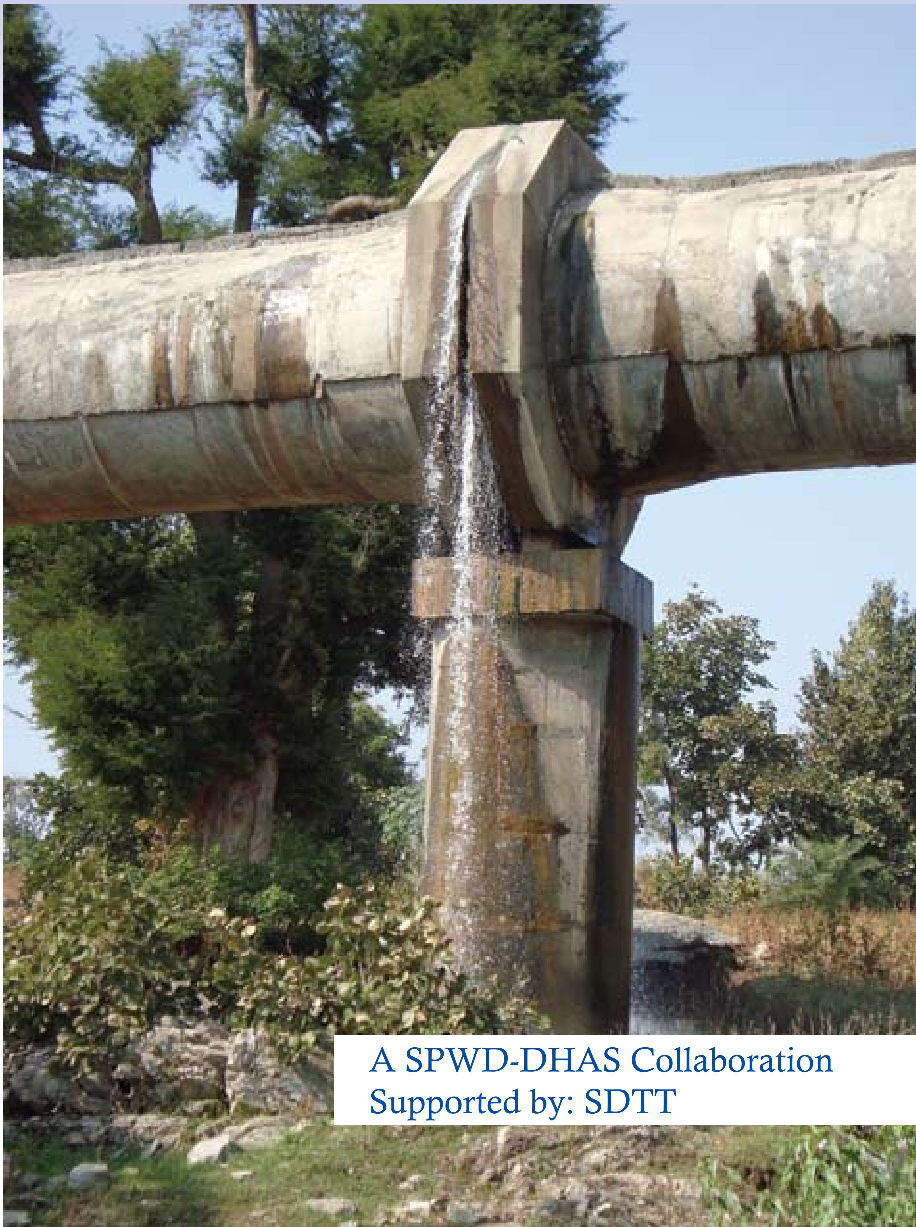
Neither Water Nor Governance

Water Governance in Man River Basin

Rahul Banerjee



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Dhas Gramin Vikas Kendra

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Preface

Bhil tribals of the western Madhya Pradesh region in India began fighting in an organized manner for a second time from 1982 onwards for the rights and entitlements that were guaranteed to them in laws and policies but were being denied them in practice. Especially as the region is notified under the provisions of the Fifth Schedule of the Indian Constitution, the Bhils theoretically can organize themselves in small Gram Sabhas to implement suitable local area development that enhances their livelihoods and their political power under the provisions of the Panchayat Extension to Scheduled Areas Act 1996 (PESA). However, despite an earlier militant organized mass movement called the Lal Topi Andolan that had a wide mass base in the region from the 1930s, the Bhils were subdued by a combination of cooption and repression by the state by the 1970s (Banerjee, 2008a). Nevertheless, it was felt that the renewed mobilization would be able to put pressure on the government to deliver on all the beneficial laws and policies and erase the state of poverty and powerlessness in which the Bhils lived due to the oppression of non-tribal traders and government staff. Mass organizations like the Khedut Mazdoor Chetna Sangath (KMCS), Adivasi Mukti Sangathan (AMS), Jagrit Adivasi Dalit Sangathan (JADS) and Adivasi Shakti Sangathan (ASS) were formed for the purpose. However, even though the oppression by local non-tribals was overcome very soon it became evident that there were more powerful forces at play in keeping the Bhils disempowered. The government itself at the highest level had no intention of implementing the Constitutional provisions as they went against the centralized resource extractive development paradigm that had been adopted for the country as a whole since independence. Not only was the development of big dams on the River Narmada and its tributaries forced down the throats of the Bhils but they were also not allowed to implement the powerful provisions of PESA which makes the tribal Gram Sabha, defined as the small community that lives together in a hamlet that may be smaller than a village, the most powerful body with respect to all social, economic and political matters in scheduled tribal areas.

Consequently most of the time of the organizations was spent in fighting losing political and legal battles against the state. Clearly the wait for a change in policies of the government would be a long one and in the interim the situation of the Bhils would keep deteriorating by the day. So it was decided to form a trust named Dhas Gramin Vikas Kendra (DGVK) to implement small communitarian forest, soil and water conservation projects and carry out research on the various problematic issues thrown up by the ongoing struggles. Here too the smallness of the organization compared to the state has proved to be an impediment. Watershed development, implemented in small watersheds in dry hard rock areas with relatively high population density, has limited scope for ensuring sustainable livelihoods even with the best community mobilization (Kumar et al. 2008). Thus, there is a need to undertake planning and implementation of water resource management of a larger unit that can provide a big enough base for integrated resource conservation and use and the initiation of non-farm value addition activities to capitalize on the higher bio-mass production arising from conservation efforts. The National Water Policy 2002 also lays stress on such holistic and aggregative water resource management (GOI, 2002).

This is the context in which the present study of water governance in the Man river sub-basin of the Narmada river basin has been undertaken in collaboration with the Society for Promotion of Wastelands Development (SPWD). The characteristics of the Man river sub-basin which make it ideal for such a study of water governance are as follows:

- The basin spans the three distinct agro-ecological zones of the Malwa plateau, Vindhya hills and the Nimar plains.
- There is a serious problem of over extraction of groundwater in the basin.
- There is a large dam in the basin affecting water governance drastically.
- There is a significant tribal population in the basin.
- Considerable soil and water conservation work has occurred in the basin.
- The basin has a considerable reserved forest area which is mostly degraded.

Conservation of water, soil and forests and the promotion of organic agriculture and associated non-farm localized industry have together become the most successful mode of ensuring sustainable development in hilly dry land and hard rock areas which are physically water scarce as exemplified by Hiware Bazaar Panchayat in Maharashtra among others (Sakhuja, 2008). This also ensures that the global problem of mitigation of climate change is addressed effectively (IISD et al. 2003). The challenge is to replicate these successes at a larger level. Given the present acute scarcity of water, its management can no more be left to individual vagaries or market forces and so over the past decade and a half or so, since the United Nations Environment Conference in Rio de Janeiro in 1992, the role of state or communitarian governance of water resources has come to be emphasized. Since the availability and use of water is also determined by other constituents of the ecosystem and the socio-economic system, water governance necessarily implies overall ecosystem governance. Thus water governance is a multi-disciplinary exercise involving the technical, socio-economic and political aspects of the availability and use of water. It has to be undertaken in an intermediate unit of a sub-basin that is larger than a watershed but not as vast as a river basin so as to ensure both genuine people's participation and long-term sustainability.

Firstly, the problem of governance begins with the proper estimation of the availability and use of water in a sub-basin. Unless it is known with a reasonable amount of accuracy what is the amount of water available and how much is the current use, planning and governance will not be possible. The methodology developed so far for assessing water resource use and availability is varied and still changing because of the difficulties of quantification. The natural processes that govern the storage and flow of water, both surface and sub-surface and the social and economic factors that influence its use are not easily modelled through mathematical formulae. Even if attempts have been made using partial differential equations in recent years an immense amount of reliable data needs to be collected and analyzed to find solutions to them. Such data collection and analysis whether on the ground or through remote sensing is very time-consuming and costly. So from the beginning empirical methods have been used which provide only a very rough estimate and are biased in one way or other depending on the purpose for which hydrological estimation is being done.

Like in the case of the rest of India, in Madhya Pradesh too the purpose of hydrological estimation by the water resources technocracy was mainly to support the building of big dams to provide canal irrigation to external input intensive agriculture. Traditionally, however, the agriculturists of this region had adapted to local agro-climatic characteristics and made the most use of the soil moisture and conserved the ecosystem to ensure a sustainable output. The scenario changed drastically from the decade of the 1970s with the introduction of an intensive agricultural system involving the use of external inputs such as hybrid seeds, chemical fertilizers, pesticides and irrigation either through canals from dams or through groundwater extracted with pumps. This system was heavily subsidized with respect to the costs of all these external inputs. Economically powerful interests were in favour of such centralized agriculture and dam building and so this was promoted by the political elite. This change initially achieved higher yields and production but with time the ecological limits of this kind of agriculture have been reached and it is now plagued with falling yields, decimation and pollution of natural resources and a financial resource crunch.

The water resources technocracy, the powerful economic interests and the political elite that have benefited from such an unsustainable use of water and public funds unfortunately refuse to acknowledge that it is their policy of environmental profligacy that has resulted in the present situation of scarcity and continue to press for big size reservoirs for irrigation and power generation as part of an even more grandiose plan of linking the country's rivers (Islam, 2006). Thus, in practice not much attention has been given to the collation and analysis of micro-level data for accurate estimation of water availability and use. Consequently the hydrological analysis methodology used by the water resource technocracy in actual practice for estimating both surface and sub-surface water flows at the basin level are even today of an approximate empirical nature with huge margins of error geared towards approximate calculation of aggregate flows of rivers. Hydrological estimation methodologies at the watershed level too are empirical but are more accurate due to greater data collection and the smallness of scale. However, they cannot be used for higher levels without substantial errors creeping in and costs increasing.

The first challenge in water governance, therefore, is to develop more accurate methods of estimating water resource use and availability at the sub-basin level which are at the same time cost effective. In this study a methodology has been developed from studies done earlier in other basins to assess in a comparatively rigorous and fairly cost-efficient manner the availability and use of water resources in the Man river sub-basin. The results of this analysis show that the availability and use of both surface and sub-surface water and electricity is highly unsustainable. A review of the performance of the Man dam reveals that it has failed to fulfill most of its design targets primarily because of bad design and subsequent worse implementation. Consequently there is a need for a drastic reorientation of water resource management and agriculture in the basin. To this end a pilot programme of dryland wheat cultivation with less requirement of water was carried out in some farm plots. The results show that this is both economically and environmentally more sustainable than the cultivation of high yielding varieties.

Secondly and more importantly, owing to this lack of a realistic estimation of water scarcity and its long term consequences by the water resource technocracy in pursuance of its big dam building aspirations, the people in general have not really woken up to the severity of the scarcity of water and other natural resources that they face. So, mainly, they continue to manage both natural resources and agriculture which is the main sphere of the use of these resources in most basins, in ways which are unsustainably resource extractive. Successive governments too, under the compulsion to win elections, have been forced to pander to this misguided popular perspective, created by the earlier adoption of wrong policies with regard to agriculture and natural resource management, by continuing to subsidize these wrong resource use policies. This has further aggravated the ecological and fiscal crisis. So much so that there are very few takers of the alternative dry land wheat programme that was initiated as a possible remedial measure as part of this study.

Not surprisingly this has given rise to a vicious circle of technological and political mis-governance at the national and state levels leading to injudicious natural resource use at the local level which in turn puts popular pressure for more such mis-governance at the higher levels. Matters have been compounded by the fact that this ecologically fatal fascination with gigantism with regard to water resource management still bedevils the World Bank's thinking, which continues to support big dam building in the country even though it does recommend more sustainable use of groundwater also (Briscoe & Malik, 2006). The net result is that grassroots water governance has suffered and watershed development committees and water user associations are mostly dysfunctional.

Furthermore, Panchayati Raj has for all intents and purposes become an appendage to the centralized state system instead of being a vibrant institution of direct democratic grassroots governance of natural resources for sustainable development. The Gram Sabha which theoretically has tremendous powers to ensure proper natural resource management in scheduled tribal areas is at present totally powerless and neglected. Consequently, not only has the potential of the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) for sustainable natural resource augmentation and management and biomass based sustainable development remained largely unrealized but what is even more of a concern, customary communitarian natural resource management which was traditionally a great strength of Bhil tribal society has decayed almost to the point of non-existence in the sub-basin. This has further exacerbated the negative impacts of state policy failure. This injudicious policy of subsidies has also distorted the functioning of markets by encouraging a deleterious culture of leakages and thefts. So, if markets are to efficiently allocate increasingly scarce natural resources much better communitarian governance is a must.

Thus, good water governance involves proper data collection and estimation regarding the prevailing water availability and use. If these are found to be unsustainable then the initiation of policies that will facilitate a reorientation of both agriculture and natural resource management towards enhancing water availability and ensuring sustainability of its use are a must. This has to be achieved through a stress on genuine communitarian management of these scarce resources and a better targeting and delivery of subsidies and grants so as not to distort the functioning of the market. Clearly, this is difficult and uncharted territory and the present study has been more of a learning exercise to get to grips with this problem. The insights gleaned from the grassroots mass organization process of the Bhils over the past two and a half decades have been combined with the findings from the present study to chart out an appropriate course for sub-basin level water governance in dry hard rock areas and the following major recommendations have been made in conclusion -

- Farms have to be assessed for their soil quality and suitability for various kinds of crops and research, credit and marketing support provided for cultivating them. All these are crucial as without a reorientation at the policy level it is very difficult to initiate changes in cropping practices at the ground level. Currently there is a woeful lack of data, research, credit and marketing support with regard to water conservative crops in the basin in particular and the country as a whole in general.
- There is need for calculating the “virtual water” embedded in a particular crop being produced in an area. Even though there are some problems with the calculation of virtual water at the moment , these can be overcome to reveal a true picture of the water embedded in different types of crops. This can be used as an advocacy tool to convince people to change consumption patterns towards lesser virtual water crops so that the demand pattern for crops also changes and it becomes easier to ensure more sustainable water use in agriculture.
- Measures have to be taken to increase the sustainable water availability through soil and water conservation and afforestation and reduce water consumption through greater reliance on the use of in situ soil moisture. The MGNREGS provides the best option for ensuring this and so steps have to be taken to improve its functioning to make it realize its goal of conserving and enhancing the natural resource base of the basin. Panchayati Raj, MGNREGS, PESA and the Scheduled Tribes and Other Forest Dwellers (Recognition of Rights) Act 2006 must be synergized to revitalize communitarian natural resource management as a solution to unsustainability of water use. Care should be taken to ensure that women participate equally in these efforts.
- Biomass-based local farm manuring and energy production has to be encouraged to reduce fertilizer application, enhance soil quality, soil depth and water retention and reduce the use of fossil fuel-based

energy. In the initial stages this also needs to be provided grant support as a considerable amount of labour has to be expended in this activity. This too could be included under the MGNREGS.

- A thorough revamping of the working of the Man dam has to be done to increase its economic and environmental usefulness from the present negative status.
- All of the above have to be combined in an integrated people-centred plan at the sub-basin level so as to optimize sustainable resource use while at the same time ensuring a decent livelihood for the people. Such plans have been drawn up for specific basins but have not been implemented primarily because they involve a redirection of subsidies and grants from the presently prevailing system of unsustainable agriculture to the proposed newer system.
- Serious thought has to be given to the methods in which grant and subsidy support are to be given to farmers and the poor, including those involving direct cash transfers so as to ensure that leakages do not take place and the market can function in an efficient manner to allocate scarce resources.
- Given that carbon trading has gained in acceptance, efforts should be made to get carbon credits for the poor in all the above efforts especially in the scheduled tribal areas.

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Study Report of Water Governance in the Man River Basin 2009

The field of study and analysis of water governance in river basins is still in its infancy. There are no well developed research designs and survey methodologies for conducting such a study. Thus the present attempt to study water governance in the Man river basin is of an exploratory nature. More so because the area is being so studied for the first time. The report begins by discussing the relevance of the new concept of Integrated Water Resource Management (IWRM) to water governance in river basins. It then sets out the reasons for the choice of the basin, its characteristics, the problems encountered with computation of water balance, the revised methodology of estimation of water use developed to suit the present study, the results of applying this methodology, a political economy analysis of the prevailing water use in the basin, the results of an experiment to make water resource utilization for agriculture more sustainable in the basin, a review of the performance of the Man dam and an analysis of the interface between the government, community and market. Finally the report sets out a course for the future in the conclusions.

1. INTEGRATED WATER RESOURCE MANAGEMENT

The western Madhya Pradesh region is a naturally water scarce region due to four characteristics that are peculiar to it -

- The average annual rainfall is low being around 700mm with the number of rainy days being around 50.
- The soil is mostly clayey and so infiltration of rain water is low. Moreover such soils tend to get waterlogged if subjected to flood irrigation.
- The underlying rocks are basaltic and sedimentary having low porosity and permeability and so their capacity to store water in underground aquifers is limited.
- The average evapo-transpiration rate for the area is very high at about 2100 mm and so a considerable amount of the rainfall evaporates immediately. In the dry periods during the monsoons and later the moisture retained in the soil evaporates. A substantial amount of the water stored in surface storages big and small too evaporates.

