nature, should not depend on the ability to tap it, as boundaries of the land do not coincide with the source of water and spread of the aquifer. What's more, groundwater is part of the commons and cannot be treated as a private resource. However, even beyond the law, there's little shared sense of the commons here as far as groundwater is concerned.

Though how much water is being extracted is not easy to quantify, annual groundwater extraction in north Gujarat around the turn of the century was put at 1,528 million cubic metres (M. Dinesh Kumar, 'Value of Groundwater: Case Studies in Banaskantha', *Economic and Political Weekly (EPW)*, 31 July 2004, p. 3495). (Every cubic metre equals 1,000 litres of water). This extensive tapping of groundwater had a series of significant implications, whose ripples are still being felt. It contributed to a greater commercialization of agriculture in north Gujarat. In 1971-73, traditional food crops used to dominate agriculture in Banaskantha — bajri (pearl millets) and jowar in particular. Cash crops such as cotton, mustard and castor were a mere 2% each at the time (Navroz Dubash, *Tubewell Capitalism*, p. 79). As groundwater tapping grew, the agrarian economy got more commercialized, more cash crops were cultivated, in particular, jeera (cumin seeds), mustard, castor, potatoes and cotton. In recent years, the main crops

grown in the rabi (*siyalu*) season are castor, wheat, mustard, isabgul, and in the kharif (*chaumasu*) season, cotton, makka, til and groundnut, and in the summer (*unhalu*) season, bajra and potatoes. What we saw most travelling through Banaskantha and Sabarkantha were castor, cotton, makka, potato, and some papaya, obviously for commercial sale, not household consumption. We visited pre-rabi, wheat had yet to be sown. What is relevant for our purposes is that cash crops such as potato, tobacco, castor and mustard usually need several rounds of irrigation water, much more than traditional food crops, to say nothing of other increasingly costly inputs such as fertilizer.

The increase in irrigation helped a shift from single cropping to multiple cropping to a degree, an increase in gross cropped area. This led to a greater demand for labour. As we shall see in chapter 4, the terms under which such labour is employed is quite varied. Despite the rise in demand for labour, the intensified tapping of groundwater increased income inequality, and strengthened the hands of the landowners. It was the landed that were more likely to have the money to install wells or access to sources of money; what may be called the social economy ensured that formal bank credit for wells, which expanded in the sixties and seventies, was most easily procured by the dominant castes. Dubash shows a clear correlation between landownership, dominant castes and well owners — in one of the villages he studied in Banaskantha district, well owners owned on average two plots of 9 bighas each; those without wells owned on average only one plot of 2 bighas (p. 46). Effectively it meant that the poor were not only subject to any adverse consequences that might follow from such commercialization, but could not get any immediate benefits from it.

This changed to a degree with the spread of water markets in the 1990s. This was catalyzed by the introduction in 1988 of flat rates for electricity for agriculture, a demand for which the Patels intensely lobbied. From being calculated per unit consumed, rates began to be calculated per horsepower of motor independent of how long that motor ran. Basically, it did not cost more to pump more water, which those who controlled water sources could then sell to those who did not. It enabled the less privileged to access water easier, of course at a price. Three kinds of payments prevail for supply of water over the season — a payment in kind, but fixed; a payment in kind, not fixed, but a portion of the output, usually one-third; and three, per hour of water supplied. In case of sharecropping, a portion of the crop is taken for supplying the water. Water, essentially, became a new way to extract surplus from labour.

Besides land and water, there's a third element that's central to the agrarian economy in north Gujarat — **livestock rearing**. Taking the state of Gujarat as a whole, in 1998, 65% of the 4.84 million tonnes of milk produced was from buffaloes, and 29% from indigenous cows. Crossbred cows supplied only 6%, though their numbers are on the rise. What's more important, as they told us in Chitroda village, Banaskantha, most households keep animals, even poor households have at least one or two buffaloes or cows, the better-off more. It's not

uncommon for even landless households in this region to have a buffalo or two. In a meeting in Prantj taluk, we were told that there were numerous milk cooperatives in the region; they date back 35-40 years, presumably to the genesis of Operation Flood in 1970 and the National Dairy Development Board. Typically, all the milk is sold, not kept for household consumption. The earnings depend on the fat content in the milk, ranging from Rs 22-32 a litre for buffalo milk. Cow's milk yields less, Rs 12-13 a litre. The fat content in turn, depends upon, among other things, the quality of fodder.

Livestock rearing is deeply interlinked with the first two elements of the agrarian economy, land and water. A not insignificant portion of the cropland in north Gujarat is apportioned for growing fodder. The acreage of land under fodder crops has been rising in north Gujarat in general and particularly sharply in Banaskantha district since 1991. By 1995, crops for fodder occupied 211,503 hectares, a significant 19% of the total crop area in the district (O.P. Singh, et al, 'Virtual Water Trade in Dairy Economy: Irrigation Water Productivity in Gujarat', *EPW*, 31 July 2004, pp. 3492-97). Fodder for livestock is of three kinds: green fodder, which is grown specifically for feeding animals, mainly alfalfa (*rijka/ garari*) and local grasses; dry fodder, the by-product of other crops, mainly straw from the bajra and jowar crop; and concentrates in the form of balanced cattle feeds and cottonseed cake. The cost of animal feed, they told us, is Rs 800 for 60 kgs. Those without land, or those who don't have adequate land, buy fodder or lease in land as sharecroppers, and keep a portion of the crop as fodder. But again, it's the better off who are able to grow or provide their animals the nutritionally better fodder, given the costs or inputs involved.

Growing these fodder crops, alfalfa in particular, involves a huge amount of water. At 198 million cubic metres per annum, alfalfa alone accounts for 13% of the total groundwater extraction in north Gujarat. Irrigation costs form 70% of the input costs in growing alfalfa (M. Dinesh Kumar, 'Value of Groundwater: Case Studies in Banaskantha', *EPW*, 31 July 2004, pp. 3498-3503). If one were to include not only what these animals drink directly, but also the 'virtual' or 'embedded' water contained in the food animals eat, water consumption in north Gujarat comes to a staggering 11,810 litres for buffaloes, 11,630 litres for crossbreed cows and 7,110 litres for indigenous cows every single day! Looked at differently, it takes 4,546 litres of water for a buffalo to produce a single litre of milk, and for cows 2,941 litres (O.P Singh, et al, 'Virtual Water Trade', p. 3496). Milk, like so many other products, seems to be based on large volumes of invisible water.

Some Recent Developments: There have been four developments in roughly the last 5-15 years, all of which directly or indirectly relate to water, and which also have a bearing on the present, in an era of climate change. There is in fact a fifth factor, — the introduction of the Mahatma Gandhi National Rural Employment Guarantee Scheme (NREGA/ NREGS) — which influences available work and agricultural wages.

The first, and most obvious, is **the decline in groundwater**, in Banaskantha in particular. The aquifer under Banaskantha is layered and alluvial, layers of water, clay, sand and silt. Alluvial aquifers tend to have storage going down dozens of metres, and are also where falling water levels impact hits if extraction outpaces recharge. The implication of the aquifer being layered and alluvial is that recharge from lateral flows underground is difficult, and that "90 per cent of recharge results from vertical flows" (Dubash, *Tubewell Capitalism*, p. 39).

Water tables in Banaskantha, which had been falling by about 1.5 metres a year in the 1980s, began to fall more sharply thereafter. As tubewells are significantly more expensive — costing at least a lakh rupees or more, and often five times as much as a DCB — and often installed only when groundwater levels have fallen below what is viable for DCBs, the numbers of tubewells in Banaskantha (Table 3, p. 23) suggests that groundwater levels have fallen sharply. Recent data, for 2005-2009, collected by the Central Ground Water Board indicate a current decline of over 2 metres a year in some stations in Banaskantha (Mahi tw i), much more steeply in others (JerdaPz-I and Jerda Pz-II) and a more mixed picture in yet others *(http://gis2.nic.in/cgwb/Gemsdata.aspx)*.

As it declines, only those who can afford such expensive equipment increasingly control groundwater. Irrigation forms a significant proportion of the input costs, mainly for rabi crops, varying from crop to crop. Declining groundwater has undoubtedly increased the cost of tapping it — a detailed study of four villages in Banaskantha found that, between 1970 and 2003, the cost of irrigating wheat had increased, in constant prices (the year 2000), from Rs 1,960 per hectare to Rs 4,595, and mustard from Rs 1,482 to Rs 2,952 a hectare (M. Dinesh Kumar, et al, 'Value of Groundwater: p. 3502).

