Responding to Complexity:

Local Approaches to Water Management in India and Nepal
A collaborative research program

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CONTEXT AND RESEARCH LOCATIONS

In South Asia and many other parts of the world, emerging water problems threaten the viability of entire ecosystems and the sustainability of water supplies for fundamental human needs. The nature of these water problems, however, varies greatly between locations and scales of analysis. Pollution[1], groundwater level declines[2], flooding [3]and water logging can all represent significant water management problems even within local administrative areas. High geographic variability is compounded by great seasonal variability. An area may experience severe seasonal water scarcity during the hot season and also have major flooding problems. Many such problems are inherently local in nature; others cannot be addressed without coordinated action at a regional or basin scale.

Social responses to water management needs throughout South Asia have tended to fall into three broad categories: (1) highly centralized projects undertaken by national and state governments; (2) high-level attempts to influence the legal and economic environment in which water use occurs; and (3) village or community level initiatives. These approaches reflect three underlying models of social change. The first emphasizes the dominant role of formal 'decision-makers' within governments and development organizations as the agents through which policies and programs are first formulated and then translated into governmental action. The second downplays the role of national or local organizations and focuses instead on the role of economic incentives, rights, markets and the private sector as the primary mechanisms for allocating water and limiting extraction to sustainable levels. Finally, the third emphasizes the role of individuals and communities as the dominant factor determining water use and management at the local level. These models are, of course, not isolated and the broad stream of literature, research and implementation projects focused on 'participatory' approaches and the links between economics and institutions reflects common attempts to integrate them. Our main concern with the models, however, is that none has proved effective in initiating widespread development of effective management systems.

We believe the above failure stems from fundamental misconceptions regarding the manner in which social change occurs. From our perspective – one which is admittedly difficult to prove – social and institutional change emerges from a contested terrain in which many actors (individuals, communities, businesses, NGOs, local government organizations and the State) compete to protect their economic, political, cultural, social and other interests. This competition occurs at multiple levels within the frameworks created by markets, laws and social norms. It often results in deadlock. In some cases, this deadlock is related to inherent conflicts of interest and can only be resolved through the victory of one or another set of stakeholders. In other cases, however, conflicts of interest are not inherent but

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[1] For instance, several villages of North Arcot district (in Tamil Nadu) in Palar river basin do not even have drinking water availability because of severe pollution due to tannery effluents.
[2] For instance, ground water levels are in the range of 80-100 metes in Mehsana district of Gujarat; of late, for sustainable drinking water supplies, borewells around Rajkot city are drilled to 400-470 meters below ground level.
[3] Such as the recent floods that devastated Hyderabad in Andhra Pradesh.

deadlock occurs because there is no common framework for identifying, understanding or negotiating potential solutions. Innovators and social auditors capable of identifying potential solutions and creating common frameworks for understanding, dialogue and negotiation among stakeholders can play major catalytic roles in this latter type of situation.

Our research project is designed around this alternative model for social change. The core presumption is that development of a common, quantitative, framework for understanding water problems combined with detailed analysis of the social and economic context can be used to create a foundation for stakeholders to reach agreement regarding potential solutions. This foundation can then be combined with networking and the creation of forums for negotiation that encourage the development of water management solutions at whatever scale is most effective given the hydrologic, institutional, economic and social context.

In order to develop and test the above model for social change, our project involves coordinated research in five field sites – three in India and two in Nepal. These are:

1. **The Sabarmati Basin**: This basin wends through a semi-arid section of Gujarat in western India. Groundwater overdraft is a major concern throughout the region and water supplies for both agriculture and urban uses in Ahmedabad (a city of approximately five million) are extremely limited. Water supplies are, however, likely to become available through the controversial Sardar Sarovar (Narmada) project. Similar, but far smaller, projects are already present in parts of the basin and in adjacent areas. Water logging problems are severe in some of these projects (such as the lower portion of the Mahi project in Kheda District). Groundwater overdraft, water logging and the allocation of available supplies between uses are, as a result, some of the most major challenges in this basin.

2. **Banganga River Basin**: This basin is in the arid state of Rajasthan, neighboring Gujarat in India. This basin has severe groundwater overdraft problems. Local responses have, however, been substantial. Tarun Bharat Sangh, a local NGO, has catalyzed water-harvesting activities in numerous villages of Alwar district and there is a substantial opportunity to improve understanding of the motivations for local water management in the basin.

3. **Palar Basin:** This basin runs through central Tamil Nadu, a state in South India. Groundwater overdraft is a major concern in much of the basin as is pollution. Overdraft problems here are, however, significantly different from those in the deep alluvial aquifers of Gujarat because most of the region is underlain by crystalline rock. This type of formation has little storage capacity (that is, storativity) and complex ground water (or aquifer) flow patterns making management more of a local, rather than aquifer-scale, issue.

4. **Tinau Basin:** This basin runs from the middle Himalaya into the Terai of Nepal. Management concerns in it range from local issues over the maintenance and sustainability of traditional irrigation systems to the

potential pollution of the lower basin as cities along the base of the Himalaya grow.