Agriculture is the largest consumer of water in the region. Thus it will be necessary to study the development of agriculture to understand the use of water in the region. Under centralized planning for the agricultural sector after independence and especially since the decade of the 1960s, an agricultural regime was promoted that ensured higher productivity in the plains areas upto the decade of the 1990s based on subsidized supply of external inputs like water, power, hybrid seeds, chemical fertilizers and pesticides. This initially increased yields and production phenomenally but has now become problematic as will be discussed in detail later. This concentration on productivity through artificial means in the plains areas has also meant the neglect of the more widespread dryland agriculture in the hilly upper watersheds which are mostly inhabited by the Bhil tribals. With regard to water use this has meant the over exploitation of groundwater aquifers and the near total neglect of soil and water conservation measures in the upper watersheds. The lack of adequate soil moisture is the major constraint on agricultural productivity in dryland areas (Benites and Castellanos, 2003). Not surprisingly the unsustainable use of natural resources, especially water, has led to a retrogressive deterioration in both their stock and flow and the quality of human resources causing the rural economy and culture to fall into crisis and this according to Dasgupta is a nationwide problem (Dasgupta, 1993). Thus, the proper conservation and equitable utilization of water is the most important determinant of agriculture in dryland areas and the key to the revival of the environment and economy of western Madhya Pradesh (Shah et al. 1998). Rahul and Nellithanam have contended that the vast majority of farmers in western Madhya Pradesh cultivate small plots of land on terrain that is unsuitable for flood irrigation and they have traditionally been driven by the desire to produce for subsistence rather than for profit (Rahul & Nellithanam, 1998). They add that over thousands of years these farmers had developed a system of agriculture that made the most of the locally available resources in terms of seeds, organic fertilizers, soil moisture and natural pest management and shown that these methods are more cost-effective in the case of dry land varieties. Vijayshankar has outlined the policy changes necessary to bring about a revival of agriculture in Madhya Pradesh on these lines (Vijayshankar, 2005).

Given these problems arising out of the neglect of dryland agriculture, forest conservation and small-scale water harvesting and recharge, scholars and practitioners of development began trying to find solutions (TWN, 1990). This led to the adoption of Watershed Development (Vaidyanathan, 1991) and Joint Forest Management (Poffenburger and McGean, 1996) at the grassroots level in the decade of the 1980s. Chambers drew the attention of development practitioners to the woeful lack of involvement of the people themselves in planning and implementation and suggested new methodologies to correct this serious anomaly (Chambers, 1983). Later there was a rethinking at the beginning of the decade of the 1990s all over the country with regard to the implementation of watershed development leading to the "ridge to valley" approach as opposed to the treatment of isolated areas and the active involvement of the beneficiaries in planning, implementation and post-project maintenance of the created structures (Shah, 1993, GoI, 2006).

The Government of Madhya Pradesh initiated the ambitious Rajiv Gandhi Watershed Development Mission (RGWM) in 1994 incorporating these new ideas by pooling all the funds being made available to it by the Government of India for poverty alleviation and treatment of drought-prone areas under various schemes. This increased stress on watershed development on the part of the Government of Madhya Pradesh came from the realization that since the state is situated across a drainage divide involving as many as six river basins, the terrain is undulating and is underlain by hard rock and so water storage in the natural system is low. Moreover the state has only a limited share in the river waters because it lies on the upper catchment of the six basins as noted in the review of the programme done by TARU (RGWM/TARU 2001). However, the review also noted several problems in the implementation of the programme notably that of a lack of adequate people's involvement and empowerment. Moreover, Kerr has pointed out the problem of externalities within and without the small watersheds arising from larger societal and agro-ecological considerations (Kerr, 2002). This is in fact the most important criticism of local area watershed development. Even in the case of very successful communitarian watershed development efforts, as in Alwar by the Tarun Bharat Sangh, the increase in yields have not been substantially above the Indian average while downstream water availability has been adversely affected bringing down yields there. (Sharma, 2002).

Scholars have also noted the problems arising out of the mismanagement of dam irrigation on the one hand (Dharmadhikary, 2005) and the consequent over dependence on groundwater for irrigation purposes on the other that has led to a serious crisis of over exploitation of groundwater in large areas of the country (Chatterjee & Purohit, 2009) and also an increasing inequity in water usage among the rich and the poor arising from the creation of water markets (Prasad, 2002). Concerns such as these have led to the conceptualization of participatory integrated resource planning for the empowerment of the poor and management of natural resources for ensuring sustainable livelihoods (Chambers et al. 1989).

Another major concern is that the vast majority of the poor in India live at subsistence levels, with high population density and inequitable access to resources and this is incompatible with the achievement of overall human development within small micro watersheds. Thus even if successful implementation of micro level watershed development may ensure better management of natural resources this might still not ensure sustainable livelihoods for the majority (Banerjee, 2009). Thus the need arose for considering bigger planning units which would allow for diversification of livelihoods, equitable access, wider political mobilization and provide opportunities for optimal cross watershed sharing of natural resources.

Once a larger unit than a watershed is considered for water resource management immediately the question of water governance assumes paramount importance. Given a situation in which water resources are becoming increasingly scarce combined with the failure of the market and centralized regulatory mechanisms to ensure equitable and sustainable use of this scarce resource, the importance of decentralized people's governance and the institutional mechanism through which this will be achieved comes to the fore. Presently, at the behest of the international funding agencies more concerned with cost recovery of water distribution systems of big dam projects, the push is for participatory irrigation management and many state governments have faithfully passed legislation in this regard. However, for true water governance the complete harnessing of water resources and their use has to be considered from the poor people's point of view and this means the evolution of people's institutions and practices rather than the adoption of handed down agenda.

Following on the World Environment Conference in Rio de Janeiro in 1992 the concepts of River Basin Management and Integrated Water Resource Management (IWRM) to make possible more holistic planning of water resources came into vogue and a Global Water Partnership was established to push these ideas for adoption in the water sector on a wider scale (GWP, 2000). However, scholars and practitioners have criticized this concept for being narrowly underpinned by neo-liberal principles, dominated by technical and managerial concerns and concentrating on the marketability of water. The inequity of distribution and the politics associated with it have been ignored serving only to legitimize the prevailing governance mechanisms. These critiques have questioned the applicability of IWRM in Third World countries like India (Jairath & Ballabh, 2008). Subsequently there is at present an ongoing attempt to redefine and reformulate the concept to make it suitable to the management of natural resources and sustainable development in Indian conditions (Shah & Prakash, 2007). Mollinga treats it as a boundary concept which is still evolving out of the negotiations regarding its meaning between different stakeholders (Mollinga, 2006). Thus a modified IWRM framework with adequate attention to the pro-people social and political aspects can be used for the initiation of water governance in a river basin. The National Water Policy of 2002 also lays stress on IWRM - "Water resources development and management will have to be planned for a hydrological unit such as drainage basin as a whole or for a sub-basin, multi-sectorally, taking into account surface and groundwater for sustainable use incorporating quantity and quality aspects as well as environmental considerations" (Section 3.3, GOI, 2002). Even though the policy does not explicitly mention this people's informed involvement at the grassroots in such planning is most essential for its success.

There is consequently a clear case for the undertaking of a rigorous estimation of the status of natural resources, the sustainability of their use and the causes that have led to the present situation in dry land areas at an aggregative level bigger than a micro-watershed as a prelude to pro-people planning and implementation of a holistic water governance programme as no such exercise has been done yet. The ideal unit for such an exercise is a sub-basin, as a larger unit will not only require large resources for data collection and analysis but also make it difficult to ensure informed participation of the people in governance. This is the rationale behind the present exercise as expressed by the Water Governance team of SPWD - "The aim of this programme on Water Governance and Livelihoods is to develop a methodology for taking into account the particularities of the livelihood systems, agrarian structure and institutions in the various regions (basins) for planning for water in a sub-basin assuring minimum livelihoods for all, building capacities of community organizations on water governance and contributing to policy dialogue" (Singh, 2007). Since the availability and use of water are linked closely with other constituents of the ecosystem and socio-economic system of a particular area, so the detailed study of the governance of this resource will involve a study of the whole eco-system and socio-economic system of the area.

The overall study is being conducted in six sub-basins in the three states of Andhra Pradesh, Maharashtra and Madhya Pradesh so as to cover most of the agro-climatic and hydro-geological diversity of the dry hard rock regions of peninsular India. Two sub-basins have been selected in each state for the purposes of this study. One of the sub-basins selected in Madhya Pradesh is the Man river basin while the other is the Kalimachak river basin, both being tributaries of the Narmada river. The methodology adopted for the study at the sub-basin level within a broad IWRM framework is as follows (Singh, op cit) -

- Identification and classification of institutions directly mediating human interventions for meeting water needs.
- Scientific estimation of water availability and use and gauging their efficiency and ecological sustainability.
- Understanding the underlying socio-economic and political factors governing water availability and use and the equity of institutional mechanisms.
- Involving the people of the basin in the study process so as to broad-base the knowledge gained and facilitate good water governance.

2. CHOICE OF BASIN

The basic objective of the present research, as mentioned earlier, was to study water governance in a medium sized river basin that is bigger than a watershed and smaller than a large river so as to overcome the isolation of small watersheds and dispense with the errors arising out of planning on the basis of generalizations of large river basins. Thus the target was a river basin of a size of between 50,000 to 1,00,000 hectares. Moreover, there had to be problematic issues of water governance in the basin which could be studied and analyzed for generating insights and guidelines that could be important for both grassroots and policy level interventions in future. Since the World Bank funded Water Sector Development Programme in Madhya Pradesh (World Bank, 2004) has been looking into the issue of water governance, among other things, in the rest of the river basins in the state this project decided to concentrate on the Narmada river basin. The Man river basin was chosen because of the following unique characteristics which made its study both challenging and interesting -

- The basin spans the three distinct agro-ecological zones of the Malwa plateau, Vindhya hills and the Nimar plains.
- There is a serious problem of over extraction of groundwater in the basin arising mainly from the cultivation of high yielding varieties of wheat.
- There is a large dam in the basin affecting water governance drastically in the catchment and command areas.
- There is a significant tribal population in the basin which is mostly dependent on subsistence agriculture on small farm plots and its proportions in the different agro-ecological zones is different thus providing an opportunity to segregate tribal and non-tribal resource use.
- Considerable soil and water conservation work has taken place in the basin but its impact has not been as expected.

- The basin has a large reserved forest area which is mostly degraded as there is not much communitarian protection going on.

The construction of the dam on the Man river faced opposition from the oustees who were mobilized by the Narmada Bachao Andolan. Thus, this added an interesting social and political dimension to the study of water governance in the basin. Moreover, the influence of the mainstream political parties is greater in this basin compared to other predominantly tribal areas of western Madhya Pradesh and so the effects this has had on communitarian grassroots mobilization for natural resource conservation could also be studied.

3. GEOGRAPHICAL CHARACTERISTICS OF THE MAN RIVER BASIN

The Man river rises in Lunehra village in a tank called Man Sarovar on the Malwa Plateau and then flows for about 12 kms eastwards before plunging down the hilly escarpment of the Vindhya range for 35 kms upto the Man dam at Zirabad. Thereafter it flows for a further 44 kms through the Nimar plains to its confluence with the Narmada at Kothra village. The map of the basin showing the three distinct agro-ecological regions, the tributary rivers, the reserved forest area, the Man dam location and the two main towns is given in Fig. 1.

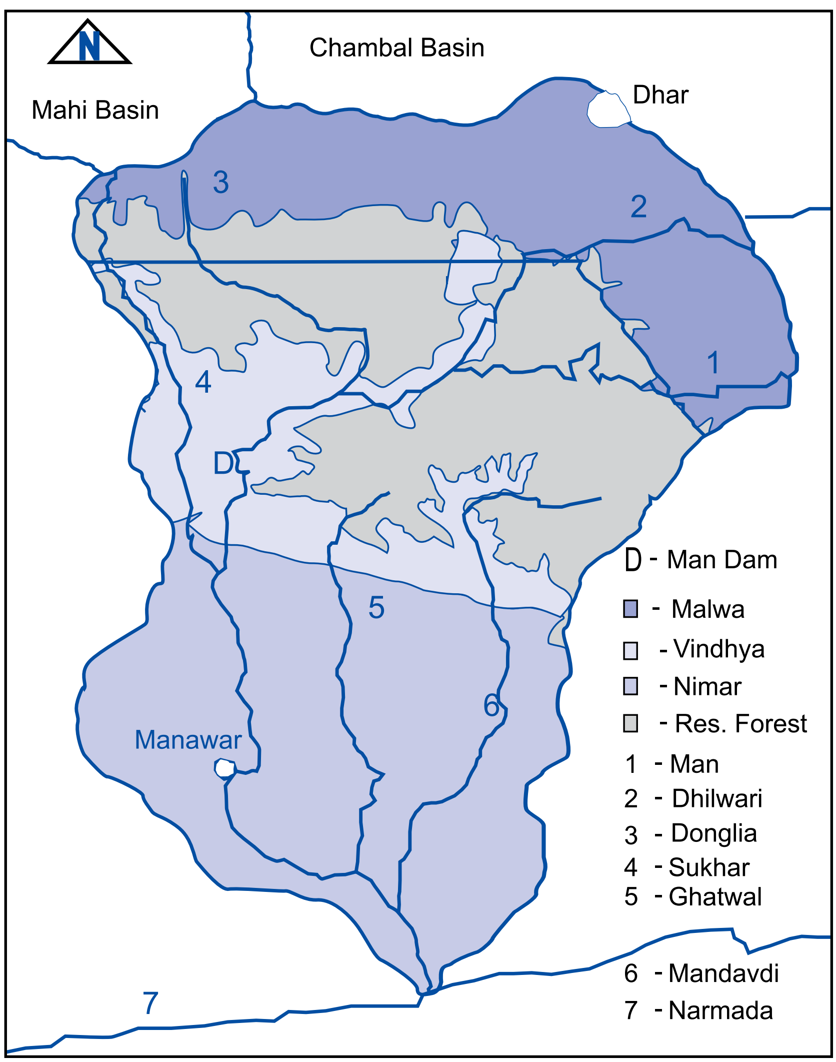

Fig. 1: Map of Man River Basin with Rivers and Agro-Ecological Zones

The geographical characteristics of the Basin have been summarized in Table 1 below.

Table 1: Geographical Characteristics of Man River Basin

	Malwa	Vindhyas	Nimar
Mid Latitude	22^035	22^025	22^01
Mid Longitude	75^008	75^008	75^008
Ht. above MSL	560 m	450 m	220 m
Rock structure	Basalt	Granite & sandstone	Granite
Soil	Clay & sandy loam	Sandy loam & alluvium	Clay, sandy loam & alluvium
Rainfall	913 mm	738 mm	711 mm
Avg. PET	2100 mm		

Source: District Statistical Handbook 2009, Dhar.

There is a steep drop from the Malwa plateau to the Nimar plains in the form of spurs of the Vindhya range of about 340 metres. The Malwa plateau, which extends about 10 kms at the top of the basin is underlain with basaltic rocks known locally as the Deccan Traps. These rocks are of low porosity and permeability and have water retention capacity only in the fractures and faults. The Vindhya area, extending about 10 to 20 kms in the centre of the basin, is made up of granite and sandstone which have slightly better water retention and permeability. The Nimar region, extending about 15 kms at the bottom of the basin, is underlain with granite. The soil is mostly rich black cotton clay in the Malwa region with some lateritic sandy loam, while in the Vindhya region it is mostly sandy loam with some deposits of black cotton and alluvial soils in the valley of the Man river just above the Dam at Zirabad.

The Nimar region has an equal mixture of black cotton clay and sandy loam soils with some deposits of alluvial soils along the river valleys. The rainfall is fairly heavy on the Malwa Plateau and most of this water flows down into the dam. However, the rainfall occurs mainly in the monsoon months of mid-June to mid-September and the number of rainy days is on an average only 50. The average potential evapotranspiration rate for the area is high at about 2100 mm. Consequently the soil moisture zone remains completely dry for about 90 days in the summer period. The whole basin has been classified on the Thornthwaite system of climate classification as a transitional ecosystem of moist semi-arid and dry sub-humid type with an index (-) 41.9 (Tamgadge et al. 2001). The contribution of the sub-basins to the area of the Man basin is given in Table 2 below.

Table 2: The Contribution of Sub-basins of the Man River Basin in Ha.

	Malwa	Vindhyas	Nimar	Total
Man	7943	23875	28931	60749
Dilawari	11330	4850		16180
Donglia	7488	15930		23418
Sukhar	2387	8243	475	11105
Ghatwal		3743	10238	13981
Mandavdi		10462	11925	22387
Total	26761	69490	51569	147820

Source: Calculation from Survey of India Toposheets.

The Vindhya region contributes the most to the flow in the basin and its topography being hilly and covered mostly with degraded forests and cultivated land, the water runoff and sediment load are both high. The 69000 ha catchment area of the Man dam is constituted by the Donglia, Dilawari and Man river catchments. The map detailing the sub-basins and the catchment and design command (15000 ha) areas of the dam is given in Fig. 2.