Things have now reached such a pass that many areas have been declared 'dark zones'. Farmers in a dark zone cannot get loans for digging tubewells, and no new power connection is provided for agriculture, implying that no new borewells can be dug within. In Chitroda village, they said that their village along with another 109 villages in Vadgam taluk in Banaskantha, falls within such a zone. In some villages, it has led to farmers moving away from rice, which requires huge volumes of water, but, as we shall see below, not halted the rise of other water-intensive crops. Falling groundwater has also led to the adoption of sprinklers in fields, of which we saw many pipes. Only the better-off can afford most sprinklers. In Ghodiyal, a village in Banaskantha with over 500 households, they adopted sprinklers first in 2005, something that has led to a 40 per cent saving on water. Climate change has begun to hit at the very time when groundwater is declining, precipitously in places. When June rains are lessening (Table 1, chap 1) or rains get more erratic, it leads to an ever-greater tapping of groundwater to ensure water is available when it is necessary.

Second, in 2003, the Gujarat government **restricted electrical power for tubewells** to 8 hours a day, whereas earlier it was irregular, its quality poor, but theoretically unlimited. Its

effects have been, again, varied. Tushaar Shah has argued that though they were unhappy elsewhere in Gujarat, tubewell owners in Sabarkantha welcomed the restrictions. Sabarkantha is a hard-rock area; here wells tend to run out after some hours of pumping, so it's best regulated and supplied twice a day. But the brunt of this restriction in tapping groundwater has fallen, adversely, on marginal farmers and landless labourers; water markets, which, as mentioned above, grew after flat rates were introduced, have shrunk in many districts, and led to an increase in the price of water by 40-60 per cent (Tushaar Shah and Shilp Verma, 'Co-management of Electricity and Groundwater: An Assessment of Gujarat's Jyotirgam Scheme; *EPW*, 16 February 2008, p. 64). But even this is not enough to contain the damage of excessive withdrawal.

Three, **the development of the public irrigation network**, which has been partial. For instance, in Sabarkantha, 60 villages in Wadali taluk, 35-40 villages in Idar and 40 villages in Himmatnagar have surface irrigation facilities. But the canal for Himmatnagar was not completed up until 2009; hence Himmatnagar did not get water. There is no perennial river in northern Gujarat. Sidestepping the vexed question of displacement and related issues, in some places there has been some recharge from the Narmada — the Hatmati river in Sabarkantha gets some water from the Narmada — but this is limited so far. Despite promises made, much of the Narmada water has been diverted for industry and for use in urban areas, rather than for agriculture, for which it was first promised. Some of the canal water percolates, a point that Rajnabhai Dave, the respected editor of *Bhumiputra*, made in a meeting with our team on 1 December in Ahmedabad. The spread canal of the Narmada, he said, is not lined with concrete and hence some of that water percolates to the ground, and Sabarkantha benefits from this to a degree.

Four, globalization in agriculture and agricultural markets, and changing consumption of urban elites in India, has catalysed the entry of large capital over the last few years. These large companies try to ensure and regulate the supply of food to be processed, through **contract farming**. For instance, companies such as Pepsi, and McCain have entered into contracts with medium or large farmers here, for the ensured supply of potatoes. In a village in Banaskantha, we were told that the company's middlemen provide the seeds and the fertilizers to the farmer. Half the money of the seeds has to be returned to the company. They said that costs work out to Rs 35,000 an acre; roughly, fertilizer costs Rs 10,000 an acre, pesticides Rs 5,000, seeds Rs 12,000, and labour Rs 10,000. Water costs work out to about Rs 1,000 an acre. Profits, when the crop is good, are also relatively high, about Rs 25,000 an acre. What happens when the crop fails is another matter. An issue with contract farming is the capacity of companies to corner the profits but pass on the risks to the individual farmer. Also, a hidden cost is the amount of water potato needs, many more waterings a season than most other crops, again emphasizing how companies and relatively affluent farmers benefit, while adversely impacting the rest of the community.

Land, Water and Work in Eastern Gujarat

Much of what has been discussed in this chapter thus far pertains to north Gujarat. Eastern Gujarat is different, regarding both land and water, and livestock to a degree.

But to start with the most obvious, Panchmahal, and Dahod district in particular, have a much higher scheduled tribe population than the Gujarat average, a lower scheduled caste percentage, a low level of urbanization, and a higher number of persons per household *(Table 2)*.

Table 2 Population, SC and ST Population, and Household Size in the Four Districts

Category	Panchmahal	Dahod	Sabarkantha	Banaskantha	Gujarat
Population (in millions)	2.02	1.63	2.08	2.50	50.67
Rural pop	1.77 (87.5%)	1.48 (90.4%)	1.86 (89.2%)	2.22 (89%)	31.74 (62.6%)
House size	5.6	6.7	5.2	5.9	5.2
ST pop	556,000 (27.5%)	1.18 million (72.3%)	420,242 (20.2%)	205,904 (8.2%)	7.48m (14.8%)
SC pop	92,492 (4.6%)	32,884 (2%)	173,325 (8.3%)	271,484 (10.8%)	3.59m (7.1%)

Source: Primary Census Abstract, *Census of India 2001*

Regarding land, as elsewhere, the Land Ceiling Act worked patchily. Much of the land surrendered under the Act was of relatively poor quality. But one of the most significant issues in adivasi areas tends to be land alienation. This is chiefly due to mortgaging of land and distress sale of land to non-adivasis due to poverty, often through mechanisms such as usury and money-lending, pointing to the lack of appropriate credit infrastructure or risk insulation for the poor by the state. The relevant laws were flawed and inadequate in preventing this land grabbing here. This was made worse by the fact that some adivasi areas of eastern Gujarat have not been declared 'scheduled areas' as they were settled under the colonial administration. At least up until the 1990s, the relevant section in law to prevent land alienation did not apply in 882 villages of Limkheda, Santrampur, Jhalod and Devgadh Baria in Dahod (Harish Trivedi, *Tribal Land Systems*, Concept Publishing, 1993, p. 132).

Pateliya Bhils are the dominant landowning sub-tribe among adivasis in these areas. Going by the Census 2001, Bhil Garasiyas, Dhodias, Nayakas, Naikdas and Dholi Bhils comprise a significant proportion of workers, both main and marginal, but they are likely both cultivators and agricultural workers. Impressionistically, the sense we got from adivasi villages in eastern Gujarat is that large holdings are few in number. Most holdings here are small, 1-2 acres, likely made smaller over time by land fragmentation. Even in the case of large holdings, — we encountered one landowner in Kanto village, in Dhanpur taluk with 35

acres — adivasi lands often tend to be of relatively poor quality. Additionally, there is an overwhelming dependence on rain-fed agriculture even for households with large landholdings. In the case of this landowner for instance, only two of his 35 acres had any source of irrigation (well water) other than rain.

In fact, what is striking about Dahod and Panchmahal is the extremely low level of irrigation overall; 82% of lands in Dahod and 77% in Panchmahal district are dependent on rain *(Table 3)*. Tubewells are conspicuous by their near absence. At least up until 2001, tubewells with electricity irrigated barely 180 ha of land in Dahod and 715 ha in Panchmahal. There has been a slight shift towards wells using electric motors in Panchmahal but it has been limited. Government canals and wells without electricity (animal power or diesel pumps) constitute the biggest sources of irrigation in these districts. There is a likely combination of reasons for this — the limited electrification for agriculture; lower bank credit; the absence of household resources to invest; and the undulating, rocky nature of the terrain, which makes digging deep a risky and costly process. Since erratic rainfall — discussed in the preceding chapter — is the most widespread symptom of climate change, all of the above implies that these regions of Gujarat are the most exposed to its vagaries.

Table 3 Extent, Sources and Percentage of Irrigated Land (in hectares)

District	Govt Canal	Well without Elec	Well with Electricity	Tubewell without electricity	Tubewell with elec	Total Irrigated (all sources)	Total Unirrigated (all sources included)
Banaskantha	2,204	58,177	1,13,267	16,386	1,76,391	3,72,523	3,67,635
(in per cent)	0.6%	15.6%	30.4%	4.4%	47.35%	100%	-
Sabarkantha	26,161	44,079	1,12,647	4,891	31,793	2,29,218	2,15,083
(in per cent)	11.4%	19.2%	49.1%	2.1%	13.9%	100%	-
Dahod	10,235	11,485	2,392	342	180	35,963	1,59,525
(in per cent)	28.5%	31.9%	6.7%	0.9%	0.5%	100%	-
Panchmahal	29,888	16,609	12,494	538	715	65,835	2,22,501
(in per cent)	45.4%	25.2%	19%	0.8%	1.1%	100%	-

Source: Compiled from the Village Directory (for each district), *Census of India, 2001*
Note: Additionally, in Dahod, tanks irrigate 4,233 hectares, and rivers 3,968 hectares.