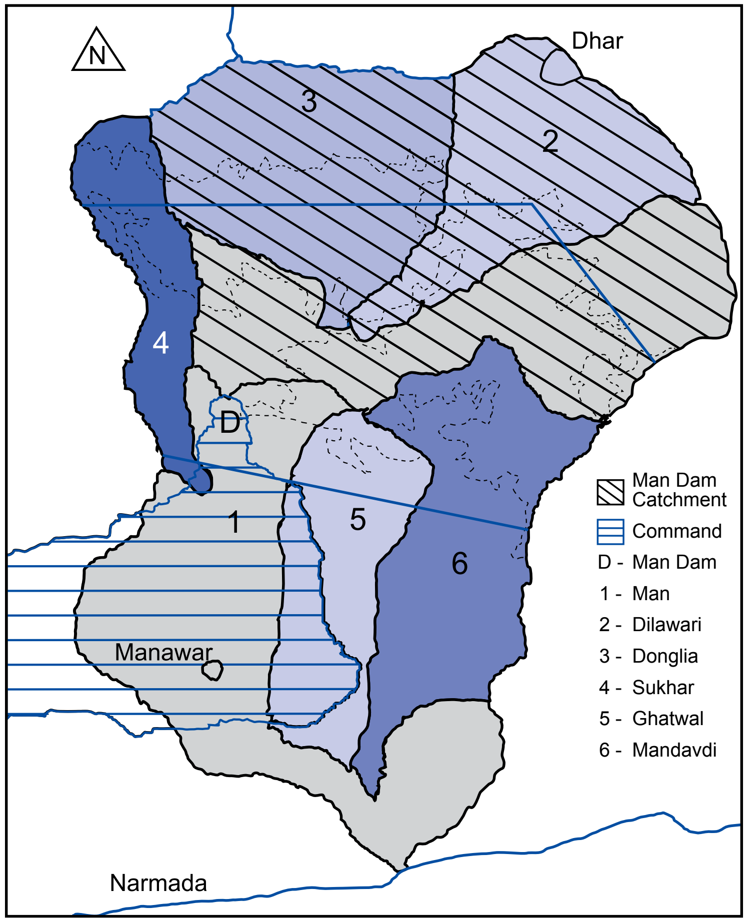

Fig. 2: Sub-basins of the Man River Catchment and Command Area of Man Dam

The constraints of time and resources precluded the undertaking of a study of the whole Man river basin. Consequently the present research concentrated on water governance in the catchment and command areas of the Man dam including the two towns of Dhar and Manawar. Thus the sub-basins that were studied are the Man, Donglia and Dilawari.

4. SOCIO-ECONOMIC CHARACTERISTICS OF THE MAN RIVER BASIN

Secondary data available with the Department of Statistics and Economics and published in the form of the annual district statistical handbooks has been relied on for a study of the socio-economic characteristics of the study area and unless otherwise mentioned all charts and tables in this section are based on these data. The major utilization of water in the basin is for irrigation in agriculture. A substantial increase in water use in the basin came in the late 1980s when extensive rural electrification and the supply of electricity at a subsidized rate for irrigation prompted the use of submersible pumps for extraction of groundwater from the deeper confined aquifers. Since this groundwater extraction began just after the withdrawal of the monsoons it led to the drying up of return flows in the Man river basin in the winter season. So a comparative analysis of the socio-economic characteristics between 1989 and 2005, which were both normal rainfall years, has been done here to highlight the changes that have resulted from this developmental intervention that are crucial with respect to water use in the basin. For the population the comparison is between the census data of 1981 and 2001. For the purposes of comparison data for Dhar tehsil has been taken to represent the Malwa region, that for Gandhwani tehsil has been taken to represent the Vindhya region and that for Manawar tehsil has been taken to represent the Nimar region.

4.1 Demographics

The Vindhya region of the basin has the heaviest concentration of tribal population as shown in Fig. 4 followed by the Nimar and Malwa regions. However, the population density is much less in the Vindhya region compared to the other two regions as shown in Fig. 3. Over the two decades the increase in population density has been the least in the Nimar region at 55 per cent, while in the Vindhya region it has been 66 per cent and 87 per cent in the Malwa region. The heavy increase in population in Malwa is most probably due to the development in the 1980s of the Pithampur industrial area, which is not in the Man river basin, which should have led to an influx of migrant labouring population into the area. This seems to be confirmed by the fact that the proportion of cultivators in the population is much less in the Malwa region than in the Vindhyas and Nimar as shown in Table 3. There is not much agricultural labour in the basin but the cultivators in the Vindhya region are mostly small landholders as becomes clear later and so they migrate seasonally to the Malwa and Nimar regions to work on the farms there during harvest time to supplement their meagre incomes from their own farms. Thus, the increase in population while providing more labour has also increased the pressure on natural resources in the basin, especially in the tribal-dominated Vindhya region as will become clear in due course.

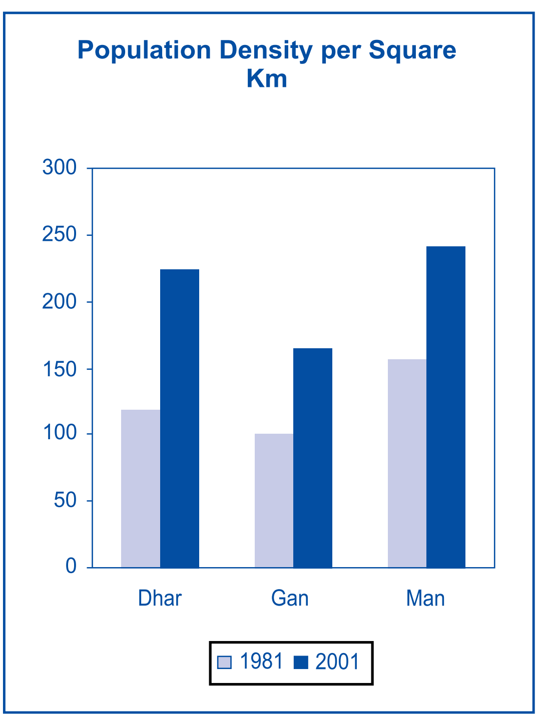

Fig. 3: Comparative Population Density Man Basin

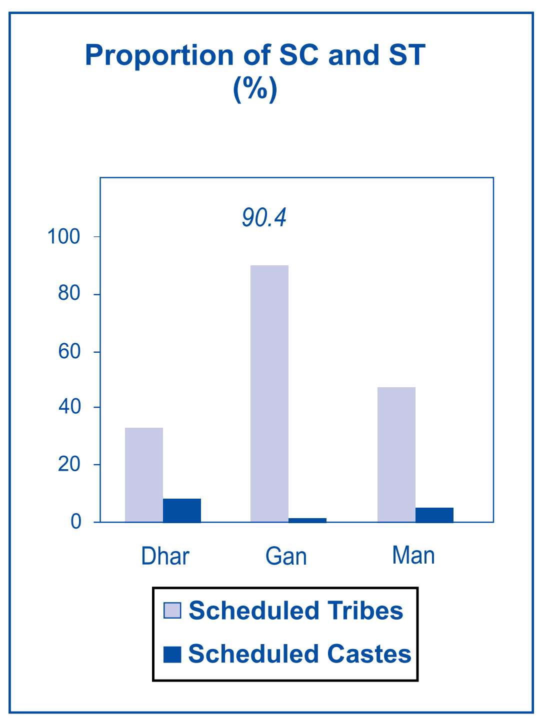

Fig. 4: Comparative Proportion of ST and SC in per square km

Table 3: Comparative Population Characteristics in the Man Basin (2001)

	Literate (%)	Working (%)	Cultivators (%)	Agriultural Labour (%)
Dhar	61.1	40.7	11.8	4.9
Gandh	52.4	49.4	34.5	3.7
Manawar	42.9	48.1	21.2	9.3

4.2 Landuse Pattern

The landuse pattern is a significant determinant of water availability and water use in any basin. Consequently a study of the changes in landuse over the period under consideration shown in Table 4 will give valuable insights into the changes in water availability and water use.

Table 4: Comparative Landuse Pattern in the Man Basin in Sq Kms

	Total Land		Reserved Forest		Non-agricultural land		Pastures		Cultivable Waste		Waste-land		Agricultural land	
Year	1989	2005	1989	2005	1989	2005	1989	2005	1989	2005	1989	2005	1989	2005
Dhar	1908	1926	399	393	133	159	135	104	56	49	20	11	1165	1192
Gan	735	736	289	220	36	124	29	44	34	2	6	7	341	339
Man	1049	1049	42	32	156	204	84	49	17	17	16	10	734	738

Ignoring the slight discrepancies between the total land area and the sum of the different land uses the most significant fact to come out of the comparison above is that reserved forests constituted as much as 39 per cent of the total area in the Vindhya region in 1989 but this proportion had declined to 30 per cent in 2005. Moreover the density of forest cover too has gone down and the proportion of open forest in 2009 is as high as 81 per cent (FSI, 2009). This open forest is mostly degraded with minimal forest cover or even scrubland and meadows. This means that the major segment of the basin that contributes to recharging of water and is also very hilly has become deforested considerably reducing the recharge of water and increasing the soil erosion. This is further of concern as the land in use for non-agricultural purposes has risen by 340 per cent in this region in the form of mines, industrial plants and the Man dam reservoir. While agricultural land use has remained more or less the same the pastures and wasteland areas have gone down.

4.3 Irrigation Prevalence

As mentioned earlier, irrigation in agriculture is the major determinant of water use in the basin and so the study of changes in this sphere is crucial to the understanding of water availability and use. The change in irrigation prevalence and the type of irrigation is mentioned in Table 5 below with the area in the first row and the proportion of type of irrigation in the whole irrigated area in the second row for each Tehsil.

It is interesting to note that tubewell irrigation was quite widespread in the Malwa region even in 1989 at 20112 ha but nevertheless there has been a massive 47 per cent increase over this high base which dwarfs by over four times in absolute terms the seemingly high proportionate increase in tubewell irrigation in the Nimar region of 2500 per cent. There is negligible increase in tubewell irrigation in the Vindhya region primarily because the underlying sedimentary rock confined aquifers have poor water retention. Thus overall there has been a phenomenal increase in tubewell irrigation in both the Malwa and the Nimar regions which has led to both these regions being declared over-exploited by the Central Ground Water Board. This combined with the deforestation in the Vindhya region has meant that there has been a double squeeze in the basin with less water availability and higher water use. While there has been a fair increase in tank irrigation in all three regions primarily due to extensive construction of small earthen dams during the period under review there has been a corresponding decrease in canal irrigation because the larger dams which are dependent for water on the streams originating in the Vindhya and Malwa region have failed to fill up adequately owing to less return flows. Irrigation from these dams which have less water is thus now done by motorized lifts instead of by canals which lie moribund. There has been a decrease in dugwell irrigation in the Malwa region and the Vindhya region due to the lowering of the water table. However the underlying rock strata in the Nimar region being broken granites, gravel and alluvium the unconfined aquifer has still a fair amount of water available.

Table 5: Comparative Irrigation Prevalence and Type in Ha (Prop in %).

	Canal		Tank		Tubewell		Dugwell		Others		Total	
Year	1989	2005	1989	2005	1989	2005	1989	2005	1989	2005	1989	2005
Dhar	728	333	703	2890	20112	29493	2949	1765	895	978	25387	35459
	2.9	0.9	2.8	8.2	79.1	83.2	11.7	5.0	3.5	2.8	100	100
Gan	345	308	255	500	0	60	2737	2551	439	2844	3776	6263
	9.1	4.9	6.8	8.0	0	1.0	72.5	40.7	11.6	45.4	100	100
Man	4382	2205	1125	2627	82	2136	11840	15456	4622	16530	22051	38954
	19.9	5.7	5.1	6.7	0.4	5.5	53.7	39.7	21.0	42.4	100	100

Interestingly there has been a significant 258 per cent increase in irrigation through other means in the Nimar region and 562 per cent in the Vindhya region. This is mainly through lift irrigation from the Man river and its tributaries and from the reservoir of the Man dam. A number of check dams have been built on the rivers and streams of the basin which store up the water as long as it is flowing and then it is used for irrigation. There is considerable amount of seepage from the Man dam and its canals which keep the Man river flowing through to the summer season as long as the canals are charged as will be discussed in detail later.

While the irrigated area has increased by 75 per cent in the Malwa region it has gone up by 100 per cent in the Nimar region and 73 per cent in the Vindhya region as shown in Fig. 5. It is to be noted that the Vindhya region which is dominated by tribals has much less irrigation than the other two regions. Though the data are not available in a segregated manner for the other two regions there too the tribals have less access to irrigation. Most of this increase in irrigation has come through either tubewells or through motorized lifts both of which involve the use of electrical or diesel energy. Energy use in agriculture has increased tremendously as a result and consequently at present there is a supply crunch in both water and energy. Severe power cuts, frequency problems and the high cost of electricity and diesel combined with lack of water has pushed up costs while pulling down yields as will be discussed in detail later.

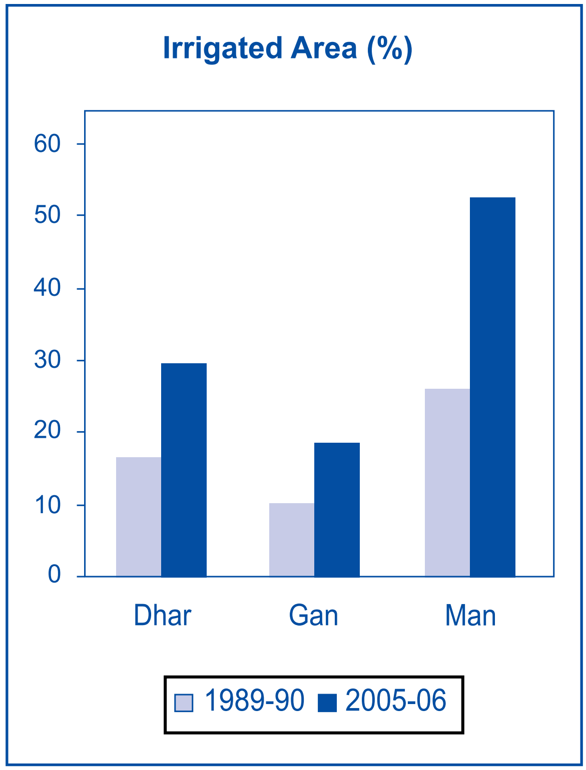

Fig. 5: Comparative Proportion of Irrigated Area in Man Basin

4.4 Cropping Pattern

The cropping pattern for the various crops in hectares is mentioned in Tables 6, 7 and 8.

Table 6: Comparative Cropping Pattern of Cereals in Ha.

	Paddy		Wheat		Sorghum		Maize		Other Cereals	
Year	1989	2005	1989	2005	1989	2005	1989	2005	1989	2005
Dhar	751	198	32349	31837	14983	945	8150	6444	16	1
Gan	826	502	2390	3200	9179	3973	8151	7574	214	71
Man	1055	325	8789	13806	14392	2408	15969	15073	360	117

Table 7: Comparative Cropping Pattern of Pulses in Ha.

	Gram		Red Gram		Black Gram		Other Pulses	
Year	1989	2005	1989	2005	1989	2005	1989	2005
Dhar	17981	15862	1949	172	2484	435	3299	2332
Gan	900	696	841	543	5875	1270	2012	2688
Man	1226	576	2044	1056	2474	519	6750	3248

Table 8: Comparative Cropping Pattern of Oilseeds and Cotton in Ha.

	Groundnut		Soyabean		Other Oilseeds		Cotton	
Year	1989	2005	1989	2005	1989	2005	1989	2005
Dhar	912	207	44980	102678	3779	1103	1215	567
Gan	1733	822	726	9595	184	223	3789	7541
Man	4173	699	291	14811	412	148	20890	31367

Except for the rabi crop of soyabean whose area of cultivation has increased by 130 per cent over the period in the Malwa region all other crops in this region have seen a decline in their area of cultivation. The reduction in area of cultivation of wheat, gram and other rabi crops is somewhat paradoxical given the increase in irrigated area over this period. The only plausible explanation can be that a substantial area under wheat and gram in 1989 was of the unirrigated dryland variety which was discontinued. This conjecture is supported by the fact that the irrigated acreage in 1989 in Dhar was 25387 ha while the area under wheat alone was 32349 ha. The most noteworthy change is that of the fall in the area of cultivation of coarse cereals like sorghum and, maize and pulses like gram, black gram and red gram all to be replaced by soyabean. This replacement of coarse cereals and pulses by soyabean has also taken place in the Vindhya and Nimar regions and has had a negative nutritional impact on the poor farmers who have had to buy pulses from the market. The Nimar and Vindhya regions have also witnessed a sizeable increase in the area under cotton and wheat. Clearly there has been a substantial increase in the water use for agriculture over this period and this will be studied in depth in the hydrological estimation exercise in the next section.

4.5 Livestock

The change in livestock population is given below in Table 9. There is a slight decrease in cattle population which is probably due to the greater use of tractors and threshers for agricultural operations and the decrease in grazing facilities. This appears to be more so in the Nimar region. The buffalo population shows a decline in the Nimar region despite milk production having become a profitable proposition in the intervening period and this seems to indicate that there is probably a serious fodder crunch in the Nimar part of the basin. The population of goats too has declined in Nimar further reinforcing the above theory. There has been a notable 75.2 per cent increase in the population of goats in the Vindhya region as these are a major source of supplementary income for the Bhil tribals of the area. The reserve forest even when degraded provides ample grazing for goats and so with the increasing fragmentation of agricultural land, goat rearing as a supplementary occupation has risen. Overall there does not seem to be any significant change in the demand on the forests and water because of livestock rearing in the basin.

Table 9: Comparative Livestock Population

	Cattle		Buffalo		Goats		Sheep		Others	
Year	1989	2005	1989	2005	1989	2005	1989	2005	1989	2005
Dhar	104840	96620	31677	35787	29945	32001	2514	2234	763	950
Gan	48113	46105	10299	15288	22403	39250	6	38	213	208
Man	64035	41954	22767	18327	46536	39196	1553	2256	974	716

4.6 Agricultural Land Distribution

The land distribution in the basin in the period under review is given in Tables 10 and 11 with total area and average size of landholding per category in hectares. Table 12 gives the Gini coefficients of inequality of land distribution for the two years.