A capital- and inputs-intensive, commercialized agriculture, which grew on the back of an electrified tapping of groundwater in north Gujarat and elsewhere, is consequently absent. The area covered by non-food crops in an undivided Panchmahal district was a low 9.6% in 1993, at a time when Banaskantha had reached 42% (Sujoy Chakravarty and Sejal Dand, 'Food Insecurity in Gujarat: A Study of Two Rural Populations, *EPW*, 3 June 2006, p. 2252). The Census village directory suggests that maize is overwhelmingly the main crop in Dahod. The crop

picture is slightly more varied in Panchmahal, with a little more wheat and pulses, but here too maize predominates. Maize, as we shall see in the next chapter, is likely to be badly hit by climate change because of the nature of its photosynthesis.

Livestock rearing plays a not insignificant part of the household consumption, despite the more limited access to groundwater. In fact in some places, as they told us in Mirapuri village in Kallol taluk, animal husbandry, not agriculture, is now the main source of sustenance. The absence of groundwater is mitigated by forest cover in some parts, where animals graze. Where forest cover is inadequate, people labour to be able to purchase fodder. Yet, there are significant differences from the north. The cooperatives market is less developed, like all other things here. The milk is both sold and likely consumed to a greater degree.

Along with livestock rearing, agriculture remains the predominant activity in eastern Gujarat. There's little industry or services. Those dependent on agriculture, cultivators and agricultural labour both, constitute 83% of workers in Dahod and 77% in Panchmahal district *(Table 4)*. But this is skewed towards those who cultivate their own land — in rural Panchmahal, cultivators comprise 57.9 per cent of the workers and agricultural labour 25.6 per cent. In Dahod, the proportion of cultivators goes even higher, to 64%. Contrast this with rural Sabarkantha (38.7%).

Table 4: Proportion of Workers in the Four Districts

District	Cultivators	Agr Labour	Other
Dahod	60.8	21.9	16.3
Panchmahal	53.7	23.9	21.1
Sabarkantha	36.0	26.8	35.6
Banaskantha	42.2	22.2	31.8

Source: Primary Census Abstract, *Census of India 2001*

The main reason why cultivators are more predominant here and why demand for agricultural labour within the region is thus stunted is that most holdings are neither large nor very productive. Whereas this would not reflect in the numbers of agricultural workers, the number of days of agricultural work available would be fewer than in northern Gujarat. In the absence of adequate agricultural work, and limited alternative employment, **migration** remains the only route to survival. The *EPW* study quoted above found that a mere 7 per cent of households in Panchmahal-Dahod were food secure for all 12 months of the year, and it presents an obvious, though revealing correlation between the percentage of those who migrate and the lack of food security. In Bhindol in Dhanpur taluk, they told us that no labour is needed in the village after Diwali, and people are forced to migrate from the area. In some

places in Dahod they said that if a family has four young people of working age, 2-3 may migrate and 1-2 of them stay behind to work the fields. Also, entire families from here migrate for work to Saurashtra and other regions of the state, seeking work in agriculture or in construction. In migrating for work, they take some grain saved along but it usually involves taking a loan to make the journey. In a region historically and still dependent on rainwater for irrigation and on migration for survival, this is an old story. But in an era of climate change, it's getting more precarious.

3 | Differential Impacts of Climate Change in Northern and Eastern Gujarat

Climate change affects people of different classes, strata and gender differently. It tends to hit more severely regions with fewer resources, households with less access to water, poor women and those at the lower end of the class (and caste, or sub-tribe) spectrum. One would think this is stating the obvious. However, consolidated reporting and data about climate change impacts often tend to be presented in isolation from this inequality that is deeply structural.

This chapter looks at how the climate changes described in chapter 1 affect people within the agrarian context discussed in chapter 2. In particular it looks at impacts upon small and marginal farmers. Impacts on agricultural workers in parts of northern and eastern Gujarat are discussed in chapter 4.

We do not claim it is comprehensive; it is very much an initial survey. In particular, there are two important social strata that we deeply regret not being able to cover. We were unable to probe, in sufficient detail, the impacts faced by poor women. Two, we were unable to visit villages with concentrations of Muslim populations. We were told that Muslims in Gujarat tend to be involved more in trades and artisanal occupations and much less in agriculture and agricultural work but that does not explain this gap.

We can only hope this report at least contributes to future work by other organizations on the ground, and for the articulation of collective demands, an issue touched upon at the end of this report.

Warmer Winters, Less 'Os' and its Effects on Crop Yields

In Prantiya Falia in Sabarkantha, they told us that the size of the grain has become smaller because winters have been getting warmer over the last 10-12 years. Put differently, winters have gotten shorter. When minimum temperatures start rising above a certain degree in March, it causes terminal heat stress during the period of grain growth, "thereby affecting grain size and thus overall yield" (Swapan Datta, et al, 'Many Physiological Traits Have Strong Correlation With Terminal Heat Tolerance', *The Hindu Survey of Indian Agriculture 2009*, p. 42).

In Dahod and Panchmahal districts, warmer winters are making rabi agriculture chancy for those without wells or alternative access to water. As we have seen, an overwhelming proportion of agriculture in Dahod (82%) and Panchmahal (77%) is rain-fed. Hence, when climate change makes itself felt, for those without access to sources of irrigation, there is little

scope for cushioning its effects by watering the fields more. Here, makka (maize), wheat, channa and tuar dal are the main winter (rabi) crops, whereas makka, bajra and tuar are the kharif *(chaumasu)* crops. In a meeting with residents of Umaria and Jer Umaria villages in Panchmahal district, we were told that some years back, everyone used to cultivate wheat in winters; nowadays only households that own wells cultivate wheat. The others are forced to leave their land fallow.

There are possibly two reasons for this change. One, hybrid seeds were introduced here about 20-25 years ago. Hybrid seeds need more water, and fertilizer, compared to traditional seeds. Two, warmer winters have resulted in **reduced or the complete absence of dew-drops** *(os)*, particularly over the last five years. Hence, while the need for water has risen, the source of water or moisture has declined. Scientists at the Indian Institute of Pulses Research in Kanpur have referred to this phenomenon as "atmospheric drought, associated with insufficient or lack of dew precipitation, as a result of high night-time temperature. The moisture available in the air — termed as 'invisible water reservoir of nature' — can be easily accessed by the crops *provided nights are cool to form dew*" (Masood Ali, Sanjeev Gupta and P.S. Basu, 'Higher Levels of Warming in North India Will Affect Crop Productivity', *The Hindu Survey of Indian Agriculture 2009*, p. 44).

In village after village in eastern Gujarat, people spoke about the uniformly negative consequences of warmer winters upon a largely rain-fed agriculture. In Umaria village, with about five hundred predominantly OBC households (Rawat, Mali, Bagi, etc), the resource that stratifies is not so much land as access to water. Most of those who own land have an acre or so, marginal farmers; the larger holdings are barely two acres. But only 10 per cent, the better-off households in this village, own wells; diesel engines are used to pump out water as there's no electricity for agriculture here. Excess water, when it exists, enables the sale of water to those without wells; in such an event, part of the yield and not money exchanges hands; as much as half the yield is taken in return by the well owner. And those without access to any water at all in Umaria and Jer Umaria, typically marginal farmers, are forced to migrate in winters to Surat and Ahmedabad for work.

In Bhindol village, Dahod, where 80 per cent of the 225 households are adivasi and the rest OBC (Baxi), only about 15-20 per cent is able to access water from the Paanam river that flows nearby. Here too, reduced dew had affected the wheat crop over the last 10 years. In other places, they said mahua production had also declined. In a completely Bhil Pateliya village with over 600 households in Garbada taluk in Dahod, only 16 households are landless; the overwhelming majority have tiny holdings — made worse over time by land fragmentation — that would qualify them as 'marginal farmers'. The village has limited lift irrigation that waters only 40-50 acres when it works; even that is now damaged. They said one used to get 12 *mand* (240 kgs) of channa per bigha. Then, it began to get warmer, something they first noticed about 15-20 years ago and which has worsened more recently. Now, no channa grows

at all on fields with no access to water. Alternative sources of livelihood for these villagers are limited. The Forest Department employs people from this and surrounding villages to cut grass, for about a month, after the winter. NREGA has given some households about 50-60 days of work in digging or maintaining wells, and protective walls, but not to all households and for less than the number of days stipulated or at the minimum wages that are part of the Act. Hence most people migrate to Rajkot, Surat and Vadodara to work either as agricultural labour or construction workers.

Eastern Gujarat is a region with little non-farm employment. People may have job cards under NREGA but the availability of work is patchy. The combination of the absence of alternative employment and the periodic lack of basic food supply forces them to seek them elsewhere. Persistent lack of appropriate development has endowed this region with a history of migration, often of entire families. Climate change is now accentuating this forced migration. As we shall see below, the places they go to seek work are getting hit by climate change too.