Table 10: Agricultural Land Distribution in Ha 1989

	Marginal			Small			Semi-Med			Medium			Large		
	Num	Area	Avg. Size	Num	Area	Avg. Size	Num	Area	Avg. Size	Num	Area	Avg. Size	Num	Area	Avg. Size
Dhar	5334	2754	0.52	5588	8426	1.51	6285	17970	2.86	6720	41899	6.23	2970	51972	17.50
Gan	1727	991	0.57	2381	3535	1.48	2898	8264	2.85	2950	17055	5.78	430	5906	13.73
Man	3171	1747	0.55	4070	5999	1.47	4852	14411	2.97	5096	31883	6.26	1636	24313	14.86

Table 11: Agricultural Land Distribution in Ha 2005

	Marginal			Small			Semi-Med			Medium			Large		
	Num	Area	Avg. Size	Num	Area	Avg. Size	Num	Area	Avg. Size	Num	Area	Avg. Size	Num	Area	Avg. Size
Dhar	11803	6134	0.52	10907	15997	1.47	8990	25200	2.80	6738	41407	6.15	1752	31670	18.08
Gan	5263	2983	0.57	4542	6331	1.39	3783	10362	2.74	2301	12981	5.64	211	2677	12.69
Man	6631	3759	0.57	6883	10261	1.49	6792	19229	2.83	4759	29278	6.15	994	15181	15.27

Table 12: Gini Coefficients of Land Distribution*

	1989	2005
Dhar	0.518	0.527
Gan	0.410	0.445
Man	0.462	0.475

**Calculated from data in Tables 10 and 11*

The Vindhya region being populated mostly by tribals has a comparatively more egalitarian land distribution than the other two regions as is evident from the lower values of Gini coefficient. However, it has shown the biggest increase in Gini coefficient value indicating that the rise in inequality from 1989 to 2005 is the highest in this region. Possibly because many marginal and small tribal landholders have sold out to larger tribal landholders owing to the unviability of small holder agriculture in the region. The noticeable trend of fragmentation of holdings seems to support this hypothesis. It has led to a massive swelling of the numbers of marginal and small farmers and has resulted in more than fifty per cent of the farmers having less than two hectares of land. The actual fragmentation is even more as the adult sons of the landholders have partitioned the land further between themselves.

The Malwa region has a distinct concentration of land in the hands of large, medium and semi-medium farmers and this is in evidence to some extent in the Nimar region also and much less so in the Vindhyas. The trend in Gini coefficients indicates that this concentration has increased slightly over time. There is also considerable leasing of land going on in the basin, though there are no records and this too contributes to further de facto concentration of land. In fact more than the development of water markets which is constrained by the poor quality and quantity of electricity supply, tubewell irrigation has given rise to leasing in or sharing in of land by those who have greater access to water through tubewells. It is these large, medium and semi-medium farmers in the Malwa and Nimar regions who have contributed the most to the depletion of the water table through indiscriminate pumping from the confined aquifer and also from the base flow in the streams and rivers.

The greatly reduced irrigation in the mostly tribal populated Vindhyas is more due to the fact that the underlying deep aquifer is not a good bearer of water and not so much to the larger share of small landholdings. A study of the RGWM implementation in a sample of tribal villages in Dhar district (Londhe, 2003) has shown that once surface and groundwater availability was enhanced through watershed development work the tribals in a wholly tribal village invested from their own resources in pumps and other accessories to access this water for irrigation. Whereas in a village dominated by the minority non-tribals, the tribals failed to do so as the dominant castes took advantage of the water. Thus inequitable access to water has added to the inequality of land distribution and increased the divide between the rich and the poor in the basin as small and marginal farmers have found it more economically advantageous to work as labourers in the fields of bigger farmers than in enhancing the quality of their own small holdings without an effective government policy to promote this. In fact there is considerable seasonal migration within the basin and outside it as the small holder tribal farmers move out particularly during harvest time when the demand for labour is at its peak both in the kharif and rabi season.

5. HYDROLOGICAL ESTIMATION

The most important technical information from a water governance point of view is that regarding the availability of water and its use. This is garnered from a study of the surface and groundwater hydrology of the basin. The concentration of hydrological studies in India have been on determining the runoff of rivers either to help in controlling floods or in estimating the dependable flow that can be impounded in dams for use in electricity generation and canal irrigation (Subrahmanya, 1994). Thus various empirical formulae have been derived that give a very rough idea of the runoff in large river basins like the Narmada. Invariably these models, which are broad approximations based on river flow measurements, tend to err on the higher side as has been amply demonstrated by the estimation of the flow of the Narmada river for the Narmada Water Disputes Tribunal which overestimates the actual flow by 27 per cent (Paranjpye, 1990).

Indeed the continuous measurement and estimation of surface and subsurface flows and water use has never been done in the Man basin and nor is it being done at present. So much so that for the design of the Man dam in the 1970s there was no data available from the basin regarding runoff, river flow, natural recharge and return flow. The design was done on the basis of the results of a linear regression equation set up between the rainfall and runoff data for the Narmada river between Mortakka and Garureshwar gauging stations which are over a hundred kilometres apart. No equipment has been installed at the Man dam for taking accurate measurements of the flow in the river. Neither have detailed geological investigations been carried out to determine the amount of natural recharge taking place in the basin. Moreover, there is no compiled record with the various constructing agencies regarding the water storage capacities of the innumerable water storage structures that have been created in the basin. Consequently the water resources bureaucracy does not have any credible estimates of water availability and use in the Man basin.

On the other hand there have been another set of hydrological studies that are concerned with the water balance in small watersheds as an aid to watershed development work. These micro-models also rely on empirical formulae for the estimation of infiltration, surface runoff, evapotranspiration and return flow based on the soil characteristics, gradient, underlying rock structure, cropping pattern and the rainfall pattern in these watersheds. A model was developed along these lines and scaled up for application at the larger sub-basin level for the purposes of this study (SOPPECOM, 2007). The model consists of empirical formulae for estimating the surface runoff, infiltration and evapo-transpiration. The return flow from groundwater is to be estimated in this model by measuring the flow of the river over a water structure at some point in the basin and deducting the contribution of surface runoff from it. However, this model turned out to be inappropriate for the Man river basin for the following reasons -

- The basin is very large in size and spans three agro-ecological regions with differing rainfall, soil, topography, underlying rock structure and cropping pattern. Under the circumstances it is not possible to assume a single average value of the empirical constants such as Curve Numbers and Crop Coefficients across the basin. Moreover without a detailed study of the underlying rock characteristics no worthwhile estimate of the infiltration or return flow could possibly be made.
- There are innumerable big and small water retaining structures in the basin and most of them do not have their dimensions formally recorded as mentioned earlier. Thus it is a Herculean task to account for the hydrological impact of these on surface and subsurface flows while attempting to estimate the water balance in the basin.
- Proper measurement of flow over the dam and the utilization of the capacity of the reservoir is not being done by the Narmada Valley Development Authority (NVDA) as only the level of the water at the dam is measured once daily. Moreover, in the Rabi season there is considerable drawal of water through lift irrigation. There is thus no possibility of getting a reliable estimate of the flow at the dam in Zirabad.

Consequently any authentic water balance estimation exercise in the basin will require the use of computer simulated models and a detailed primary investigation of soil, topographical and hydro-geological characteristics both on the ground and through satellite imagery (Singh & Woolhiser, 2002, Dhar et al. 2006). This is beyond the scope of the present research as the purpose of the present study is not so much to estimate the water balance as to study the relationship between water availability and water use to see to what extent it is sustainable and if not then suggest measures for improvement. The water availability is more or less related to the rainfall in the area whose trends appear in Table 13 over the period from 1987 to 2006. As is evident in more than half the total number of years the rainfall is below the average values and these are the years when the kharif crop is also under water stress leading to lower than potential yields.

Table 13: Comparative Annual Rainfall in the Man Basin in mm

Year	Avg	87	88	89	90	91	92	93	94	95	96	97	98	99	2000	01	02	03	04	05	06
Dhar	913	739	1099	783	1246	596	540	969	1416	822	1123	1104	916	781	524	694	725	1091	874	743	1103
Gan	738	640	483	801	1017	574	413	665	1056	532	954	861	742	584	328	603	868	1017	590	543	1171
Man	711	602	907	785	1014	535	363	694	1147	457	981	763	709	632	385	585	619	788	626	406	1050

Source: Department of Land Records, Dhar, 2007 (Shaded values used in calculations in Tables 15-17, 19)

Another major factor in both agricultural productivity and water availability are the characteristics of the soil. A perusal of the Dhar District Soil Map (Tamgadge et al. op cit) reveals that the soil depth in the catchment area of the Man dam is either very shallow or shallow except in a thin strip along the river. The soil depth is deep or slightly deep in the command area. The level and extent of soil degradation is quite high in the whole basin with a considerable amount of the land having become unreclaimable at the farm level. Most of the catchment area is subject to very severe soil erosion and the rest of the basin suffers from moderate and severe soil erosion. The available water holding capacity is either very low or low in most areas of the basin. While the organic carbon content of the soil is medium to high in the basin, the nitrogen content is low and the potassium content is medium with the overall soil quality being low in the catchment area and medium to high in the command area.

Given that the focus in RGWM implementation in the district has been more on constructing the structures rather than on ensuring people's participation and equity in the sharing of benefits, over time community maintenance of the structures has suffered and they have decayed (Londhe, op cit). Moreover, extensive soil and water conservation work has not been done because of this concentration on building structures and the per hectare investments have been only around Rs 2000 as opposed to the norm of Rs 10,000 for effective treatment (Ahluwalia, 2005). Thus, in the absence of effective soil and water conservation work due to indifferent implementation of the RGWM and also inadequate catchment treatment work by the Narmada Valley Development Authority (NVDA), in years of less than normal rainfall there is minimal scope for providing protective irrigation to most of the land under kharif cultivation. This results in water stress and lower yields. The dryland sowing in the rabi season is also adversely affected in low rainfall years owing to lack of soil moisture. The characteristics of the soil also imply that even in a normal year there is comparatively low productivity in most farms due to water stress arising from low soil moisture given the trend in the region of there being long rainless periods between heavy showers combined with a high potential evapo-transpiration rate.

Consequently what is more of a concern from the water governance point of view is the availability and use of water for the irrigated crops in the rabi season which constitutes the highest human water consumption category. What has been attempted here is a rough estimation and comparison of the amount of water used in agriculture in the Man river basin in 1989-90 and 2005-06 which were both years of adequate rainfall. The estimation is based on an empirical formula relating the water requirement to crop coefficients, the potential evapo-transpiration in the different growing periods of various crops and irrigation efficiency developed from crop water requirement research (Doorenbos et al. 1986) as given below.

$Q = 1/\text{I.E.} \{\sum A_i (kc_i \sum ET_o)\}$, where

Q = Total water needed for irrigation

I.E. = The Irrigation Efficiency given by the ratio of the water actually evapo-transpirated by the crop and the total water needed to flood the field. This ratio is assumed to be 60 per cent and so the value will be 0.6. In the kharif season since there is no irrigation the value will be 1.

Ai = The area under a particular irrigated crop

kci = Crop coefficient for the particular crop

ETo = The daily evapo-transpiration rate for a theoretical crop during the different periods

The evapo-transpiration rate and the crop coefficient are highly location specific and ideally should be experimentally determined in the basin itself in the separate agro-ecological zones. However, for the purposes of this estimation the Indian Meteorological Department data have been relied on (http://indiawaterportal.org/metdata). The average daily ET_o for Dhar district over the year is mentioned in Table 14.

Table 14: Average Values of Daily Potential Evapo-transpiration Rate in Dhar District

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ETo(mm)	6.03	6.86	7.82	8.75	8.96	7.67	5.88	5.19	5.93	6.97	6.48	5.91

Source: Indian Meteorological Department (http://indiawaterportal.org/metdata)

The daily values are summed up depending on the total life period of the crops from germination to harvesting. The cropping area data for the villages in the basin have been summed up for the main kharif season crops of sorghum, maize, paddy, soyabean, groundnut, redgram and blackgram and the three main rabi season crops of wheat, gram and cotton (this is sown in the summer or kharif season but continues into the rabi season when the cotton is harvested so its growing period has been divided into both the seasons) for 1989-90 and 2005-06 for the three agro-ecological regions. The average kc values for the crops are calculated on the basis of FAO guidelines (Doorenbos et al. op cit). This estimation gives the water demand for maximum yield under optimum conditions. The total precipitation over the whole area of the agro-ecological zone is also calculated. The results of these estimations for the three zones have been given in Tables 15 - 17.

Table 15: Estimation of Water Demand for Agriculture in Malwa Region of the Basin

Season	Crop	1989					2005				
		Area (ha)	kc	∑ETo (mm)	Q (mcum)	Total Annual Precipi-tation (mcum)	Area (ha)	kc	∑ETo (mm)	Q (mcum)	Total Annual Precipitation (mcum)
Kharif	Sorghum	2101	0.8	750	12.61		133	0.8	750	0.80	
	Maize	1143	0.9	800	8.23		904	0.9	800	6.50	
	Paddy	105	1.1	800	0.92		28	1.1	800	0.25	
	Soyabean	6308	0.8	700	35.32		14399	0.8	700	80.63	
	Groundnut	128	0.9	800	0.92		29	0.9	800	0.21	
	Pulses	1084	0.9	700	6.83		412	0.9	700	2.60	
	Cotton	170	0.7	500	0.59		80	0.7	500	0.28	
	Total				**65.44**	**333.44**				**91.26**	**295.17**
	Water Demand/ Total Prec. (%)					**19.62**					**30.92**
Rabi	Wheat	4536	0.8	950	57.46		4465	0.8	950	56.55	
	Cotton	170	0.9	500	1.28		80	0.9	500	0.60	
	Gram	2522	0.7	850	25.01		2224	0.7	850	22.06	
	Total				**83.75**	**333.44**				**79.21**	**295.17**
	Water Demand/ Total Prec. (%)					**25.12**					**26.83**

There is an increase in water demand in the kharif season in the Malwa region mainly due to the significant increase in area under soyabean which far outweighs the decrease in cultivation of coarse cereals, pulses, groundnut and cotton. The rabi season demand shows a slight decrease due to a corresponding decrease in area under the crops. Owing to lower rainfall in 2005-06 the water demand to total precipitation ratio shows more of an increase than has actually happened over the period. However, even at the 1989 level of 25.12 per cent of total precipitation the water demand in the rabi season is quite high.

Table 16: Estimation of Water Demand for Agriculture in the Vindhya Region of the Basin

Season	Crop	1989					2005				
		Area (ha)	kc	∑ETo (mm)	Q (mcum)	Total Annual Precipi-tation (mcum)	Area (ha)	kc	∑ETo (mm)	Q (mcum)	Total Annual Precipi-tation (mcum)
Kharif	Sorghum	8673	0.8	750	52.04		3754	0.8	750	22.52	
	Maize	7702	0.9	800	55.45		6089	0.9	800	43.84	
	Paddy	780	1.1	800	6.87		187	1.1	800	1.65	
	Soyabean	686	0.8	700	3.84		9066	0.8	700	50.77	
	Groundnut	1637	0.9	800	11.79		777	0.9	800	5.59	
	Pulses	8247	0.9	700	51.95		4253	1.0	700	26.79	
	Cotton	3580	0.7	500	12.53		7125	0.7	500	24.94	
	Total				**194.47**	**706.71**				**176.10**	**813.73**
	Water Demand/ Total Prec. (%)					**27.52**					**21.64**
Rabi	Wheat	2258	0.8	950	28.60		3024	0.8	950	38.30	
	Cotton	3580	0.9	500	26.85		7125	0.9	500	53.44	
	Gram	442	0.7	850	4.39		342	0.7	850	3.39	
	Total				**59.84**	**706.71**				**95.13**	**813.73**
	Water Demand/ Total Prec. (%)					**8.47**					**11.69**

There is a decrease in water demand in the kharif season in the Vindhya region. The increase in cotton and soyabean cultivation has been outweighed by the decrease in coarse cereals, pulses and groundnut cultivation and the reduction in area under cultivation as a whole. There is a significant increase in water demand in the rabi season owing to increase in wheat and cotton cultivation. But even then the ratio of water demand to total precipitation is still moderate. Even after factoring in the higher rainfall in 2005-06 the rabi water demand is within safe limits primarily because of the comparatively limited development of tubewell irrigation in the region due to unfavourable underlying deep aquifer characteristics. As noted earlier most of the additional irrigation has been achieved through lifts from tanks/ streams and well irrigation. This substantiates the earlier finding that aquifer characteristics govern the extent of water use in the basin more than landholding size or distribution.

Table 17: Estimation of Water Demand for Agriculture in Nimar Region of the Basin

Season	Crop	1989					2005				
		Area (ha)	kc	∑ETo (mm)	Q (mcum)	Total Annual Precipi-tation (mcum)	Area (ha)	kc	∑ETo (mm)	Q (mcum)	Total Annual Precipi-tation (mcum)
Kharif	Sorghum	7072	0.8	750	42.43		1183	0.8	750	7.10	
	Maize	7847	0.9	800	56.50		7407	0.9	800	53.33	
	Paddy	518	1.1	800	4.56		160	1.1	800	1.41	
	Soyabean	143	0.8	700	0.80		7278	0.8	700	40.76	
	Groundnut	2051	0.9	800	14.76		404	0.9	800	2.91	
	Pulses	5537	0.9	700	34.88		2370	0.9	700	14.93	
	Cotton	10265	0.7	500	35.93		15414	0.7	500	53.95	
	Total				**189.87**	**522.91**				**174.38**	**541.47**
	Water Demand/ Total Prec. (%)					**36.31**					**32.20**
Rabi	Wheat	4319	0.8	950	54.71		6784	0.8	950	85.93	
	Cotton	10265	0.9	500	76.99		15414	0.9	500	115.60	
	Gram	602	0.7	850	5.97		283	0.7	850	2.81	
	Total				**137.67**	**522.91**				**204.34**	**541.47**
	Water Demand/ Total Prec. (%)					**26.33**					**37.74**

There has been a slight decrease in water demand in the kharif season in the Nimar region accompanied by a significant increase in the rabi season achieved through both increase in tubewell and lift irrigation. The above water demand calculations are for maximum yield of crops which is defined as - “the harvested yield of a high producing variety, well adapted to the given growing environment, including the time available to reach maturity, under conditions where water, nutrients and pests and diseases do not limit yield” (Doorenbos et al. op cit). However, the reality in the basin is that the average yields are much lower than the maximum yields as indicated in Table 18. Clearly the average yields in the basin taking all crops is only 40 per cent of the maximum yields and so the water demands calculated above will have to be scaled down by about 30 per cent assuming that the other 30 per cent deficit is due to the other factors that determine maximum yield in the definition above.

Table 18: Average Yields of Crops in Man Basin and Their Maximum Yields (kgs/ha)

	Sorghum	Maize	Paddy	Soyabean	Groundnut	Pulses	Cotton	Wheat	Gram
Man Basin	1225	2178	773	1076	921	609	1230	3323	781
Maximum	3500	6000	6000	2500	3000	1500	3000	5000	1500

Source: District Statistical Handbook Dhar for Man Basin and Doorenbos et al. op cit for Maximum yields.

Over and above this the average rainfall in the three regions is much less than that recorded in the years under consideration which were good rainfall years. Thus it would be more appropriate to correct total annual precipitation downwards to accord with the average rainfall also before assessing comparative water demand. The comparative change in the ratio of water demand to total precipitation in the basin corrected by taking the average yield and average rainfall for calculation are given in Table 19.

Table 19: Comparative Change in Water Demand/ Total Annual Precipitation Ratio*

Agro- Climatic Zone	Water Demand/Total Annual Precipitation (%)						Change (%)		
	1989			2005					
	Kharif	Rabi	Total	Kharif	Rabi	Total	Kharif	Rabi	Total
Malwa	18.74	24.00	42.74	26.15	22.69	48.84	39.51	-5.45	14.27
Vindhya	26.55	8.17	34.72	24.04	12.98	37.02	-9.46	58.92	6.63
Nimar	36.25	26.29	62.53	33.29	39.01	72.30	-8.17	48.42	15.62

** Calculated by correcting values in Tables 15-17 downwards for average rainfall and average yields.*

Thus there has been a substantial increase in water demand in the rabi season over the period in the Vindhya and Nimar regions, while the kharif water demand has decreased slightly. The opposite is true in the Malwa region where kharif water demand has risen substantially while the rabi demand has declined slightly. Assuming that the kharif water demand is mostly being met by the rainfall the crucial issue to be considered here is whether the rabi water demand is sustainable or not. As we have seen earlier, ninety per cent of the rabi demand in the basin is being met from groundwater either in the return flow in the streams or in the confined and unconfined aquifers. Thus it has to be assessed whether the groundwater demand in the rabi season is less than the groundwater recharge or not.

Quantification of groundwater recharge as a proportion of the precipitation is a problematic exercise. It is a complex function of meteorological conditions, soil, vegetation, physiographic characteristics and properties of the geologic material within the paths of flow. Soil layering in the unsaturated zone plays an important role in facilitating or restricting downward water movement to the water table. Also, the depth to the water table is important in groundwater recharge estimations. Consequently it is not possible to estimate accurately what is the annual recharge in the Man basin without extensive physical measurements. But estimates done in dry hard rock areas with gentle slope show that it is not more than 11 per cent of the total annual precipitation (Rangarajan et al. 2009).

In the present case considerable parts of the basin have high slopes and degraded lands and so the natural recharge should be much less and since the quality and extent of soil and water conservation works has not been good not much artificial recharge is taking place. Consequently the total groundwater recharge in the basin is in all probability less than 10 per cent of the total annual precipitation. Thus, the current levels of the rabi season water demand as a proportion of total precipitation in the Malwa (22.69 per cent) and Nimar (39.01 per cent) regions is highly unsustainable and even the Vindhya (12.98 per cent) region is under stress resulting in the groundwater aquifers in the basin having become over exploited. It must be remembered that the actual water demand is higher because there are other crops also which have not been considered in the estimation because of their marginal acreage. The low average yields too seem to indicate that both in the kharif and the rabi season there is water stress despite this high level of extraction of groundwater primarily because in most farms soil depth is low leading to high evapo-transpiration losses and insufficient soil moisture.

A more detailed investigation of surface runoff, seepage and evapo-transpiration is in order to accurately estimate the water availability and use in the basin. This would require the detailed study of the hydro-geology, topography, forest cover and cropping patterns at the farm plot level. Even if this were to be done only in the catchment and command areas of the Man dam this would involve the study of as many as 265 villages with 98317 different landholdings and more than 3,00,000 farm plots. Each farm plot's characteristics would have to be noted and then the values for curve numbers, crop coefficients, infiltration and the like calculated to arrive at the aggregate surface runoff, seepage and evapo-transpiration values. Approximation even at the level of the village will lead to errors as the characteristics vary considerably across farm plots. Consequently the exercise of rigorous estimation of water availability and use is not possible within the scope of the present project.

The above analysis has made it clear that this work of detailed and accurate hydrological estimation should ideally be taken up by an autonomous government agency that has the skills and financial resources to undertake the task. This agency should not be a part of the water resource project implementation setup so as to be objective and unbiased in its work. Moreover, the collation of the ground level data on land use, cropping patterns, agricultural production, irrigation prevalence and land distribution which are crucial to such estimation should also be made more authentic by involving the people and having it verified by the Gram Sabha. At present this work is being done by the Patwari who has typically been given charge of more than one village and so the data is unreliable. Without these ameliorative measures good water governance will not be possible.

Finally a word about the deterioration of the quality of groundwater in the basin due to policy failure with respect to provision of fertilizer subsidy. A tricky aspect of agriculture is the optimization of nutrient ratios in mixed fertilizer application (Trionfo, 2000). Depending on the soil characteristics there is an optimum ratio at which the nitrogen, phosphorus, potash and micro-nutrient fertilizers must be applied. If one of these fertilizers is applied in excess of its optimum requirement then this excess application will not be absorbed by the plants because they can take up only that much which accords with the amount applied of the other fertilizers. Over the past decade or so faced with a resource crunch the government has been reducing the subsidy given to fertilizers in a lopsided manner. The withdrawal of subsidy from potassium and phosphorus fertilizers has been much more than for nitrogen. This has made the farmers apply much more urea because it is comparatively cheaper than the others. Consequently most of this over application of urea has not been absorbed by the plants and has gone waste. It has either run off, been decomposed into nitrogenous gases by the denitrifying bacteria in the soil or mostly it has seeped into the groundwater. Consequently the nitrate levels in the phreatic aquifer were well above the permissible level of 100 mg/ litre in the Malwa and Nimar regions of the basin (CGWB, 2005).

6. ANALYSIS OF AGRICULTURAL WATER AND ENERGY USE IN THE BASIN

The constraint on water availability for irrigation demonstrated above was sought to be overcome in the late 1970s by the government through provision of electricity at a subsidized rate for the operation of pumps and subsidized loans for the purchase of pumps and other accessories. Thus farmers could tap the water stored in the deeper confined aquifers by sinking tubewells and installing submersible pumps and also the base flow in the streams and rivers through lift irrigation at relatively small capital and operating cost to themselves. In 1993 the new Congress government in the state made the supply of electricity to agricultural pumps of five horsepower or less free thus further reducing the cost of water.

While this boosted agricultural production considerably it also created what has come to be characterized in natural resource economics as a "tragedy of the commons" (Hardin, 1968). Normally in the case of a non-renewable resource the user has to trade off resource use between successive time periods to optimize production in the long run because the more the resource is used the greater is its extraction cost and more is its scarcity value (Hotelling, 2003). The water in the deep confined aquifers in dry hard rock regions is akin to a non-renewable resource because it has accumulated over thousands of years from the minimal amount of percolation into these aquifers that has taken place annually. Thus when this water is pumped out in large quantities in a particular year far in excess of the minimal recharge that is taking place, the water level decreases and in the next year the extraction cost will be greater and this will keep increasing with time. However, in a situation in which this extraction cost was rendered close to zero by electricity being made free and the water itself being a common property resource did not have any price attached to it and neither did its depletion result in a scarcity value, all the farmers tended to use as much water as they could get as in the long run the water would be finished even if a few farmers adopted a more conservationist approach.

Situations in which there are public goods with no well defined property rights as with groundwater, either the state has to step in to regulate its use through fiscal or legal measures or there has to be communitarian command over its use as markets fail (Heal, 2000). However in this case the state too failed by adopting the opposite stance of subsidizing the greater use of water.

The crunch came at the turn of the century when the Madhya Pradesh government as part of the conditions for getting a loan from the Asian Development Bank (ADB) for restructuring its power sector had to begin charging farmers for electricity supplied to them at cost plus profit rates determined by the Madhya Pradesh Electricity Regulatory Commission. The ADB imposed this fiscal prudence on the government so as to ensure that it could pay back the loan that was being given. The prolonged bleeding of the finances of the Madhya Pradesh State Electricity Board and the government due to the free power supplied earlier had hampered the addition of new power generation capacity and so the quantity and quality of power supplied to rural areas also began to suffer. The shortfall had to be made up by purchasing power from the national grid and this too pushed up the cost of electricity further. In addition to this heavy withdrawals of water had led to the severe depletion of the confined aquifers and many of the tubewells had either gone dry or were yielding much less water. Most of the blocks in Western Madhya Pradesh were declared to be either critical or over exploited in terms of groundwater resources. Finally the continuous cultivation of the soyabean/cotton - hybrid wheat monoculture had reduced the fertility of the soils calling for an increased application of chemical fertilizers which too had become scarce and more expensive owing to a combination of supply not keeping pace with demand and declining subsidies.

The seriousness of the economic aspects of the problem thus created can be illustrated with the comparative economics of the production of the popular Lok 1 variety of hybrid wheat in the free electricity and bigger fertilizer subsidy era in 1997 and the cost plus profit electricity charges and lower fertilizer subsidy regime now prevailing a decade later. This has been compiled from a survey conducted under this study and appears in Table 20.

Table 20: Comparison of the Economics of Production of Lok 1 Wheat Variety

Break-up	1997	2009
Seed Cost	200 kg @Rs 8/kg= 1600	200 kg @Rs 15/kg = 3000
Sowing cost (land preparation + first watering + sowing)	1500	3400
Phosphate + Potash Fertilizer	150 kg @Rs 3/kg= 300	200 kg @Rs8.75/kg= 1750
Urea Fertilizer	180 kg @Rs 2/kg= 360	240 kg @Rs6.04/kg= 1450
Watering	5 waterings@Rs200/w= 1000	3 waterings@Rs2500/w= 7500
Harvesting	1900	2200
Threshing	1200	2400
Total Cost /Ha	7860	21700
Output Value/Ha	5100kg @ Rs 6.5/kg= 33150	3390kg @ Rs 11/kg= 37290
Net Income/Ha	**25290**	**15590**

The crucial difference has been made by the reduction in output resulting from a lack of sufficient water. If two more waterings had been possible in 2007 then output would have been 5100 kgs per hectare as before and the net income per hectare would have been higher by about Rs 10000 bringing it at par on nominal terms with the earlier net income. However, even if the farmers are prepared to pay the higher charges there just isn't so much water any more because in the intervening decade the number of farmers sowing wheat has risen considerably reducing the availability of water per farmer. The per farmer availability of electricity too has gone down.

This is in fact a nationwide phenomenon and there are many inefficiencies in this system of power and fertilizer subsidies (Bhatia, 2007). Supply of highly subsidized power provided at flat rates or free power tends to make the farmers wasteful in the use of electricity. Moreover, because it is difficult to keep track of the quantity of power supplied under a flat rate or free power system there are huge losses due to theft or illegal supply to sectors other than agriculture. Part of this loss has to made up by cross subsidies from the industrial and commercial sector thus pushing up costs in that sector and through cascading in the economy as a whole, apart from encouraging more theft. Most importantly the lack of regulation of groundwater usage that goes with this low cost supply of power disincentivizes the farmers from adopting land management and agricultural practices that conserve soil moisture and enhance artificial recharge which can in turn reduce their demand for energy (CGWB, 2008).

7. SEEKING AN ALTERNATIVE

Towards bringing about a change in agriculture and water use an experiment was tried out as part of this study with a dryland wheat variety that requires just one or two waterings. A few farmers cultivated the dryland durrum wheat variety named Amrita (HI 1500) developed by the Wheat Research Centre of the Indian Council of Agricultural Research in Indore. This variety requires just one more watering after the first watering before sowing and can give yields of between 3000 and 3500 kgs per hectare at the maximum which is comparable with the yields of Lok 1 variety under three waterings. Moreover, this wheat requires no pesticide and can be grown with biofertilizers or organic compost. Since little or no watering is required the immense amount of labour involved is saved along with the cost of electricity or diesel for pumping of water. The results have been quite encouraging as is clear from Table 21.

Table 21: Economics of Production of Amrita Wheat Variety

	2009	
Seed Cost	100 kg @Rs 16.5/kg =	1650
Sowing cost (land preparation + first watering + sowing)		3400
Biofertilizer or Organic Compost		4000
Harvesting		2000
Threshing		2000
Total Cost /Ha		13050
Output Value/Ha	2680kg @ Rs11/kg=	29480
Net Income/Ha		**16430**

It is noteworthy that in all the locations where the Amrita seed was sown, the soil type was medium quality clayey soils and owing to lack of water only the first watering at sowing could take place. Despite this the crop came to fruition and the average yield was 2680 kg per hectare. Dryland wheat requires less seed as it has to be sown at a greater distance between plants. It requires less labour for harvesting and threshing and also obviously much less water. So in the end despite a lower production per hectare than Lok 1 with three waterings, the former turns out to be economically superior to the latter. The demonstration effect of this has been tremendous. More and more farmers are adopting this dry land variety.

This variety is known technically as durrum wheat as opposed to the other which is known as aestivium wheat. Durrum wheat has a higher content of proteins, vitamins and minerals and so is nutritionally superior to aestivium wheat also, thus enhancing food security.

This opens up a whole new vista for sustainable water use in Western Madhya Pradesh restricting ourselves for the time being to just the sphere of wheat production. The proportion of net irrigated area to net sown area in the region is 36 per cent. This irrigation coverage as shown has been achieved through an unsustainable withdrawal of groundwater facilitated by the supply of cheap electricity. This is bound to decline in future if ground water withdrawal continues at the same pace as the aquifers will gradually dry up. This will lead to a decline in wheat production further raising food prices. However, now the success of the Amrita variety has thrown up an alternative and so a combination of both kinds of wheat can be sown by the farmers to optimize both their economic gains and also address environmental concerns. We can visualize a simple linear programming model that could later be augmented into a more complex non-linear one with more crops and field and market conditions and then optimized to yield a better situation with regard to land and water use and food production as follows.

Let us assume that **P** is the total wheat production, **H** is the area under hybrid varieties such as Lok 1 which on an average yield 5000 kgs per hectare with six waterings including the sowing watering, **I** is the area under dryland varieties like Amrita which on an average yield 2500 kgs per hectare with just one watering and **A** is the total arable area. Let the sustainable amount of water that can be used up in a rabi season be **W** which will be much less than the amount of water that is now being utilized and the amount of water used up in one watering per hectare be **w.** Also, let the cost of production per hectare, including the cost of water, be **h** for the hybrid varieties and **i** for the dryland varieties and the price of wheat per kg is Rs 12. Let us also assume that there should be an economic constraint that the production process should yield the farmers at least a ten per cent return on their cost of production. Then we have the following linear optimization model -

Maximize $P = 5000\,H + 2500I$, subject to

$H + I \leq A$

$6H + I \leq W/w$

$1.1(hH + iI) \leq 12(5000H+2500I)$ which is equivalent to -

$(60000 - 1.1h)H + (30000 - 1.1i)\,I \geq 0$

$H, I > 0$

H,I are the variables for this model while A, W/w, i, h are all constants that have to be determined in accordance with the local resource endowment situations and the market condition prevailing for a given agricultural season. However, W, w, h and i will vary with time and research and action can be initiated to increase W and reduce w, h and i and move towards a more sustainable regime overall.

This is of course a highly simplified model of the actual reality which consists of various other crops and soil, water and market conditions. But it serves to illustrate the fact that it is possible to break out of the present unsustainable model of development based only on hybrid and water-intensive seeds. There are other environmental benefits of adopting this model like the lesser use of artificial energy, chemical fertilizers and pesticides which will all contribute to mitigating climate change. There is also the social benefit of the greater use of human labour in natural resource conservation work which will address the problem of under employment and surplus of labour in the current rural economy.

At present the rural economy is geared towards maximization of crop production but what is required is the maximization of bio-mass production with optimum use of natural and human resources. Thus, a more comprehensive version of the above alternative modelling based on actual experimentation on the ground can provide concrete pointers to the areas in which interventions are needed in agriculture -

- Farms have to be assessed for their soil quality and suitability for various kinds of crops and research, credit and marketing support provided for cultivating them. All of these are crucial as without a reorientation at the policy level it is very difficult to initiate changes in cropping practices at the ground level. Currently there is a woeful lack of data, research, credit and marketing support with regard to water conservative crops in the basin in particular and the country as a whole in general.
- There is need for calculating the "virtual water" embedded in a particular crop being produced in an area (Hoekstra & Chapagain, 2007). Even though there are some problems with the calculation of virtual water at the moment these can be overcome to reveal a true picture of the water embedded in different types of crops. This can be used as an advocacy tool to convince people to change consumption patterns towards lesser virtual water crops so that the demand pattern for crops also changes and it becomes easier to ensure more sustainable water use in agriculture.
- Measures have to be taken to increase the sustainable water availability **W** through soil and water conservation and afforestation and reduce **w** through greater reliance on the use of in situ soil moisture. The NREGS provides the best instrument for ensuring this. So steps have to be taken to improve the functioning of this scheme as detailed later.
- Biomass-based local farm manuring and energy production has to be encouraged to reduce fertilizer application, enhancement of soil quality, soil depth, water retention and use of fossil fuel-based energy. In the initial stages this too needs to be provided grant support as a considerable amount of labour has to be expended in this activity. This too could be included under the NREGS.
- All of the above have to be combined in an integrated plan at the sub-basin level in order to optimize sustainable resource use while at the same time ensuring a decent livelihood for the people. Such plans have been drawn up for specific basins (SOPPECOM & VIKSAT, 2003) but they have not been implemented and so there is a lack of ground level validation of these plans. Primarily because as stated in the report it involves a redirection of subsidies and grants from the presently prevailing system of agriculture to the proposed newer system. So there is a need for the implementation of such plans on a pilot basis with grant support and then wider policy level changes once these plans have been locally validated.