Increased Incidence of Pests on Crops

A second, and obvious effect of a warmer climate is the greater incidence of pests. Scientists at the Indian Institute of Pulses Research referred to above write that since the internal temperature/ metabolism of insects vary depending on the surrounding temperature, "processes like [their] growth and development are all dependent more on temperature", and that "any shift in environmental temperature is likely to influence insect behaviour more than plants and larger animals". The pod fly is now emerging as a "serious" pest of pigeonpea (tuar dal) in central and south India, and the spotted pod borer a major pest of short duration pigeonpea in central and north India (*The Hindu Survey of Agriculture 2009*, pp. 47-48).

People we talked to would not go into these technicalities of course, but they are fully alive to its impacts on their crops. A word that came up often in conversations was *'kitan'*. In Kanto village in Dhanpur Taluk of Dahod district, a farmer said that his tuar dal is being increasingly affected by *kitan*. Two women from Sarsoda village in Dahod said that channa and tuar dal have gotten affected because of greater pests. In Bhindol village, they said it has been less cold in winters since the last ten years, and as a consequence pests are affecting the channa crop.

Pests seem to thrive not just in warmer winters. They also affected crops in the cloudy weather in eastern Gujarat post-Diwali, such as in Bhindol village, mentioned above. In a village in Kallol Taluka, Godhra district, where all but three of the roughly 300 households own land, but most with small holdings of not more than 2 acres, they said that makka and tuar needed the sun at this time. Instead the weather was cloudy, leading to greater prevalence of pests. Half the tuar crop and a quarter of the makka crop were damaged. In a village in Himmatnagar taluk of Sabarkantha district, white fly damaged half the cotton crop last year. A few years back there was such a severe attack of white fly here that additional workers had

to be employed to take them out. In Umaria village, the unseasonal weather, they said, affected the tuar crop.

The obvious consequence of greater pest incidence is the increased use of chemical pesticides, as bio-control of pests is virtually unpractised. But chemical pesticides have all kinds of attendant issues, which include choice and selection, risk to the health of sprayers (particularly women), and decimation of natural predators. The most obvious impact is of course to costs, as only some can afford it; in fact among poorer households or villages, most can't, as they told us in a village in Dahod. For those on the edge of an unviable agriculture, having to incur further input costs pushes them over the edge.

Falling Milk Yields

Published studies reveal that milk production in north Gujarat averages about 4 litres a day per animal for buffaloes and indigenous cows, and little over 5 litres for crossbred cows (O.P. Singh, et al, 'Virtual Water Trade in Dairy Economy, *EPW*, 31 July 2004, p. 3494). In north Gujarat, the milk is sold at rates that vary from Rs 22-32 a litre for buffalo milk and Rs 12-14 for cow's milk, depending on the fat content in the milk. However, there's less of it as summers get longer and hotter, made worse by delayed June rains. Thermal stress due to the temperature and humidity is measured by a temperature-humidity index (THI). According to the recent authoritative report by the Indian Network for Climate Change Assessment (INCCA), a THI of over 75 "affects milk production of high producing European crossbreeds and buffaloes, and over 80 severely impacts livestock health and productivity". The report says that the "heat stress days per annum are likely to increase with THI above 80 in 2030" in areas that include Gujarat (MoEF/ INCCA, *Climate Change and India: A Sectoral Analysis for the 2030s*, November 2010, p. 85). What we heard suggests that these effects have already begun to be felt. In Sonasangh village, in Sabarkantha district, they said milk yields from hybrid cows have been falling for the last 6-7 years, even as costs of fodder have risen. In Sonagadh hamlet, women told us that if, earlier, buffaloes gave 5 litres of milk twice a day, now they were lactating only about 2-2.5 litres each time. Elsewhere, they said milk production has declined in recent years by 25 per cent. The fat content too is reducing because of less fodder. We have seen the centrality of livestock to the household economy in north Gujarat. In other places, it is not sold entirely and some portion kept for personal consumption. Either way, the decline in milk yields means a loss in either income or nutrition.

Effects on Food Security

The question of how climate change is beginning to impact food security in parts of Gujarat is a complex one. Green Revolution strategies, shortsighted as they are, undoubtedly resulted in increased yields over the last few years/ decades. However, climate change in more recent times is equally undoubtedly impacting access to food, particularly for the poor. So

gauging how well or badly people are faring over time in their production of or access to food depends on what period you consider.

In areas in Sabarkantha and Banaskantha and other parts of northern Gujarat, the extraction of groundwater, as we have seen, facilitated multiple cropping and contributed to increased yields. But these gains are slowing down: groundwater has fallen, is becoming more costly and difficult to access, yields are stagnating and climate change has now begun to sweep in.

In eastern Gujarat, the adoption of hybrid seeds 20-25 years ago — adopted even more recently in some villages we visited — and fertilizers increased yields significantly. For instance, villagers from Umaria and Jer Umaria told us that makka, the most widely grown crop there, used to grow at 10 *mand* an acre with older seeds. With the introduction of hybrid seeds and fertilizer over two decades ago, yields jumped to 25 *mand* an acre. In the case of wheat, the rise was more modest. Yields have also risen due to improved agricultural practices; earlier, they told us in a village in Kallol, they used to just throw the seeds on the fields, now they are sown in a planned pattern. This is something we also heard elsewhere. Modern inputs and improved practices are not necessarily introduced at the same time, so both the jumps in yields and in input costs may happen in fits and starts. In Bhindol in Dahod, makka used to grow at about 20 *mand* an acre with local seeds. They began using fertilizer fifteen years ago and hybrid seeds barely three years ago. Now the land, presumably more fertile than Jer Umaria above, provides 40-45 mand of makka an acre.

But despite these inputs and better practices, there's still a staggering level of food insecurity among the poor. Forests have thinned out over the years; there has been a general reduced dependence on forests and forest produce, something that adversely affects the poorest forest dwellers. A study of 1,435 households in 51 villages in Panchmahal and Dahod conducted in 2003-04 found that a staggering 54 per cent were “severely food insecure” (for 7-9 months of the year), and another 20 per cent “extremely insecure” (10-12 months). A mere 7 per cent were food secure all 12 months of the year (Sujoy Chakravarty and Sejal Dand, ‘Food Insecurity in Gujarat’, *EPW*, 3 June 2006, p. 2253). This suggests that the gains of inputs are going mainly to a more privileged section mainly. And the experience of Punjab — with its stagnating yields, the necessity of spending on ever-increasing inputs, declining groundwater, farmers' debts and farmers' suicides — warns us that this is a risky road to follow in the longer term.

For poor households, particularly those without access to water other than rainfall, whatever gains they may have had is beginning to fray at the edges. The combination of less dew and more pests means that yields of food crops such as makka, wheat and pulses are suffering, as discussed above. There's no season or food crop immune any more. Someone in Matwa village in Dahod captured this one essence of climate change impacts on agriculture. Earlier, at least one crop season used to be okay; if *chaumasu* was bad, then *siyalu* would be alright. Now, he said, both seasons are getting affected.

This has obvious effects on the food access and food security of the poorest households. Those with one or two acres in not particularly fertile soils and poor water supply basically engage in subsistence agriculture. Already getting hit by rising input costs, now even that subsistence is facing further threat. Their response is to get into a cycle of loans or to migrate for work. But it is not always that the entire family migrates; sometimes, it is only the young and able-bodied. The old are left behind, and are forced to depend on remittances from their migrating offspring. Studies elsewhere suggest that poor women, old women in particular, tend to be the worst affected in a situation of food scarcity. We deeply regret not being able to probe this specific issue sufficiently. It certainly merits further attention.

The problem of food security may well become a crisis in those parts of Gujarat that grow maize. Maize is a C4 crop, in contrast to rice and wheat, which are C3 crops. They are categorized thus because they have a different photosynthesis processes. For our purposes, what this means is that C3 crops, unlike C4 crops, are able to benefit from higher levels of carbon dioxide in the atmosphere. Hence the effects of warmer temperatures or erratic rain due to global warming are offset slightly by better growth. C4 crops, such as maize, don't enjoy even that slight benefit due to a different photosynthesis process. According to the recent INCCA report, maize production in parts of the country will decline by up to 50% by 2030 (MoEF/ INCCA, *Climate Change and India,* p. 71). It was difficult for us to gauge whether yields are already stagnating, since there were a range of causal factors influencing yields over time. But the INCCA's predictions have very grave implications for the food security of a huge number of people in the region. Makka is the major food crop in the entire adivasi belt of eastern Gujarat, and beyond; what effects this might have on a region where among the poorest people in Gujarat live can easily be imagined.