Water, in the short term, is a public good in the sense that it is a non-rival because consumption by one person does not reduce the possibility of consumption by another person and it is also not possible to exclude people from using it. That is why the market fails when it comes to the allocation of this resource. There is an over exploitation in the long-term as has happened not only in the Man basin but all over India. The profligate use of water for short-term gains in agricultural productivity has jeopardized the long-term environmental and economic sustainability of agriculture, natural resources and energy production. There is thus a need for water governance to ensure either through regulation, assigning of property rights, imposition of taxes or communitarian sharing that this vital resource is properly utilized. These options will be explored and compared in further detail later.

8. CRITICAL REVIEW OF THE MAN DAM

The Man dam was built with the objective of providing irrigation to an area predominantly populated by tribals practising dry land agriculture and so improving their livelihoods. Thus, in this section, the extent

Table 22: Design Data of Man Dam

Particular	Quantity
Location	N22º24'20" E75º5'40"
Total Catchment Area	69000 Ha.
Free Catchment	57680 Ha.
Command Area	15000 Ha., 48 villages
Height of Dam	53 m.
Max.Ht. Level	301 m
Full Reservoir Level	297.65 m
Dead Storage Level	273.0 m
Canal Outlet Level	277 m
Full Reservoir Capacity	14503 Ha. m
Utilizable Capacity	12787 Ha.m
Dead Storage	1716 Ha.m
Full Reservoir Area	1094 Ha
Minimum Reservoir Area	283 Ha.
Total Submergence Area	1169 Ha of which - Res. Forest - 5 Ha Agri. Land - 783 Ha Waste Land - 381 Ha
Partial Submergence Villages	17
Number of Affected Households	993
R.B.Canal Flow	4.23 cumecs
L.B.Canal Flow	6.26 cumecs
R.B. Canal Length	11.64 kms
L.B. Canal Length	10.02 kms
R.B. Culturable Command Area	6053 Ha (27 villages)
L.B. Culturable Command Area	8947 Ha (21 villages)

Source: Detailed Project Report of Man Dam, GOMP.

to which the designed objectives have been realized will be reviewed. Even though the initial feasibility report for constructing the dam was prepared in 1972 after detailed investigations site investigations around the confluence of the Sukhar and Man rivers. Later this initial site was rejected and a proposal prepared in 1982 for the present site at Zirabad which had a better underlying rock structure. The dam construction was temporarily held up in 1995 due to infringement of the conditions imposed by the Ministry of Environment and Forests when giving clearance for construction in 1984. The dam and a part of the canal system was finally completed in 2004 by which time the cost had escalated to Rs 176.75 crores from the designed Rs 35.94 crores. The important design data as per the Detailed Project Report (DPR, 1982) of the Man dam are given in Table 22.

The maps of the catchment and command areas superimposed on Survey of India topographical sheets of 1:50000 scale is shown in Figs. 6 and 7. The boundary of the catchment area map of the same scale provided in the DPR does not tally with the toposheets and so this has been drawn below in accordance with the toposheet to correct this anomaly. The command area extends into the basin of the Uri river to the west.

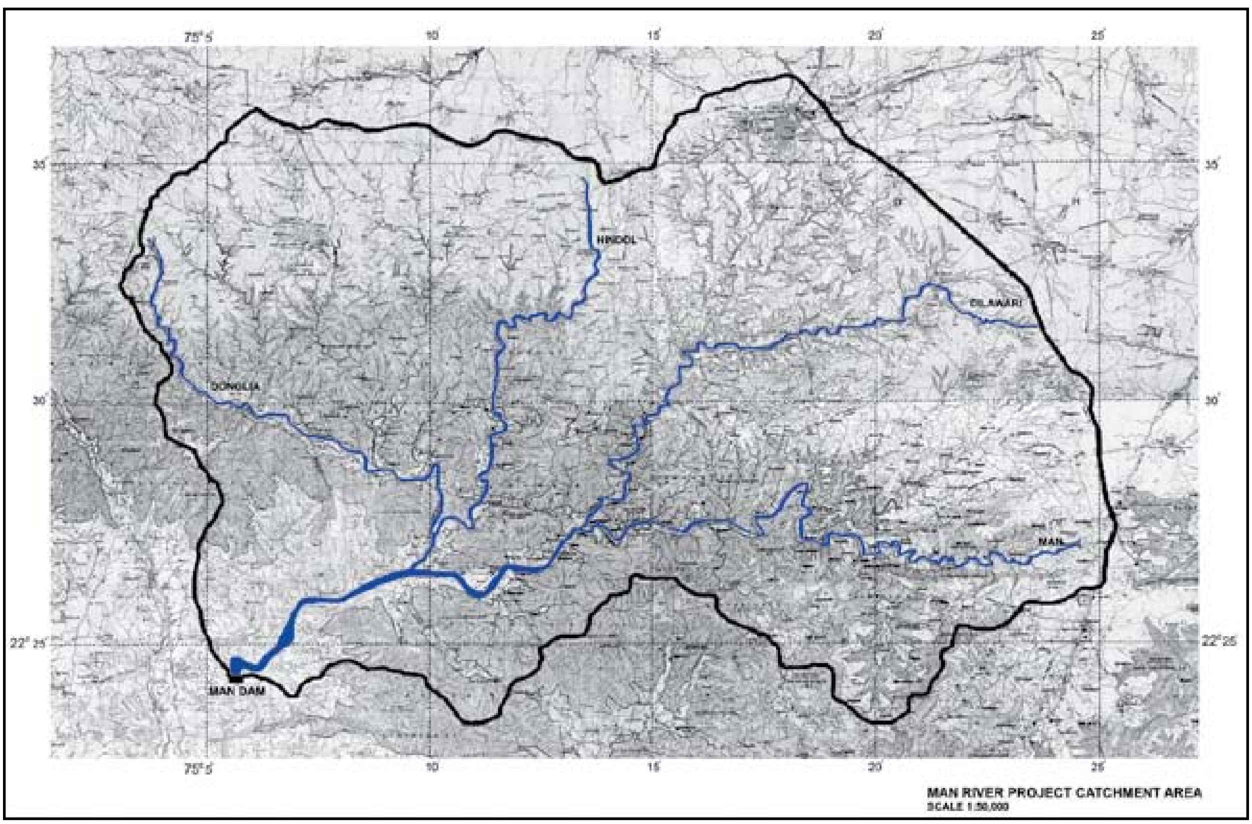

Fig. 6: Catchment Area of the Man Dam

The design benefit-cost ratio of the Man dam is flawed. There is an inadequate provision in the cost estimates for -

- The construction of canals which had to be lined upto the final 8 ha blocks for controlling seepage losses.
- Extensive land levelling and bunding to make the command area suitable for canal irrigation.
- Compensatory afforestation and catchment treatment as laid down in the conditions for environmental clearance given by the Ministry of Environment and Forests and
- Rehabilitation and resettlement of the displaced people.

Consequently the original DPR calculated the benefit-cost ratio, with a 10 per cent rate of return on investment and including the indirect benefits from water rates, irrigation cess, pisciculture, tourism and afforestation, as 0.72. With a lower 5 per cent rate of return on investment the benefit-cost ratio was calculated to be higher at 1.32. So to justify the project this lower rate of return was taken. In what follows the performance of the dam with regard to the above parameters is analysed in detail to show that the expectations of benefits have been belied and the costs have inflated many times since to render the project a failure in economic and environmental terms.

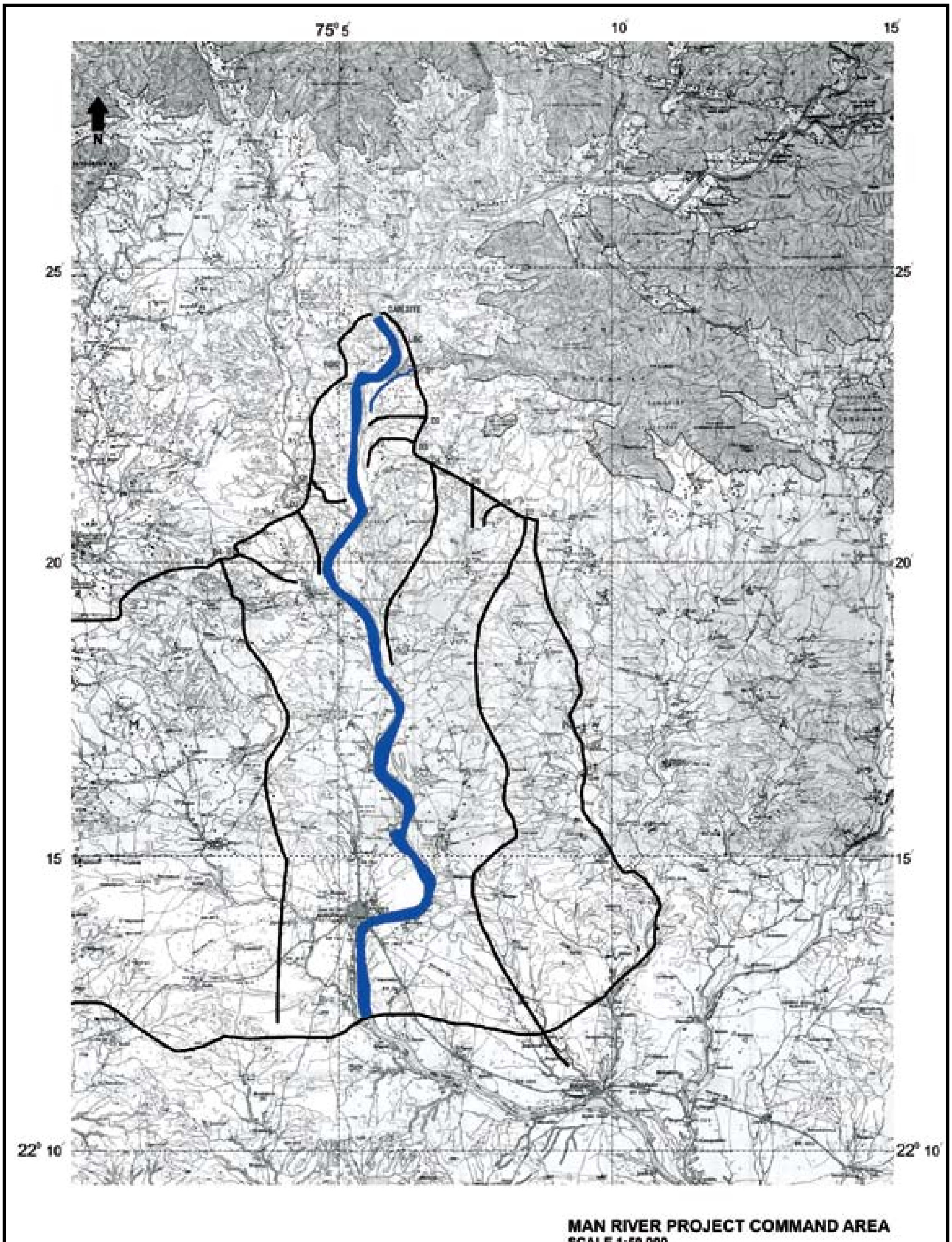

Fig. 7: Command Area of the Man Dam

8.1 Inadequate and Poorly Constructed Canal Network

Contrary to the design the Right Bank Canal (RBC) network has been developed more than the Left Bank Canal (LBC). In both cases the main canals, the distributaries and the minors have been built less than the design length. Moreover the construction of the canals is very poor and in many stretches the proper trapezoidal section and dimensions as per the designs have not been adopted, even for the main canal as shown in Fig. 8. Moreover, even though it is claimed in the final cost estimate report (CELNP, 2004) that 18.42 km length of the main canal has been lined this is not the case in reality as only those sections of the main canal that have been constructed above the ground level through earth filling to maintain the level have been lined and this length is far less. Thus, of the final cost of Rs 34.84 crores for the construction of the canal system only Rs 2.67 crores has been spent on lining of canals which is hardly sufficient for lining about 3 kms of the main canals in a proper manner. This has led to the main canals being unable to take the design flows and consequently the actual flow in the LBC varies between 2 - 3 cumecs and that in the RBC between 3 - 6 cumecs.

Fig. 8: Poorly Constructed Main Left Bank Canal

The canal structures have not been constructed properly and they are also not maintained as shown below in Fig. 9 in which the main aqueduct across the Sukhar river leaks profusely. The construction of the escapes across the main canal too are faulty and so water from the fields has breached the canal as indicated in Fig. 10.

Fig. 9: Leaking Aqueduct

Fig. 10: Breached Escape

8.2 Seepage and Waterlogging

The Water and Power Consultancy Services (WAPCOS) was engaged by the Madhya Pradesh Government to study the problems that might beset the canal network in the form of seepage given the kind of soil through which the canals were to pass and suggest remedies. The report of WAPCOS submitted in 1980 has been relied on for the determination of seepage and lining measures in the DPR. According to WAPCOS the estimated losses in the canal system are as follows -

1. Lined System
   a) Main Canal and Branches - 2 cusecs/million sq. ft.
   b) Distribution System - 4 cusecs/million sq. ft.
2. Unlined System
   a) Main Canal and Branches - 15 cusecs/million sq. ft.
   b) Distribution System - 20 cusecs/million sq. ft.

However, after a consideration of data regarding actual seepage losses in other operational projects, the WAPCOS report assumes the following estimates for losses in a lined system -

1. Lined System
   a) Main Canal and Branches - 4 cusecs/million sq. ft.
   b) Distribution System - 6 cusecs/million sq. ft.

The costs are then worked out for the canal system for different scenarios of unlined and lined systems. This is done by estimating the area of command for each scenario which keeps increasing as the system is progressively lined. Consequently even though the cost of lining rises the cost per hectare falls as the increase in the command area due to lining more than offsets the increased cost of lining as follows -

1. Wholly Unlined -	Rs 13,675/Ha
2. Main Canals and Branches Lined-	Rs 12,380/Ha
3. Lining upto 40 Ha blocks	Rs 11,033/Ha
4. Lining upto 8 Ha blocks	Rs 10,607/Ha

The DPR goes on to say on the basis of this - " In view of this and the recommendations of the World Bank in their Staff Appraisal Report no. 3260-IN of February 1981, lining of the whole canals system upto 5 to 8 Ha blocks is proposed in the Man Project." (DPR IIB pg 38)

Contrary to this, as mentioned earlier, only a small part of the main canals have been lined and so huge seepage losses are taking place. So great are these losses, given the poor construction of the canals, that as soon as the main canals are charged the drainage nullahs begin to flow with seepage water and they continue to do so throughout the irrigation season. This huge amount of water then flows to the tanks that have been constructed in the command area and overflows their waste weirs and finally reaches the Man river unutilized downstream of the dam as shown in Fig. 11.

Naturally the command area has shrunk considerably as there is not enough water flowing in the canals and in the 2007-08 season the "Elan" or announcement was for only 5000 Ha or one third of the design command. The actual irrigation took place in only 2765 Ha in 15 villages by the RBC and 2153 Ha in 14 villages by the LBC for a total of 4918 Ha. This in addition to the irrigation from water taken from the distributaries through field channels also includes the irrigation done from the seepage water collected in tanks as shown in Fig. 12 and by siphoning and pumping from the canals as indicated in Fig. 13 and Fig. 14.

Fig. 11: A Downstream Weir Overflowing with Seepage Water on the Man River

Fig. 12: Diverting Seepage Water for Irrigation

Fig. 13: Siphoning Water from the Main Canal

Fig. 14: Pumping Water from the Main Canal

The incompleteness of the canal network and the meager flow in the main canal itself, depleted by seepage, has led to the farmers using their own means to lift water from the canals quite audaciously. Moreover, the heavy seepage has also led to waterlogging in several farm plots close to the main canals. A survey was conducted in the 2007-08 irrigation season of the ways in which water was being drawn by the farmers and the number of farmers who had been affected by seepage and the data is shown in Table 23.

Table 23: Status of Water Use in the Man Dam Command

	Name of Village	No. of Farmers Irrigating Directly by Canal	No. of Farmers Irrigating by Motor Pumps on Canal	No. of Farmers Irrigating by Siphons on Canal	No. of Farmers with Plots Waterlogged by Seepage
RBC	Karondia	7	17	29	28
	Chakrud	11	32	49	22
	Bargodra	4	7	16	6
	Awalda	71	38	89	51
	Kharki	29	65	79	57
	Bhamori	2	15	15	33
	Panwa	83	60	34	63
	Lakhankot	5	27	73	25
	Baria	38	8	16	1
	Julwania	21	4	72	8
	Jaydi	23	19	51	52
	Kalwani	8	1	27	1
	Lunehra	93	8	9	1
	Chikhli	65	6	16	12
	Kustali	73	0	4	10
	Total RBC	533	307	579	370
LBC	Indiav	8	0	26	11
	Chirakhan	8	24	26	16
	Avral	3	0	23	3
	Borlai	25	51	29	47
	Temria	27	76	12	60
	Udiapur	31	0	21	9
	Muhali	30	8	23	54
	Jalkha	9	6	8	12
	Total LBC	141	165	168	212
	Total	674	472	747	582

Thus it is obvious that there are considerable problems with regard to drawal of water from the canals what with drawal by motor pumps and siphons exceeding by 80.8 per cent that being supplied directly. There are also a sizeable number of farmers affected by waterlogging due to seepage. The proportion is as high as 30.1 per cent. These farmers have had to either abandon this land or construct drainage channels to divert the seepage water as shown in Fig. 15 and Fig. 16. More than five hundred hectares of land are so affected by seepage and despite several petitions given by the affected people to the NVDA and the administration no remedial action has been taken.

Fig. 15: Land Abandoned Due to Seepage

Fig. 16: Drainage Channels for Seepage

Not surprisingly there is tremendous competition for canal water towards the lower reaches where the flow becomes very low because of seepages and unauthorized drawals higher up. Regulatory structures have been broken by the farmers and they draw water at will. Fig. 17 shows how impromptu bunds have been constructed in the Left Bank Main Canal to divert the water to their respective distributaries by villagers of two villages to the detriment of those lower down. There is a constant day and night vigil at this point by turns by the villagers so as to prevent those lower down from breaking the bunds.