Health Impacts on Humans and Other Species

Reduced nutrition has a direct and obvious bearing on human health. That is a subject of deeper enquiry. Other, more obvious health impacts on humans and other species came up. In Kanto village, new kinds of illnesses are affecting people that they did not experience before. For instance, people have begun to get afflicted by very high fever along with malarial symptoms and body ache. All the beds at the nearest clinic, we were told, are overfull and the sick are now being made to sleep on the ground. Such high fevers and sudden deaths are a recent phenomenon. In Sonagarh, Sabarkantha district, a number of women told us in a meeting with them that mosquitoes are causing new illnesses in recent years that they had not experienced before, particularly malaria and chikanguniya. A health worker comes to the village once a month but this is clearly inadequate. One activist told us that falciparium malaria is what has begun to affect people here. In Garbada taluk, Dahod, some women said that a few children had died in their village as a consequence. According to a woman from Jhabu village, also in Dahod, 5-10 people here die every month. This latter figure seemed high, but we could not go to the clinic or consult local doctors to confirm this.

It is difficult to say conclusively whether the new illnesses we were told about are occurring as a consequence of climate change. But it is likely. The greater spread of vector diseases due to greater warming is now widely accepted, not only in India but worldwide. In particular, the spread of mosquitoes to new regions, altitudes, and times of year when they did not thrive earlier. They thereby cause the greater prevalence of illnesses such as falciparum malaria, chikanguniya and dengue. In villages in Gujarat, these new illnesses are ones with which traditional systems of healing cannot cope. And, one might add, modern systems partially, at best.

Illnesses are also increasing because summer heat is getting beyond normal levels of tolerance, which particularly hits the infants, old, and impoverished more for the obvious reason that their immunity or tolerance levels tend to be low. In Idar town, in Sabarkantha, the unusually hot summer this year caused schools and offices to be closed down for some days following deaths from heat stroke. In Mirapuri village in Godhra, residents said that viral fevers are becoming more common. Greater warming is also beginning to affect **other species**, particularly livestock upon which lakhs of households depend. In Umaria, in Godhra district, we were told at a meeting that deaths of livestock have risen in recent years. In Kallol taluk in Godhra, because of rising summer temperatures, livestock have begun to suddenly get affected by loose motion and many of them die.

Impacts due to Irregularity in Rainfall

In our view, the biggest section of society affected by climate change is generally **poor women**, as they are the ones who are entirely responsible for domestic work around water and also do agricultural labour. In Bundelkhand, we have seen lakhs of women having to do much more labour to procure water in a climate change induced drought. In Uttarakhand, drying streams forces them to trudge long distances to water sources, for themselves and for farm animals. At a public hearing on climate change in dryland areas, women from Rajasthan said they were far more insecure because both agriculture and sources of water are getting affected ('Jalvayu Parivartan Se Mahilayen Ab Aur Asurakshit', *Jalvayu Parivartan: Varsha Adharit Kshetron Par Prabhav, 2009*, p. 37)

Hence one question for us is how women are coping with delayed rains and more erratic supplies of water in parts of Gujarat. Our impressionistic sense was that in the non-adivasi areas of northern Gujarat, its impacts are being cushioned by the fact that a high percentage of homes have access to tap water. For instance, in Chitroda village in Banaskantha, they said that access to water itself was not the problem; the problem is that there is too much fluoride in it. In Sonasangh village, they said most houses have taps now. This is the case even in poor households. In Sonagadh, Sabarkantha, in a meeting with women of largely landless households, who only have homes on homestead land, they said every house has a tap, and the panchayat ensures water. Not only does this cushion women from the immediate impacts of

climate change, it also has positive implications for their health, and for the amount of time and energy they have to spend procuring water.

As in all other welfare indicators, the situation in adivasi areas is strikingly different, where houses generally don't have the infrastructure for water supply within homes. One reason we were told for is that in adivasi areas of eastern Gujarat, the distance between houses is much more. To us, it seems more the lack of political will and selective channeling of resources rather than logistical constraints. In Matwa village, in Dahod, nearly all the 616 adivasi households have electricity in their homes but no taps at all. In a village in Panchmahal district, women said they are dependent on well water and handpumps for water, which become more difficult when the rains get delayed. In Bhindol village, Dahod, located next to Paanam river, they said the rains have been coming late for 10 years. When the river dries up, they make a hole in the river bed. The women there also said that nowadays they need to go much further to get drinking water.

Erratic Rains and Agriculture: The effects of a delayed southwest monsoon over the last few years, and hotter summers, are being felt by different classes differentially. As discussed in the previous chapter, the restriction of electricity for agriculture to 8 hours a day under the Jyotigram scheme in 2003 shrunk water markets and adversely affected the supply of water to marginal farmers. Only those with the resources to install and operate dug-cum-bores (DCBs) and tubewells pump out water to make up for a delayed monsoon. In doing so, they are basically using their greater economic clout to corner what is a commons resource. It's not as if they escape unscathed though, because it means increased costs of diesel for non-electrified engines. What's more, the higher ambient temperature still adversely affects the crops. Steady and regular rainfall contributes to plant growth in ways that merely pumping water from the ground simply cannot.

Installing a DCB costs Rs 50,000; a tubewell costs over a lakh, something that most households cannot afford. Those without access to groundwater either directly or through purchase are not being able to sow until the delayed rains arrive. Generally, their yields and quality are worse than those who manage to sow on time, as they told us in a village in Dahod. A situation then made even worse by rain occurring in concentrated bursts nowadays.

If it does not rain when it should, the better off with access to other sources of water can at least ameliorate the situation by tapping those sources. If it rains when it should not, there's little that anyone can do. Such as the unprecedented rains after Diwali in northern Gujarat and cloudy weather in Dahod and Panchmahal.

Besides Saurashtra region, Sabarkantha and Banaskantha districts are centres of cotton production in Gujarat. In some villages in the latter districts, we saw mounds of plucked cotton pods blackened at the base of the pod. However, in the case of cotton, the damage was not only to present pods but also future yield. Cotton pods tend to flower in a roughly 15-day

cycle, so there's periodic, albeit lessening output over the season. A lot of the damage was to the entire plant, not just these specific pods, hence affecting the entire crop cycle. Cotton is a particularly risky crop due to constant need for high-cost inputs. The head of the NGO Disha told us that according to the Gujarat government, 321 farmers committed suicide in the Saurashtra region of Gujarat alone in 2009. If 321 is the figure the government admits, the actual number of suicides is likely to be much higher. It's possibly because of these suicides that the Gujarat government increased the support price for cotton from Rs 600 per *mand* (20 kilos) of cotton last year to Rs 950 this year. Usually, the costs total about Rs 500 a *mand*, with a profit now of Rs 400 or so. But this year the crop has been hit by the rain. In Prantiya Faliya, where there are mostly small farmers, they said, "We sold what cotton we could retrieve, roughly 50%. But had to sell it at a lower price because the quality was lower."

Other crops were also affected. In Chitroda village in Banaskantha, the groundnut and potato crops were almost totally destroyed; only those with fields on sloping land were able to save some of the crops, presumably because some of the excess water runs off. Potato can be profitable but is also a very risky crop. In Sonasangh village in Sabarkantha, the damage to crop was up to 80%. "God alone knows what compensation we will get," some old farmers said. In Khandol village in Sabarkantha, the castor was damaged, and much of the cotton "dried up". By which, they mean that because of crop damage, the stem is unable to provide nutrition to the pod. It's not just the crop, some people told us that the quality of grass has been affected due the rains and become "dirty". In Dahod and Godhra districts, the damage was caused more by cloudy weather, leading to attacks by pests, as discussed above.

Again, the effects of such sudden crop failures are felt differentially. For dominant caste households with relatively large holdings, such setbacks are mitigated by the fact that they have the savings, in the form of food, seed or cash, to fall back upon. They also usually have the access to water, either through borewells and traditional wells, which enables them to prepare for the next crop. In north Gujarat, some of them had given up on the current cotton crop and began to prepare for the winter wheat crop.

For small and marginal farmers, crop failure can be an unmitigated disaster. It can plunge them further into a cycle of debt. Usually, small farmers use the returns from a normal crop for certain kinds of personal spending, and for the repayment of loans. Loans, if taken from banks, are usually repaid in March. Now they are unable to do so. Which makes them seek out private debt, at usurious rates, usually 3-4% every month, or about 40-50% interest a year, or more. This cycle of debt is made worse by the fact that they don't have the access to borewells to start work on the next crop. The choices essentially are forced migration or a downward spiral of debt.

How extensive the damage was within Gujarat can be gauged by how far-reaching it was beyond. To the north, it damaged the onion crop in Rajasthan, the unusual rain causing "*see-lan aur safed chakhte*" (*Rajasthan Patrika*, 2 December). To the south, Maharashtra chief

minister Prithviraj Chauhan admitted that more than half the crop grown on 5.44 lakh hectares (over 1.3 million acres!) had been damaged. As a result, suicides occurred among grape farmers (*The Hindu*, 5 December 2010). Even further south, it damaged crops extensively in Andhra Pradesh; in Karnataka, an activist said that heavy and unseasonal rain badly damaged the rice, betelnut, onion and coffee crops in villages as far away as coastal South Karnataka. In Gujarat, as elsewhere, the extensive damage to crops affected not just small and marginal farmers. The scale of the damage was such that agricultural labour was also hit. It is this silenced majority that we now need to hear.

4 | Impacts of Climate Change on Agricultural Labour

The reason impacts of climate change on agricultural labour are being dealt with in a separate, short chapter is not just because it is a hugely important issue that is beginning to affect millions of agricultural workers in Gujarat and elsewhere in this country, but also because the impacts of significant processes on workers and certain other sections in society tend to get invisibilized. For instance, when displacement happens due to an industrial project or a dam, there's some, though limited, focus on those who own land and will lose it. What happens to all those who work on that land or provide a range of related services is not even considered. The same may well happen with agricultural workers affected by climate change.

A section of agricultural workers — who tend to be overwhelmingly from the underprivileged castes in an agrarian setting — are also often small farmers or marginal farmers who are forced to work on others' lands because their own are inadequate. How they get impacted as marginal farmers, or how their health or food security is beginning to get affected by climate change has already been touched upon in the previous chapter. This chapter provides some glimpses of how agricultural labour specifically is beginning to get affected in parts of Gujarat. However, we first need a broad sense of what that work is.

Different kinds of agrarian labour relations prevail in Gujarat, including those that may be deemed pre-capitalist. One is sharecropping *(bataidari)*. For instance, in Chitroda village in Banaskantha, fifty of the roughly 500 households in the village engage in sharecropping. The *bataidar* in Chitroda gets only one-fourth of the produce, and the costs are borne by the landowner. In different places, we heard terms of *batai* varying between either one-fourth or one-fifth of the crop yield. Usually, the sharecropper gets only a share of the crop and not any of the grass/ fodder, essential for livestock, which goes entirely to the landowner. There's another variant of *bataidari*, in which the costs of water and half the other input costs are borne by the landowner. The sharecropper also bears half the input costs, including animal labour, puts in his own labour power, and gets half the yield. This second variant tends to be practised more by absentee landowners as they are not around to keep close control of input costs.

The other kind of labour relation is obviously wage work. The wage is usually calculated on a daily basis, but for certain kinds of work — such as plucking cotton — it depends on the weight (in this case, of cotton pods plucked), calculated per kilo or *mand* (20 kilos). Rates for daily wage workers in Banaskantha and Sabarkantha range from Rs 70-100, most often

around Rs 80 for different kinds of work. The work is from 8 in the morning to about 6.30 pm with a 2-hour rest period. Unlike other places, the employer does not provide any food, only tea. The wage rates for ploughing, spraying pesticides and loading a tractor with bundles tend to be higher, Rs 150 a day. In eastern Gujarat, like in everything else, it's different. Wage levels that may be Rs 70-80 a day in Banaskantha are about Rs 40-50 a day here, with tea and sometimes food.

Women are socially denied certain kinds of work, presumably due to patriarchal, misplaced notions of purity, lack of strength or of skill. Some of it is traditional methods such as working with the plough, and some more recent, such as operating the tractors, loading bundles of produce and the spraying of pesticides. Other than these, women do all other kinds of agricultural work (in addition to *all* the domestic labour). In some places, we were told they get paid the same amount as men, though in others we heard differently: if men got Rs 80-90 a day there, women got Rs 60-70.

The amount of work available or labour needed has fluctuated over the years due to four complex developments. One, we were told in some villages that agricultural work has increased over the years because of better irrigation infrastructure (in northern Gujarat) and because of improved agricultural techniques (in eastern Gujarat). For instance, in Chitroda in Banaskantha, earlier, agriculture was only feasible near the river. With the growth of tubewells — census data for 2001 suggests that 203 hectares were irrigated by tubewells in this village — more village land has come under the plough. Two, in contrast, mechanization in the form of tractors — common in northern Gujarat but much less so in Dahod or Panchmahal — and combine harvesters, just beginning to enter north Gujarat, has meant that one worker now does the work that 2 or even three workers used to do with the plough earlier, and that too covering a larger area faster. Hence one worker and machine does the work of dozens. A third influence is the introduction of NREGA in recent years. Though partial and patchy in its actual implementation, it has meant that agricultural wages benefit from an upward pressure to keep up with NREGA rates, particularly if the latter are paid as per what is mandated. A fourth, and major influence on agricultural work and wages is the demand for labour by the construction industry in towns in Saurashtra and elsewhere.

So what are the major kinds of agricultural work available? Starting with the main kharif *(chaumasu)* crop, the sowing for cotton, castor, rice or dals usually continues for about 15 days after the first rains. For sowing rice, the payment is not by a daily rate, but usually per *bigha*, about Rs 600 a *bigha*, since it is very laborious work. A group of workers may get together, finish the work, and share the wage. For other crops, such as cotton or castor, the sowing rate is paid at Rs 60-80 a day, higher if the workers are organized. This is often done by landless agricultural workers, since those who have small plots of agricultural land are working their own fields at this time.

After a lull in work of little less than a month, the grass is removed in July, which takes 15 days of work for which the wage is also in the range of Rs 60-80. Then, in late July and early August, *falikaran* of the Bt Cotton crop is carried out, for about a month-and-a-half or even two if the crop is good. This is often done by migrant labour as well, for which the wage rates are again in the vicinity of Rs 60-70 a day. The plucking of cotton pods starts two months later, around Diwali, and continues until March. If the crop is good, every *bigha* of cotton crop needs five workers for 1-2 days every fortnight. This fortnightly work is done 3-4 times at first, then less frequently for later pluckings. For castor too, the harvesting can occur 7-8 times, from August to April.

In the rabi season that follows, ploughing for wheat in winter needs two workers a day per bigha (work often done with a tractor nowadays by those who can afford it). After watering it every 15 days or so, the wheat crop is harvested *(katai)* around end March-April 1st week. The rate for harvesting is either a daily wage of Rs 80-100 a day, or is paid by piece rate, of 2.5 *mand* (50 kilos) for every 50 *mand* (1,000 kgs) yield per bigha. Following which, there may be the mid-season *(unhalu)* crop, such as peanuts, — which needs a significant amount of labour — castor, etc.

Rather than in this disaggregated manner, if one were to consider the amount of work available over the year, then the two regions are again very different. In some villages in northern Gujarat, they told us that the agricultural work adds up to about 5-6 months a year. In Umaria village, in Panchmahal district, they said agricultural workers get a total of about 3-4 months' work over the year. In Dahod and Panchmahal in general, the number of days of agricultural work and number of workers employed are significantly fewer than northern Gujarat, — despite less mechanization of agriculture in these two districts — partly because holdings are smaller, and hence family labour suffices, and partly because productivity is lower. Besides this, in forested areas of eastern Gujarat, there is some work available from the Forest Department — such as to cut grass for a month after winter. But this is seasonal, NREGA is patchy, and migration is often the only route.

It follows from the above that the **impacts of climate change on agricultural workers** vary, depending on the nature of agrarian relations, the kind of work, and the number of days lost.

For a *bataidar*, reduced yields or a near total loss of crop due to erratic rainfall results in a decline in his/ her already low share. In Sonasangh, farmers said yields had fallen by 80 per cent after Diwali, in some places they said 50%, in others completely. A decline of even 50 per cent would mean he/ she is left with practically nothing. For a sharecropper already kept stretched at the margins of survival, a sudden loss of share due to a climate change event can be a calamity. Unable to repay already existing loans, it would push them further into debt, as they are forced to take further loans from moneylenders or the landowner. The latter results in forced labour the following season.

For wage workers, the loss depends on the number of days of work lost. Looked at differently, it might be due to fewer workers hired than would have been the case had the crop been fine. This year, the damage first happened during July-August when because of the light rain, much less *falikaran* was needed for the Bt cotton crop. Consequently, whereas five workers would have been needed for every bigha, only two were employed. This work carries on for 6-8 weeks. A loss of 6 weeks' work results in a loss of nearly Rs 3,000 for every worker.