Fig. 17: Impromptu Bunds on the Main Canal Diverting of Water into Distributaries

8.3 Unsuitability of Command for Flood Irrigation

A discussion on the suitability of the command area for flood irrigation is also in order. The discussion in the DPR in this regard is very illuminating and needs to be quoted fully (DPR I p. 76)-

Section 5.26: Land Irrigability Classification

For land irrigability classes, the following factors are taken into consideration in addition to the soil properties mentioned above.

i) Quality of water

ii) Environmental and physical factors with special reference to slope of land.

iii) Drainage requirements

iv) Economic considerations like production cost and yields

Taking the above facts into consideration the command area land is classified into the following land irrigability classes according to I.S. 5510-1969:

***Class 1:** Lands that are most suitable for sustained irrigation have been placed in this class. These are level lands (slope upto 1 per cent) with very deep soils of sandy clay loam to clay loam texture, well drained having adequate water holding capacity. The soil and topographical conditions are such that minimum erosion will result from irrigation and need for land shaping and land levelling is also minimum. Lands in this class are also free from any danger of rise in water table under irrigated conditions. Such land can produce all crops as per agro-climatic conditions of the command area. 217.36 Ha is covered by this class which is 0.76 per cent of the command area.*

***Class 2:** Lands of this class have moderate limitations for sustained use under irrigation. The slope of the land varies from 1 to 3 per cent. Soils vary in texture from clayey to loamy sand. Soils are subject to moderate erosion necessitating more care and greater cost of irrigation. This class of land is also capable of producing all crops suitable to agro-climatic conditions of the command area. This class covers an area of 7507.079 Ha which is 26.17 per cent of the command area.*

***Class 3:** Lands of this class have some limitations for sustained use under irrigation. Soils are deep to moderately deep with 2 to 5 per cent slopes and subject to some erosion. Soils can produce a good yield of corps after levelling the lands and bunding. These lands are spread over 4553.458 Ha which is 15.87 per cent of the command area.*

***Class 4:** Shallow and eroded lands have been included in this class. Surface soils upto 22 cms depth are only available for growing crops. As such, these lands can be used for growing fodder crops and dwarf wheat varieties in the rabi season with levelling and bunding. 11573.477 Ha of the command area is occupied by this class of land which is 44.33 per cent of the command*

The rest of the land, constituting 12.87 per cent of the command area, consists of uncultivable pastures, hills and forests.

Section 5.27: Recommendations

From the land irrigability classification, it is seen that the command area is average and large scale command development works, such as, land levelling and bunding are required to make the command suitable for cultivation of all the crops.

Thus, 60.2 per cent of the command area consists of land that is unsuitable for flood irrigation without extensive land levelling and bunding work and yet the project was sanctioned without any provision in the budget for such land levelling work. In fact in addition to this considerable length of drainage channels also need to be built but this finds only cursory mention and a provision of a paltry Rs 9.42 lakhs in the original DPR of 1982. However, later this absurdly low provision also has been dispensed with in the final cost estimate of 2004. This omission has obviously been done to reduce the costs of the project and artificially improve the cost- benefit ratio.

8.4 Inadequate Catchment Treatment and Compensatory Afforestation

There is mention in the DPR that extensive soil conservation and afforestation work needs to be carried out in the catchment area to ensure that the post-monsoon flow into the reservoir is augmented and also to reduce the silt load. However, once again there is no provision in the budget for these activities and so none have been carried out specific to the dam. The Ministry of Environment and Forests (MoEF) gave an environmental clearance to the Man dam project vide order no 11016/98/82-EMV5 of 2, January of 1984 (FoRN, 2009). The clearance was conditional with the major conditions being the following:

- Restoration of the construction site (Levelling and filling of dug areas as well as plantations on slopes).
- Compensatory afforestation along the full reservoir level of the dam and on both sides of the canals.
- Wood depot for inhabitants in the catchment to stop forest felling.
- Plans for rehabilitation of the project-affected families on non-forest lands.
- Establishment of a green belt of 500 mts breadth in the forest area and 50 mts breadth in the non-forest area to stop soil erosion.

These conditions were to be implemented pari passu with the construction. However, none of them have been implemented even after the completion of the project. The dam work was withheld for some time in 1995 due to this non-compliance and also that of rehabilitation but it was allowed to proceed later. This shows a very lackadaisical approach of the government as a whole towards ensuring environmental sustainability despite the blatant violation of the safeguards by the implementing agency.

There has been work done in soil conservation and small water structures through the Rajiv Gandhi Watershed Mission and by various other agencies. However, these have only intercepted more of the monsoon flow and have not really done much soil conservation owing to the lack of community involvement as mentioned earlier. In fact the post monsoon flow into the reservoir is negligible because most of the streams dry up once the rabi season pumping begins.

The forest area of 8778 Ha is of moderate crown cover only on the slopes on both sides of the Manawar to Amjhera road covering an area of about a 1000 Ha. A typical such reserve forest area is shown in Fig. 18. Otherwise it is all degraded forest. According to the DPR, only about 6 Ha of reserved forest area came under submergence so Rs 70,000 was spent on afforestation work on 10 Ha. This is highly inadequate given the nature of the terrain and the level of degradation. The catchment treatment work was supposed to be done as part of the Sardar Sarovar project as the basin also forms part of the catchment of that dam. However, minimal work has been done actually on the ground and vast areas of steep slopes remain barren and unbunded. Consequently not only have the economic costs been neglected, but as a result of this negligence the total annual flow of water into the dam has been reduced, while the silt load has increased reducing the utility and life of the dam.

Fig. 18: The Best Forest in the Catchment Area of the Man Dam

8.5 Problems with Rehabilitation

There have been serious problems with rehabilitation of project-affected persons. The provisions of the Narmada Water Disputes Tribunal Award and the Madhya Pradesh Rehabilitation Policy were not followed, especially with regard to giving a minimum of 2 Ha of irrigated land as compensation not only to the recorded landholders but also to their adult sons. Even those few who were rehabilitated in Kesur village in Dhar district in the Chambal basin were given less than the stipulated amount of land. Consequently from 2000 onwards, there was a militant mass movement against the construction of the dam by the oustees under the banner of the Narmada Bachao Andolan (IPT, 2002).

Even though this protest movement of the dam affected was eventually crushed through state repression and the dam built, nevertheless it has had some serious negative repercussions on the dam and its viability. Owing to inadequate rehabilitation many of the oustees have remained in the catchment area. They survive somehow on their unsubmerged land in the monsoons and then as the water in the dam recedes down with the release of canal water they begin practising drawdown agriculture on their submerged lands as shown in Fig. 19. Thus, there is considerable agricultural activity in the vicinity of the reservoir and inside it leading to higher silt load. Obviously under such circumstances afforestation of all the land on the rim of the reservoir to establish a green belt as stipulated in the environmental clearance given by the MoEF has not been done.

The Narmada Bachao Andolan has persisted with its struggle for justice in the High Court of Madhya Pradesh and has recently won a judgment that all adult sons of oustees should also be given two hectares of irrigated land. This effectively means that the government will have to spend at least another Rs 60 crores on rehabilitating around a thousand adult sons given that the price of irrigated land has escalated to Rs 3 lakhs per hectare even in the interior areas of Dhar district. What this will do to the financial viability of the project can be easily imagined.

Fig. 19: Women Practising Drawdown Agriculture in the Reservoir of the Man Dam

8.6 Actual Benefit-Cost Ratio

The benefit-cost ratio arrived at in the DPR assumed that not only would the operation and maintenance (O&M) costs of the dam be recovered but there would also be a surplus from the levy of irrigation and water cesses. The budgeted revenue expenditure on the Lower Narmada Projects Division of the Narmada Valley Development Authority (NVDA) in 2008-09 was Rs 2,06,57,000 (http://nvda.nic.in/budget.htm accessed on December 29, 2009). There are two projects of Jobat and Man dam in this division so roughly the O & M cost of the Man dam can be said to be Rs 1 crore. As opposed to this no revenue was generated from the beneficiaries in the command through collection of cesses. Even though under the provisions of the Madhya Pradesh Sinchai Prabandhan mein Krishakon ki Bhagidari Adhiniyam, 1999 (the legislation for facilitating participatory irrigation management) water user associations have been democratically constituted and elections to the canal level committees have been held, these are there on paper only as all operation and maintenance is still in the hands of the NVDA and given the bad state of the canal infrastructure no cess is being levied.

The non-realization of even the O&M costs, let alone the huge investment costs, is a standard feature of large-scale irrigation projects in India (Iyer, 2004). This is despite the existence of the Madhya Pradesh Irrigation Act 1931 which gives the government the right of use over all surface water sources and the power to levy irrigation cess. Thus, irrigation charges have either been levied minimally or not at all. So O&M has suffered and most canal systems are in disrepair. This is a vicious circle as bad canal systems and poor water delivery increase the reluctance of the farmers to pay irrigation cess. Combined with the tendency of the water resource bureaucracy not to complete the canal systems and develop the command area this has in effect meant that the irrigation potential created by the dams has not been realized in practice. A study of the Ministry of Agriculture data of the Government of India has revealed that over the period from 1989 to 2004 while Rs 99,610 crores were spent on major and medium irrigation projects and command area development in the country, the total area irrigated by canals actually fell by 3.18 million hectares (Thakkar & Chandra, 2007).

Similarly in the Man command area too no additional irrigation has been achieved due to the project. The actual irrigation by the Man dam canals is only 5000 hectares and that too is inclusive of the irrigation being done by pumping and siphoning. The land lost to seepage and submergence of about 1000 hectares has to be subtracted from this. Also the land that was already being irrigated in the Man command from various sources before the project was about 7000 hectares. Thus there is no additionality whatsoever and all that has happened is that some farmers who had previously been using other sources for irrigation have switched to the Man project water which is free for them at present without any cess being levied. The public saving from the project has been that of the electricity subsidy given to these farmers.

The lack of command area development too is a serious constraint and is yet another cost cutting measure that is relied on to boost the benefit-cost ratio to the long-term detriment of the project that is still continuing. The public investment proposed in irrigation enhancement by the Government of Madhya Pradesh through major, medium and minor projects and command area development in the annual plan for 2009-10 is Rs 1271.71 crores (GOMP, 2009b). However, this investment is mostly in the construction of the dams and main canals and there is an investment of only Rs 10 crores on command area development. This will compound the already serious problem of inadequate command area development that afflicts projects in the state in general and the Man project in particular.

The final cost of the project in 2004 was Rs 176.75 crores compared to the design cost in 1982 of Rs 35.94 crores (CELNP, op cit). The only return from the project so far is the saving in electricity subsidy due to some farmers having switched to canal irrigation from pump irrigation say over two thousand hectares or so if one subtracts the loss due to seepage and submergence. This saving would in all probability be much less than the Rs 1 crore annual O&M expenses of the project. Thus the net current economic impact of such a huge investment is negative on the government finances and there is no possibility whatsoever of the recouping of the investment let alone the earning of any returns. The social and environmental impacts of the project are even more negative in nature. The engineers of NVDA, however, smugly claim that the Man dam is a great success because it has significantly raised the groundwater level in the command area!

9. DRINKING WATER SITUATION

The drinking water scenario in the Man river basin is also a cause for concern. There are two municipalities - Dhar with a current population of about 90,000 people and Manawar with a current population of about 30,000. Both these towns have piped, filtered and treated water supply from tanks built on streams.

However, in the case of Manawar the municipality now draws water from the Man river which has water flowing in it as a consequence of the seepage flow of the Man dam as mentioned earlier. The municipality pays Rs 1 lakh annually to the NVDA for this facility. Both the towns need much more water than is supplied by the municipality and so there are a number of private borewells and also public handpumps. But the Public Health Engineering Department or the municipalities have not conducted any survey regarding the extent of groundwater extraction. In summer, especially in years of deficient rainfall, there is a drinking water crisis as tubewells and handpumps go dry. This is mitigated on an ad hoc basis by supplying water in tankers. Consequently the poorer citizens who cannot invest in their own supply arrangements have to make do with lesser quantity-wise and poorer quality-wise water than the more affluent sections. There are rules for artificial recharging of rainwater but these are not followed and so the situation keeps deteriorating. Moreover, the costs of piped and tanker water supply are not recovered from the charges levied from the citizens and the water supply system is subsidized by the state government. This problem of environmental and financial unsustainability of urban water supply in fact is a common phenomenon in dryland areas and is aggravated with the increase in the size of the urban unit (Banerjee, 2008b).

Larger villages too have piped water supply systems based on public borewells. Here too the operation of these systems has to be subsidized by the government owing to limited recovery from user fees. The village of Zirabad, for instance, has a piped water supply system fed from a tubewell. The monthly cost of running this system is about Rs 40,000 but the recovery from the 150 registered recipients is only Rs 4,500 per month as many do not pay the nominal Rs 50 per month charge on time. The huge deficit has thus to be made up from various government grants and poses a major problem. There is currently a deficit of Rs 34,000 in unpaid electricity bills. A new scheme is being implemented with Rs 4.95 lakhs of funding from the MLA Local Area Development Fund for drawing water from a well close to the Man dam reservoir which is about two kilometres from the village. However, this will push up running costs even further and increase the subsidy burden on the government.

The smaller villages are mostly dependent on dugwells and handpumps. The excessive drawal of groundwater for irrigation has affected the water availability of dugwells and handpumps. In 2008-09 due to deficient rainfall a serious water scarcity began to emerge from the March 2009 itself. So Zila Panchayat, Dhar, approved an ambitious scheme called Mahabhagirathi to combat the crisis in the villages (GOMP, 2009c). All 669 Gram Panchayats of Dhar district approved Mahabhagirathi drinking water microplans prepared by the villagers in all 1487 villages with the support of trained animators. These plans used Rs. 6.05 crores of funds already available with the Gram Panchayats under the Jawahar Gram Samriddhi Yojana (JGSY) and State Finance Commission grants. On April 14, 2009 these plans were approved by the Gram Sabhas and numerous instances of public contribution to solve drinking water problems came to light.

Dhar district had about 2,300 handpumps when the Rajiv Gandhi Drinking Water Technical Mission began in 1986. Today, it has over 11,500 handpumps. Thus, in 23 years, the number of handpumps has increased fivefold. In the same period, the number of irrigation tubewells has grown at a pace of 4 per cent p.a., whereas population has grown at 2 per cent. In the competition between public drinking water and private irrigation water, increasingly, groundwater is going for private irrigation purposes. Out of the 11,500 odd handpumps in the district 2,500 had gone fully dry by the end of March. Another 2,000 had their yield declining. Overall, 40 per cent of the handpumps in the district were affected and by May this had increased to 50 per cent. Certain Blocks are more affected than others.

The traditional solution of water transportation is an expensive one and difficult to implement on a large scale. So what was done was that submersible pumps were installed in the handpumps to tap the deeper water that cannot be pumped up by handpumps and a 1200-litre iron tank placed right next to the handpumps for water storage and working as a drinking water standpost. A drinking water cattle trough takes care of cattle drinking water problems too. Besides this, control of water wastage, social regulation of tubewell irrigation, repair of existing piped water or spot source supply schemes, restoration or desilting or deepening of existing dugwells or *bavadis*, timely collection and payment of water supply electricity bills, disconnecting illegal water connections and training school children in water management were some of the other steps taken.

The cost of a submersible pump, additional hundred feet of riser pipe, starter and panel box which was about Rs. 20-24,000. A locally fabricated 1200 litre 3.5 mm thick iron cistern cost about Rs. 6000. The total cost was thus, Rs 30,000. This one time cost was less than the recurring cost of water transportation. The average problem village requires transportation for about 2 months or 60 days. The typical tractor-tanker load of 6000 litres costs about Rs. 500 per trip. The average village needs about Rs. 1000 per day. The cost of transportation would have been Rs. 60,000 but comparatively the submersible pump system had an annual recurring cost of about Rs 12,000 in electricity bills and another Rs 3000 for maintenance.

Village-wise Mahabhagirathi drinking water plans had been prepared through animators trained in PRA (participatory rural appraisal) techniques at 155 cluster headquarters of the Rajiv Gandhi Education Mission. For this, all 155 cluster Academic Coordinators were given two-day training by master trainers at district level. Most of the animators were Education Guarantee Scheme (EGS) centre gurujis (teachers) or village watershed programme secretaries since they are local villagers who have a greater rapport with the villagers than other government functionaries. Women's drinking water watch committees were also formed in every village to check wasteful or unclean water use. Public Health Engineering department handpump mechanics and sub-engineers as well as Sarpanches, Up-sarpanches and Gram Panchayat secretaries were briefed about how they were to tackle the problem with the help of the community. Thus, a comprehensive people centred plan of action was undertaken to meet the drinking water crisis in a cost effective way.

The actual implementation of the programme was of average success as many handpumps did not have water at all and so water transportation had to be resorted to in the end. Though this was a good effort to meet the crisis situation in summer, it did not encompass a more holistic strategy of artificial recharge which is a more lasting solution to the problem. Moreover, the electricity supply was not always regular and of good quality so there were many cases of motors getting burnt and placing a further financial burden of repair on the already cash strapped panchayats.

The lowering of the groundwater table has thrown up yet another problem in the district. This problem is there in some villages of the Man basin also. The borewells have had to be sunk into rock strata that have fluoride content in them. Consequently there are 980 handpumps in 324 villages in the district that are affected with the problem of fluoride contamination in the water above the permissible limit of 1mg/litre (Vajpayee, 2005). This has led to dental and skeletal fluorosis in children. The government, UNICEF and WaterAid in collaboration with some NGOs address this problem by providing alternative water sources and free medical treatment to those affected.

Fig. 20: The Handpumps Still Bring Smiles

The overall drinking water situation in the basin is thus affected adversely by the unsustainability of water use in agriculture and the drinking water supply system has to be propped up by heavy government subsidies in the rural and urban areas. Since this system does not work very well because of a public funds crunch those few who can afford it seek individual solutions. Consequently the poor generally have to make do with inadequate and poor quality of supply. Moreover, since women have to do the work of getting domestic water this water supply crunch affects them the most.