Later, the cotton crop and other crops were hit by the unseasonal rains after Diwali. In Khandol village in Sabarakantha, where cotton plucking ought to have been taking place, a meeting of women told us that "no one calls us for work as all the crop has been damaged". Cotton picking usually operates at piece rates, of about Rs 3-3.50 per kilo of cotton picked or about Rs 60-70 per *mand*. A worker can pluck 1.5 *mand* (30 kgs) or even two *mands* (40 kgs) a day. Which works out to about Rs 140 a day. Five workers are needed every 15 days for every bigha of cotton crop, but since they work on different fields on different days, the immediate loss of work, they told us in Khandol, was 15 days' work. Cotton picking goes on periodically until March, and since the damage was not only to the current pods but often to the entire cotton plant, further output, and hence future work, was also affected. The total loss might add up to 30-40 days over the cotton season. Conservatively, the loss would be over Rs 4,000 per worker. For those households in which more than one member is engaged in wage work, the potential loss of earning is even more. And even where the cotton crop partially survived, they managed to pluck only about a mand a day at Rs 3 a kilo because the cotton yield is less, as they told us in in Sonagadh in Sabarkantha. In Kenpur village, they said that each person can normally pluck 30-40 kilos a day, now that had fallen to just 10 kilos. Even if some of them manage to shift to a daily wage system instead of piece rate, it would be a significant loss of earnings. The loss of income is only the more obvious effect. Less obvious is the loss of access to food that follows, loss of nutrition, and the desperation of keeping the household going, the burden of all of which falls more on women. Women form a huge proportion of marginal workers (those who are employed for less than 180 days a year) among scheduled castes and scheduled tribes; around 75-80 per cent are women (Census 2001). It follows that the burden would fall inordinately on poor women, particularly in eastern Gujarat.

From the districts of eastern Gujarat, and also parts of Baroda and elsewhere, entire families migrate for work to Saurashtra and other regions of the state. In migrating for work, they take some grain saved along but it usually involves taking a loan to make the journey. After this Diwali, thousands of migrant workers made that journey to find no work at the end of it because the cotton crop had got damaged in Saurashtra too. Once they reached there, it is not as if there is a clear picture about when their labour would be needed because there is no saying when the rains may clear. Hence they just had to hang around and wait. Which involves taking a further loan to be able to tide over those days. This has happened this year

to tens of thousands of workers; some of them likely returned with a further debt on their hands; those who found work in construction went off elsewhere.

Understandably, conversations about loss of agricultural work again focused on the most recent unseasonal rains. But loss of work from other impacts of climate change discussed in earlier chapters can well be speculated. Such as from more land being left fallow due to the absence of atmospheric or soil moisture in warmer winters. This would extend over thousands of acres, hurting those who would potentially work on those lands. And then, in June, people not being able to sow their fields due to delayed rains has effects on a large scale on landless labour in particular since it is they who usually do this work. Or less labour employed due to erratic rains affecting crop yields. These disruptions in available work are going to happen more frequently and erratically as climate change intensifies, something that is inevitable. Which means that agricultural workers will get hit more often and more sharply. How one needs to respond to this loss of work and earnings is one key question, discussed in the last chapter that now follows.

5 | What Might Be the Way Ahead?

The impacts of climate change on small and marginal farmers, and on agricultural labour, discussed in the previous two chapters, brings out one of its ironies — that those most affected most by global warming are those who have, and are contributing to it the least.

Numerous people from various parts of India we have spoken to over the last few years say that they first observed changes in weather patterns about 15 years ago, some say 10-15 years. It began slowly, they tell us. But they noticed that over the last few years, changes in rainfall patterns have been happening more often or more severely. The impacts of climate change are intensifying, and will continue to do so. Because of the lag between emissions and warming, a significant amount of further warming and deepening impacts are unavoidable. We need to anticipate them, and prepare in advance. However, not all impacts can necessarily be cushioned against. For instance, it may be possible (for some) to cushion the effects of rain not falling when it should. Whether one can cushion the effects of rain falling when it should not is another matter.

Our response would then need to be at different levels.

1. Compensation for workers and farmers: The most immediate is the question of compensation for those affected. Activists of Disha and Bandhkam Mazdoor Sangathan in Gujarat have recently voiced a significant demand that has a bearing throughout Gujarat and beyond — that agricultural workers impacted by climate change need to be compensated for their loss of work and loss of wage. Accepting equity would imply that these claims should have priority. It's true that establishing that an agricultural worker has been impacted at all is not easy; to overcome this, perhaps agricultural workers can be compensated whenever farmers also are. The details of such compensation are tricky, as often small landowners are also agricultural labourers, the number of days lost may be hard to identify precisely, etc. However these specifics merely need more work, depending on the context and are hardly insurmountable problems. Acceptance of the principle is important for now; the specifics lie beyond that.

There are three possible sources for the payment of such debt. One, some of that amount should be sourced from prosperous farmers through the levy of a small cess on any sale in a *mandi* that is above a stipulated amount. That this is levied only on large sales of goods would ensure that small and medium farmers don't carry this burden. Two, of course, is the governments, central and state. A third source is the payment of ecological/climate historical debt that developed countries owe to the poor countries and people everywhere, for their overoccupation of carbon space since the Industrial Revolution, and the impacts that it is inflict-

ing on the latter. Over two hundred organizations, including Delhi Platform, in a joint memorandum to the central government in November 2009 said that "any financial transfer mechanism needs to be transparent, decentralized, democratic and decided by the people at all levels — through participation in consultation with national, state and local self-governments". More recently, a number of international organizations have demanded that the World Bank and other large financial institutions that have historically favoured rich countries, large industry and elites everywhere should be kept out of such debt transfers. There is however no need for the payment of compensation to wait for such an international transfer mechanism to be put in place.

The same sources would apply for compensation to farmers. The first — government compensation — is currently in use already when farmers are compensated for crop losses. Farmers however get compensated only when at least half their crop is damaged. Given the precarious nature of most agriculture nowadays, that is too high a bar. Additionally, that compensation levels are too low is a constant complaint at such times from farmers' organizations, and need upward revision for the compensation to be meaningful.

2. The Use of NREGA: We had mentioned in chapters 3 and 4 that the distress migration from eastern Gujarat in particular, a historical trend, is now being accentuated due to climate change. Better implementation of NREGA would help reduce such distress migration. According to a study of NREGA and migration across four states, including Gujarat and particularly Banaskantha, Sabarkantha, Panchmahal and Dahod, more than half the respondents "felt that migration had been reduced in their families due to NREGS" and their proportion increased to a remarkable 99% if 70-100 days of work was provided (Paulomee Mistry and Anshuman Jaswal, 'Study of the Implementation of the National Rural Employment Guarantee Scheme: Focus on Migration', Disha, August 2009, pp. 21, 28). This is also in keeping with what we have heard from activists in other states.

Even though we found a fair amount of awareness of NREGA, and possession of job cards, the number of days of work people got, even where NREGA was being implemented was disappointingly low, usually around 40-60 days a year. Payments are delayed and compensation if work is not provided is non-existent. The study quoted above found that in roughly half the cases, people got work for less than 50 days against the stipulated hundred a year (Fig. 31, p. 30). Let alone meet this stipulated minimum, additionally, given that an average size of household ranges from 5.2 in Sabarkantha to 6.7 in Dahod (Census 2001), giving work to only one household member is too low. Several unions all around the country have demanded that the work entitlement under NREGA should be for each household member and not merely for one member per household. The Gujarat Agricultural Labour Union (GALU) has demanded that every person should be entitled to work over the year. Their slogan: "When the sun rises, we should have work." As much as 80% of respondents in the 2009 study pre-

ferred NREGS to migration, as migration was very disruptive (p. 28). Only a better and higher level of implementation would help reduce it.

There are undoubtedly a whole range of issues that would make the NREGS much more effective — higher wage levels; indexing NREGS wages to inflation; ensuring that it met at least the stipulated minimum wage in each state; prompt payment of wages; payment of prompt compensation if work is not provided; prompt sanctioning of work that is demanded and planned for; making people more aware of these provisions in law; providing the statutory facilities at work sites; ensuring a more democratic process in the consultation about what works are needed and where, consulting women in particular.

But for the purposes of this report, the benefit of NREGA is that it can be used in the better distribution of water and electricity, key areas in climate change. Pond work (41%) and the creation of check dams (13%) already constitute a significant portion of the work done under NREGA (NREGS Study, p. 15). To this need to be added —

- the digging work and laying and maintenance of water pipes to households that do not have tap water, particularly in eastern Gujarat and to adivasi areas in Banaskantha and Sabarkantha;
- the planting of traditional trees and the revival of forests in eastern Gujarat, which has a bearing on fuel, fodder, produce and climate;
- the development of grasslands and afforestation;
- the promotion of water harvesting through the digging of community lakes and ponds
- the development and maintenance of decentralized and renewable electricity generation and distribution infrastructure

3. Cushioning Impacts and Equity: Another level of intervention would be anticipating and cushioning the impacts of climate change. As has been said time and again in this report, the impacts that we are already witnessing in eastern and north Gujarat are only going to intensify over the next few years because of the lag between carbon emissions and warming. This needs more study, both by organizations on the ground, and by appropriate governments. And since adequate baseline data for all indicators don't exist, it is essential that such work incorporates people's perceptions of climate change over time. Agricultural research needs to study adaptive responses by farmers and others that may be relevant for people in other places with similar ecologies. Such information — and research on crops that can better withstand impacts — needs to be placed more accessibly for all, in the public domain.

Some impacts, such as the lessening dew in winters, would need to be met with a more equitable distribution of groundwater, on which more below. Others, such the possible spread of vector diseases, and the issue of food security due to food crops being affected, need more proactive intervention by a democratic state. Both food and health care are complex interconnected issues, whose ramifications extend beyond climate change. Intervening

to reduce climate change impacts in these would have a range of connected benefits overall.

Equity in coping with climate change impacts is essential; it needs to form part of our larger notion of equity, particularly since not all impacts can be cushioned against. The two cannot be separated. Equity in coping with climate change would mean a betterment of the lives of scheduled castes and scheduled tribes, poor women, of Muslims and other minorities, of the underclasses in general. In any agrarian setting, the crux of that are land reforms, such that the landless and those at the margins have basic access to the most important means of production. Land reforms needs to be fulcrum of any longer-term struggle in thinking about coping with climate change.

4. Equity and Water: Reviving the Notion of the Commons: Equity around access to water, both for drinking and for irrigation, is one the central ways of helping the majority cope with climate change. As far as water is concerned, any of the relevant measures listed above would be undermined if the current unequal water arrangements continue, because excess extraction by elites would ensure that any improved water supply would be promptly sucked out.

The greater distribution of water in north Gujarat in particular occurred through the development of water markets, something that is essentially iniquitous. It is the responsibility of governments — in which they has sorely fallen short thus far — to create the infrastructural frame for a more equitable access to water that does not rely on the market, but on a better regulatory framework instead. In this, they need to reverse the bias in favour of the elites by ensuring that public wells are dug in the poorest *tolas* and bastis, and they have access to water in times of delayed rains. But even this would not halt the profligate use of groundwater by landed elites, and hence restrictions of groundwater tapping by elites ought to be enforced more strictly.

The onus cannot be on government alone. Equitable arrangements need to be put in place at the community level, and can obviously only be the end result of sustained struggle. For equity to function and sustainability to thrive in the medium term, one would need to revive the notion of the commons. In this specific context, groundwater is central, to view it as a shared resource for all in the present and for the future, that hence needs nurturing. Such nurturing would mean a combination of things: of restricting drawing out to what is renewed each year; to move away from water-intensive cash crops, and limiting the excessive use of fertilizers that need more water.

A tried and tested technique for the reduced use of water is the System of Rice Intensification (SRI). SRI avoids the continuous flooding of fields that is central to conventional rice growing practices. Instead, under SRI, the rice field is merely kept moist, or an alternate wetting and drying method is practised. It has been suggested that these techniques improve root development and "provide better soil aeration". And since the spacing between individual plants is more under SRI, plants enjoy better access to soil nutrients,

sunlight and benefit from higher leaf area index at the time of flowering. So despite fewer plants per unit area, yields have been shown to be higher than conventional rice practices. Whereas yields are a matter of ongoing debate, there's no doubt that SRI involves less use/waste of water and other inputs such as petro-based fertilizer, hence also reducing input costs. One study in West Bengal showed plants under SRI were also better equipped to cope with drought. It is hence not surprising that SRI is being practised by 1.5 million farmers in at least 39 countries (Amod K. Thakur, 'Critiquing SRI Criticism', *Current Science*, May 2010, pp. 1294-99). This includes SRI on 34,000 hectares in Tripura and also on extensive lands in Tamil Nadu. It clearly needs greater active encouragement for it to be adopted more widely.

Central to the shared notion of the commons is the concept of equity. One movement around the sharing of water and that has acquired resonance in different parts of the country is the pani panchayat movement. Originally led by Vilasrao Salunkhe in Maharashtra in the mid-1970s, it involved the relatively equitable distribution of water around a lift irrigation society in Purandara taluk of Pune district. It must be pointed out that pani panchayats have not always led to its proclaimed aims of water equity — P. Sainath has written scathingly of its limitations towards this end in Orissa ('Less Pani, Less Panchayat', *www.indiatogether*, October 2002). It has also been pointed out that pani panchayats do not address the question of the landless' access to water. Notwithstanding these flaws, there's a lot in the pani panchayat notion that is relevant. The pani panchayat in Maharashtra included a self-imposed ban on water-intensive crops of the region such as bananas and sugarcane, only community irrigation schemes, and no individual wells in the command area.

Equity in the tapping of groundwater would also mean snapping the link between access to land and access to water. How does one have arrangements in place at the community level that ensure that even the landless have a right to water? This question, among others, was addressed by a series of progressive movements around a more equitable distribution of water in southern Maharashtra. This began in the 1980s, led by the Mukti Sangharsha Chalval and Shramik Mukti Dal, which demanded: one, equitable distribution of water; two, in drought-prone, low rainfall areas, "using dam water to supplement ground and surface water made available through local watershed development". Their third main demand of rehabilitation of dam oustees enabled the movement to get wider support. It began with the construction of a 120-metre long, 4.5 metre high Baliraja Dam, but a crucial part of building this dam was equity in the water distribution and moving to a cropping pattern that would need less water. In 1989, this extended to a successful demand for equitable distribution around a lift irrigation scheme, which would cover families residing in 60 villages to irrigate 60,000 hectares. Then, in 1993, the movements widened into a broad front: a rally of 25,000 people in Aatpadi taluk demanded equitable distribution of water from two dams. Within a few years, "the movement for equitable distribution of dammed water spread to 13 talukas in the

low rainfall zone of Sangli, Satara and Solapur districts (Anant Phadke and Gail Omvedt, 'The Anti-drought Movement in Southern Maharashtra', p. 9). A subsequent struggle led by the Shramik Mukti Dal in 2004 got the Maharashtra government to agree to redrawing water distribution of canal schemes in three taluks "if people in a taluk form water-users' societies and decide to redistribute water amongst themselves equitably" (Anant Phadke, '*Thiyya* Agitations in 2004-05', *EPW,* 21-27 February 2004, pp. 775-777).

Though the context was different, there is much in this movement around water there that is relevant for our current concerns, in particular the notion of equity that enabled the widening support. Two, their demand for equitable water distribution incorporated a limit in the volume of water per person irrespective of the amount of landholding that person possessed. Hence, interestingly, the movement included small farmers, peasants and landless agricultural labour. With the right to water, the landless would lease in land from those who had excess land but no water, and till the land. This has enormous potential both for landless agricultural labour and in particular for poor women. Three, there was the acknowledgement to shift to cropping patterns that would be more sustainable in the long run.

To conclude: The need for an alternate development trajectory

Our notion of the commons needs to extend beyond water; at the largest level, to the Earth itself, which has been pushed into multifaceted crises. Climate is only one in a range of interconnected ecological crises humanity has created and faces. A study in the journal *Nature* examined nine indicators: rate of loss of biodiversity on land and at sea; stratospheric ozone depletion, ocean acidification, global freshwater use, global warming, the nitrogen and phosphorus cycles, chemical pollution, atmospheric aerosols and changes in land use. It concluded we had worsened in all nine systems and had already crossed safe boundaries in three of them, including the rate of loss of biodiversity and global warming (Johan Rockstrom, et al, 'A Safe Operating Space for Humanity', *Nature*, 24 September 2009, pp. 472-475).

In the course of the last few years, we have often encountered people who have told us, warming has always happened in the past, what is unique about this phase? It is true that carbon has been central to life, and warming has happened before cyclically. But the speed at which we are spewing carbon dioxide into the atmosphere and drowning it in increasingly acidic oceans has little precedence. Over tens of millions of years before the current phase, CO2 used to go in and out of Earth's ecosystems at 1 ppm every 10,000 years. We are now spewing it at over 2 ppm a year, 20,000 times the long-term average rate. Earth's history has shown that subsystems tend to react in a non-linear, abrupt fashion. Because of feedbacks in the climate system — which have already begun to occur — we have very little time to ensure that it does not spin out of our control.

Safety would entail that carbon dioxide emissions be brought down to below levels the Earth can safely absorb. A very basic notion of equity would entail that this level be distrib-

uted equally to everybody. Hence, though dealing with its impacts are very important, far more so than it is usually granted, the issue of attempting to tackle global warming goes far beyond that. It raises questions about how production is organized, what is produced and for whom. It forces us to think about urban consumption — from which 70 per cent of carbon emissions emanate — and about the movement of goods and people over large distances, on which modern economies and ways of life are based. Alternatives would need to include decentralized energy, in production so it is sustainable and in distribution, so people have control over how that energy is used.

Many of the so-called solutions to global warming — technology, greater efficiency, etc — tinker with the problem at best, and more likely underestimate the gravity and urgency of the problem. Global warming forces us to rethink our entire development trajectory itself. In this we have to overcome our own inertia, the inertia of the system, and the vested interests who are trying their best to prove the science wrong or resist change. The need to tackle global warming hence becomes part of a larger struggle for change. It has its specifics — dealing with impacts are part of them — but it needs to be seen as part of larger struggles for equity, as much as there is the need for existing movements to incorporate it in their long-term visions.