10. GOVERNMENT, COMMUNITY AND MARKET

The serious and growing threat to sustainable development arising from misuse of fresh water leading to its pollution and scarcity was comprehensively discussed for the first time at the International Conference on Water and Environment organized by the World Meteorological Organization in Dublin, Ireland in January 1992 (GDRC, 2009). The conference, attended by water resource experts from over a hundred countries, put forward four guiding principles for concerted action to ensure sustainable use of water resources known as the Dublin Principles that have since come to be universally accepted as the basis for all future governance in the water sector and so they are being quoted here in full -

Principle No. 1 - Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment

Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or groundwater aquifer.

Principle No. 2 - Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels

The participatory approach involves raising awareness of the importance of water among policy makers and the general public. It means that decisions are taken at the lowest appropriate level, with full public consultation and involvement of users in the planning and implementation of water projects.

Principle No. 3 - Women play a central part in the provision, management and safeguarding of water

This pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development and management of water resources. Acceptance and implementation of this principle requires positive policies to address women's specific needs and to equip and empower women to participate at all levels in water resources programmes, including decision-making and implementation, in ways defined by them.

Principle No. 4 - Water has an economic value in all its competing uses and should be recognized as an economic good

Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

Clearly these principles have been wantonly violated by the Government of Madhya Pradesh in water governance in the Man basin over the last two decades in a manner that seems to indicate that the government agencies are not aware of them at all. The major consequence of this has been that traditional communitarian practices with regard to soil and water conservation, especially among the Bhil tribals, have decayed and a culture of unsustainable water consumerism has set in. Panchayati Raj has been in operation here for a long time now pre-dating the 73rd Constitutional Amendment. Consequently people in the basin are well aware of their political rights and are mostly affiliated to either the Congress or the Bharatiya Janata Party which have both been promoting an unsustainable water use paradigm. Consequently with regard to water use and governance people are mostly of the opinion that water should be made available in some way or other for farming and other use and are not overly concerned about the sustainability of water use.

An attempt was made during the research to spread the message that it is necessary to harvest rain water and conserve soil as much as is possible in situ and use the increased topsoil depth and moisture to grow the less water demanding traditional crops over a larger area rather than extract excessive water either from the deep confined aquifers or by building expensive and harmful large dams to grow high yielding varieties of wheat. This did not arouse much enthusiasm apart from nods of the head. The people in one village who had lost most of their lands in the reservoir of the Man dam listened patiently to this and then said that there was one large stream, Donglia, a tributary of the Man river, that did not have any dam on it. If one big dam was built on it then all the lands below it including those in their village that were not yet submerged could be irrigated. When they were asked whether those upstream of the dam were prepared to give up their lands for this they remained silent.

An attempt was also made to organize a public meeting in this village and many other oustee families from neighboring villages were invited to discuss the whole issue of in situ water and soil conservation and the practising of an agriculture based on the optimum use of conserved soil moisture. Two whole weeks were spent in going from village to village and talking to people and they all nodded their heads and said that this was indeed the way to go. However, only five people came to the meeting. In the desultory conversation that took place these people said that they should be given either drip or sprinkler irrigation systems which were more efficient in the use of water than traditional flood irrigation. Once again the penchant was for energy guzzling and capital intensive modern technological solutions that could be implemented at best in a very small area. There was no enthusiasm at all for the traditional communitarian labour intensive and resource conservative agriculture. Such is the hegemony of modern development that even when one version of it fails people still feel that a newer version based on newer, more energy intensive technology supported by higher government subsidies will succeed. Just one farmer in the Man basin agreed to undertake the dry land wheat cultivation experiment described earlier which was adopted by a number of farmers elsewhere in the western Madhya Pradesh region where DGVK has been active for over two decades and so has greater credibility to be able to counter the dominant and unsustainable development paradigm.

There has been considerable work done under various schemes like the Rajiv Gandhi Watershed Development Mission (RGWM) and the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) in the sphere of watershed development. But this has remained restricted to the physical works without much involvement of the people in communitarian practices that can improve the water availability and use in the basin. Moreover, a serious problem in both the RGWM and the MGNREGS is the tremendous delay in the payment of wages which puts people off from participating in these schemes. In Madhya Pradesh the MGNREGS has been coupled with the State Government's own Kapil Dhara scheme for digging of dug wells. This has led to the indiscriminate digging of dug wells with little regard to water availability and many of these wells go dry in winter or are unable to provide enough water for irrigation.

An analysis of the MGNREGS and Panchayati Raj as they have evolved in the area reveals the difficulty of people's mobilization for water governance. The entire basin is a Fifth Schedule Area and so under the provisions of the Panchayat Extension to Scheduled Areas Act (PESA) 1996, the Gram Sabha should be the most powerful body. However, the reality is quite different. The elections to the Panchayat Executive constituted by the directly elected Sarpanch and the Panches or ward members ensure that it is this body that holds the powers and in most cases Gram Sabhas are not held at all. Development works are carried out arbitrarily by the Sarpanch and in many cases the accounts are maintained without transparency. Into this the MGNREGS has now been dovetailed. In all the works that were going on under the MGNREGS that were surveyed during this research, there were no muster rolls being maintained at the site and only the names of the workers were being noted in a register. Neither were the job cards being filled daily. It appears that the job cards and the muster rolls are filled in later and the former are mostly kept with the Sarpanch or the Panchayat Secretary. Thus the same corrupt nexus of elected representatives and government staff that bedevils the functioning of public services at the central, state and district levels has now manifested itself at the panchayat level. Ingenious methods have been found to circumvent the latest provision of making payments of wages directly into the bank accounts of the workers by roping in the bank staff also into the system of graft. The Sarpanches and Panches along with the Panchayat Secretaries have become considerably more powerful by feeding on the MGNREGS funds and are bent against the holding of Gram Sabhas. Not surprisingly the attempt during the research to involve people in studying the problems of water governance and seek communitarian solutions to them did not get a favourable response.

The command area of the Man dam, as mentioned earlier, is plagued with serious problems arising from the poor construction of the canal system which has led to considerable conflict among the people. Despite there being Water User Associations and Canal Level Committees in place to which elections have taken place, there is not much people's participation in the management of the canal or the redressal of the grievances of the people who are affected by the malfunctioning of the canal system, especially the problem of seepage and waterlogging. Here too there is the problem of delayed payments for work done on repairing the canal system under the MGNREGS. As mentioned earlier, the provisions of the Participatory Irrigation Management Act have been complied with only on paper because the ground conditions for its actual implementation do not exist.

The World Bank is a major inspiration for water resource development and governance in this country and has provided considerable technical and financial support to the kind of unsustainable water resource development that we have witnessed in the Man basin. Once the Dublin Principles became widely accepted the World Bank, perforce, had to subscribe to them and so it came up with a new water resources management policy (World Bank, 1993). While continuing with its thrust on large projects there was now a greater stress than before on recovery of capital investment and O&M expenses of these projects through greater involvement of the beneficiaries in the management of the distribution system. So all lending was made conditional to the charging of realistic irrigation cesses and the implementation of participatory irrigation management for ensuring their collection. Simultaneously there was a push for IWRM ostensibly for ecological sustainability through rationalization of surface and groundwater usage in a holistic basin wide approach but more importantly, to try and ensure that electricity supplied for groundwater irrigation was also charged at rates that were economically sustainable for the power generation and distribution companies. There was little appreciation of the fact that over four decades of unsustainable agriculture and water use had made it impossible for the farmers both rich and poor to bear the present full economic costs of water.

The Ministry of Water Resources followed suit and constituted a National Commission for Integrated Water Resources Development in 1996 which submitted its report in 1999 which too recommended that ongoing projects should be expeditiously completed and water charges should be raised and their collection facilitated through implementation of PIM. Consequently the focus was directed on more efficient delivery of water and an Accelerated Irrigation Benefits Programme was initiated in 1996 and PIM took off in a big way from 1997 onwards. The crisis of groundwater too received attention and as a corollary the sore point of non-recovery of electricity charges from farmers. The National Water Policy of 2002 (GOI, 2002) and the Madhya Pradesh Water Policy of 2003 (GOMP, 2003) are comparatively good documents that incorporate the Dublin Principles and try to strike a balance between the need for greater public investments in the water sector and cost recovery, between the need for adequate supply of water for various uses and the requirement of environmental sustainability, the need for greater involvement of people in water resource management, the need for complementarity between land and water use especially with regard to augmentation and use of groundwater. Both stress the importance of good data collection and analysis for consistent planning and management of water resources.

However, in practice there is hardly any awareness or implementation of these policies at the ground level among the water resource department staff in the Man basin. The concern is only for creating more structures big and small. None of the engineers interviewed had heard of the “Master Plan for Artificial Recharge of Groundwater in India” prepared by the Central Groundwater Board (CGWB, 2008) which gives detailed state wise plans for surveying and using underground aquifers for storage of monsoon rainfall through appropriate recharging techniques involving the direction of surface water to fractures in the hard rock. Instead their view was that river interlinking should be adopted to bring water to the region. The NVDA bureaucracy is also not concerned at all about the serious problems besetting the canal system of the Man dam which have made it a total failure.

Finally a word about the possibility of introduction of water rights and recovery of costs through appropriate pricing and creation of water markets in the basin on the lines suggested by some proponents for India as a whole (Saleth, 1996). The creation of water rights is based on the principle that it is possible for the government to create individual rights over a public good through legislation and then apportion these rights to a set of people (Coase, 1960). Thereafter trading in the market place it is argued will ensure an equitable and efficient use of the public good. This is the principle for the apportioning and trading of pollution permits in the USA under the Clean Air Act of 1990 and the carbon credit trading system set up under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC, 2009).

However, even theoretically there are several problems in this because this holds only in a perfect equilibrium market situation where there are only two bargainers. When there are many bargainers and they have different endowment levels with regard to other resources, then this system does not work as the apportionment of rights suffers and the markets also tend to malfunction. Moreover in the case of water for apportioning of rights to be possible first there must be an accurate estimation of the amount of water available for apportioning. As we have seen this is a highly problematic area in India and especially so in the Man basin. The ownership of land is highly skewed and tends to distort the economic and political power structure in the basin and this too will affect the apportionment of water rights and trading. Finally given the long history of free or subsidized supply of water, electricity and other inputs and the overwhelming dominance of external input agriculture it is very difficult for any government in a democratic set up to impose an actual cost based trading system for these inputs. Thus in reality this system of creating institutions for apportioning rights in public goods and creating markets for trading in them has not worked very well anywhere. In the water sector in India, where there is practically no effective regulation and most people source their water directly from nature in an informal water economy, despite over a decade of implementation of IWRM and PIM the results are not very encouraging (Shah, 2007).

There have been suggestions, on the basis of the fact that the actual loss to the economy is much greater than the actual amount of the subsidies due to inefficient use, leakages and theft that these subsidies encourage, that the subsidy amounts should be directly transferred to the beneficiaries while letting the prices of water, diesel and electricity be fixed at levels that cover the actual cost (Morris ed, 2004). This is similar to the direct cash transfer approach being advocated as being a more efficient method of subsidizing the poor than the MGNREGS (Kapur et al. 2008). The Planning Commission has even started implementing some pilot schemes of direct cash transfers. Even though this is quite appealing at an academic level, there are many problems with its implementation not the least being the ingenuity of politicians and bureaucrats in subverting any scheme (Nayar & Pillai, 2009).

The foregoing discussion makes it abundantly clear that ultimately competent governance in any sector can take place only if there is conscious community mobilization at the grassroots level in support of this. Even markets by themselves cannot function equitably and efficiently without proper regulation. As we have seen, macro-level policies that have fostered bad governance and market failure have also led to the decay of communitarian management of resources and especially those of land, water and forests. Given the sad lack of vision and commitment in the government and the bureaucracy, good water governance will have to be attempted at a decentralized level by communities themselves. Especially as such communitarian water governance will also have a mitigating effect on climate change (Cruz, 2009) and make the communities eligible for carbon credits. One of the foremost votaries of such communitarian approaches to the management of common pool natural resources, Elinor Ostrom, has recently been awarded the Nobel Memorial Prize for the Economic Sciences in 2009 thus putting the imprimatur on the validity of this approach (Ostrom, 2001). However, as has been amply demonstrated by the failure of attempts to get people organized in the Man basin, people's mobilization for alternatives in the face of government and bureaucratic apathy and opposition is a difficult task. Thus, alternative water governance experiments should first be taken up in places where there is already people's mobilization of a high order so as to demonstrate the feasibility of this approach while simultaneously advocating and campaigning for a drastic change in macro level policies.

One such area in the western Madhya Pradesh region is Alirajpur district where the Khedut Mazdoor Chetna Sangath (KMCS) has mobilized the local Bhil tribal population on rights issues for over two and a half decades (Banerjee, 2008a). Apart from rights-based mobilization the KMCS has taken up soil, forest and water conservation work on a large scale through voluntary participation in defiance of the negative attitude of the government and the bureaucracy and the results are evident. The stream running through village Attha, shown in Fig. 21 has water flowing perennially even though there are as many as seventy motor pumps on the stream drawing water from it for irrigation. In the light of the insights gained from the present research, detailed geo-hydrological investigations should be carried out in such a sub-basin and alternative water utilization plans for agriculture and bio-mass development should be drawn up and implemented as a pilot which can then be projected as a replicable prototype for adoption by others.

Fig. 21: A farmer with his suction pipe on the perennial stream in Attha

11. CONCLUSIONS

The exploratory investigations carried out under this research and detailed above unequivocally indicate that there is neither water nor governance in the Man river basin. The primary problem is with regard to unsustainable use of water resources arising from a misconceived agricultural policy. Even now the Madhya Pradesh government is forced to provide an annual subsidy of about Rs 1000 crores for the supply of cheap electricity to farmers. However, since this culture of subsidies for over consumption of water has decimated the state's coffers it does not have enough resources to build new power stations. Thus, there is a tremendous shortage of power and the deficit peaks on an average to 2000 MW in the rabi season. Consequently there is insufficient supply of this cheap electricity forcing farmers to use more expensive diesel to meet the gap.

This means that an unsustainable agricultural regime is being sustained through subsidies and grants inefficiently. On the whole it is turning out to be costlier both economically and environmentally. Similarly the Man dam too embodies a colossal waste of resources and it is an economic and environmental fiasco. The net result of all this is that farmers continue to labour on in an unsustainable regime and are not inclined towards trying out more sustainable agricultural options. The situation has been compounded by a decay of traditional communitarian natural resource management practices due once again to government support for an unsustainable system. The provisions of the Fifth Schedule of the Constitution, PESA, NREGA and the Scheduled Tribes and other Forest Dwellers (Recognition of Rights) Act 2006 and various other enabling provisions that favour Scheduled Tribes can together ensure a revival of communitarian and sustainable natural resource governance in the basin which is predominantly a tribal area but there is minimal initiative on the part of the government to make this possible. All efforts made to wean farmers away from this unsustainable system as a part of this research came a cropper in this basin primarily because of the government's support for the system.

Summarizing the insights gained from this study the following recommendations can be made for improving the prevailing sorry state of affairs -

1. Farms have to be assessed for their soil quality and suitability for various kinds of crops and research, credit and marketing support provided for cultivating them. All of these are crucial as without a reorientation at the policy level it is very difficult to initiate changes in cropping practices at the ground level. Currently there is a woeful lack of data, research, credit and marketing support with regard to water conservative crops in the basin in particular, and the country as a whole in general.
2. There is need for calculating the "virtual water" embedded in a particular crop being produced in an area. Even though there are some problems with the calculation of virtual water at the moment these can be overcome to reveal a true picture of the water embedded in different types of crops. This can be used as an advocacy tool to convince people to change consumption patterns towards lesser virtual water crops so that the demand pattern for crops also changes and it becomes easier to ensure more sustainable water use in agriculture.
3. Measures have to be taken to increase the sustainable water availability through soil and water conservation and afforestation and reduce water consumption through greater reliance on the use of in situ soil moisture. The NREGS is the best option for ensuring this. So steps have to be taken to improve its functioning and make it realize its goal of conserving and enhancing the natural resource base of the basin.
4. Panchayati Raj, NREGS, PESA and the Scheduled Tribes and Other Forest Dwellers (Recognition of Rights) Act 2006 along with various other enabling provisions for tribals must be properly synergized to revitalize communitarian natural resource management as the major thrust for solving the problem of unsustainability of water use in the basin given that the numerically dominant population is one of tribals. Care should be taken to see that women participate equally in these efforts.
5. Biomass-based local farm manuring and energy production has to be encouraged to reduce fertilizer application, enhancement of soil quality and soil depth and water retention and use of fossil fuel-based

energy. In the initial stages this also needs to be provided grant support as a considerable amount of labour has to be expended in this activity. This too could be included under the NREGS.

6. A thorough revamping of the working of the Man dam has to be done to increase its economic and environmental usefulness from the present negative status. Further investments have to be made in rehabilitating the displaced, carrying out catchment treatment and afforestation, properly constructing and lining the canal system, levelling and bunding of the command area and provision of drainage before it can be integrated into a communitarian management system within a localized sub-basin level IWRM framework.

7. All of the above have to be combined in an integrated people-centred plan at the sub-basin level so as to optimize sustainable resource use while at the same time ensuring a decent livelihood for the people. Such plans have been drawn up for specific basins but have not been implemented primarily because they involve a redirection of subsidies and grants from the presently prevailing system of unsustainable agriculture to the proposed newer system.

8. Serious thought has to be given to the methods in which grant and subsidy support are to be given to farmers and the poor, including those involving direct cash transfers so as to ensure that leakages do not take place and the market can function in an efficient manner to allocate scarce resources.

9. There is considerable scepticism regarding the equity and feasibility of the cap and trade mechanism for combating climate change (Hovi & Holtsmark, 2006) but nevertheless in the near future this is going to be the way forward. The United Nations has initiated a programme for transfer of funds for Reducing Emissions from Deforestation and Forest Degradation in Developing Countries and associated efforts to conserve, sustainably manage, and enhance forest carbon stocks (UN-REDD, 2009). Measures should be adopted for registering the programmes above under this scheme for providing direct support to resource conserving tribal communities.

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