5. **The Kathmandu Region**: This region has been selected because it contains a major urban area in Nepal where water scarcity and groundwater overdraft are emerging as major points of concern – despite the local availability of substantial water supplies. Proposals are present to meet Kathmandu's water needs through major transbasin diversions from other basins. The cost of such projects would, however, be huge and, even if completed, they would leave many major water problems in the basin unresolved. The question of community-based management is, as a result, of tremendous immediate importance.

PROBLEMS, CONFLICTS AND OPPORTUNITIES

On one level, the community-based water management research program focuses on a broad array of emerging water problems, such as groundwater overdraft, that threaten basic livelihoods in South Asia and, for that matter, many other parts of the world as well. Problems, such as the 3m/year decline in aquifer levels now common in much of Gujarat, generate conflict both at the very local level between individual users and at higher levels between, for example, urban and rural areas or between states. Specific conflicts of this type are well documented in the book, *Rethinking the Mosaic* that was produced during the first phase of the project. Looking beyond these immediate tangible conflicts, however, the core challenges lie not in the physical problems themselves or in the conflicts between users and regions but in the social and institutional context determining how society responds to water problems and the conflicts they generate. As discussed in the previous section, three conflicting models of social change dominate most approaches to water – and other natural resource – management. These models are also ideological endpoints and stem from the fundamentally different worldviews of their proponents. They are, in themselves, perhaps the most fundamental points of conflict.

The conflict between worldviews is clearly evident in current debates over the viability and desirability of large dams. In South Asia, large dam projects have been designed and implemented by the state and are run through highly centralized irrigation departments. This approach has its roots in Nehruvian socialism with its emphasis on the State as a primary actor and motivator of development. Opponents to such projects often propose community-based management through communities and the revitalization of traditional water management systems. This approach is perhaps best articulated in recent publications such as *Dying Wisdom* [Agarwal, 1997 #173]. Opposition can also come from organizations, such as the World Bank, that emphasize the dominant role of economics and the private sector. This worldview may not oppose the dams *per se* but focuses on reducing the role of the public sector in their construction, operation and maintenance. The conflicts generated by the above worldviews can be intense. In Gujarat, for example, debates over the Narmada project and potential alternatives to it have led to withdrawal of the World Bank's financing for the scheme and to many instances of physical violence between opponents and the State.

Opportunities also often abound in the contested terrain between worldviews. In many cases ideologies can be undermined by rational arguments based on neutral scientific information and data. In the large dam debate, for example, most scientific information has been collected and project proponents have done engineering analysis. Alternatives have rarely been analyzed in a systematic or professional manner – one that would be viewed as technically equivalent to the analyses undertaken for the dam project. Proponents of community-based approaches to water management lack the professional capability and scientific information necessary to establish whether or not the approaches they advocate represent viable alternatives to large state-centric projects. Opponents are, at least in some cases, capable of blocking the implementation of large projects such as the Arun III project in Nepal. They are, however, rarely able to develop comprehensive alternatives. Deadlock results. This type of situation represents a potentially major opportunity in which professionally competent and politically neutral "social auditors" can catalyze change by undertaking high quality analysis of alternatives and engaging the full range of involved stakeholders in dialogue. This is the type of opportunity our collaborative project is designed to exploit.

RESEARCH GOALS

The core research objectives in the second phase of the collaborative program are:

1. *To develop quantitative order-of-magnitude scenarios that explore the extent to which different combinations of "local' supply or demand side water management interventions could balance water supply and demand in each study area*. This is currently being done using the WEAP modeling system.

2. *To evaluate the economic viability of management approach scenarios by comparing order-of-magnitude costs for potential community-based management interventions to the value of water in each study area*. This is currently being accomplished through field research to estimate the value of water combined with cost estimates developed for each water management scenario.

3. *To evaluate opportunities for initiating demand side management through economic mechanisms (pricing or markets).* This has yet to be initiated but will be achieved by combining estimates of the value of water, evaluation of conservation costs (such as the cost of a hectare of drip system) and identification of potential avenues for creating economic incentives (such as the pricing of energy for groundwater pumping).

4. *To evaluate the capacity of existing organizations and institutions to enable community-based water management approaches and, where these appear insufficient, to evaluate potential avenues for catalyzing change.* Political economic research is currently underway and will be combined with stakeholder forums in each region. Specific methodologies for this component were identified in an *economic and institutional analysis capacity building workshop* at the start of the second phase and are currently being finalized. These are discussed further below.

ACTIVITIES UNDERWAY

At present, a wide variety of field research and modeling activities are underway in each of the case study sites. In addition, stakeholder forums have been initiated in most areas. The project is complex and involves a wide array of components. For this reason, this paper does not attempt to describe the full array of activities underway but focuses on a number of key aspects we believe will be of interest to workshop participants. Detailed descriptions of some activities are included in the accompanying poster presentations being made by each partner organization.

RESEARCH QUESTIONS

At the most broad level, the research questions being asked in each site are intended to form a logical progression from problem identification to the identification of solutions that are economically viable and socially equitable. Previous research and the broad literature on water in South Asia have identified a wide array of "generic" water problems. These include water scarcity and broad areas affected by groundwater overdraft, pollution, salinization and water logging. As any researcher working in the field knows, however, these generic water problems are rarely similar at local levels. Problem characteristics and the hydrological and social contexts in which they are emerging vary greatly as do the array of technically feasible solutions. As a result, preconceived or generic definitions of problems are insufficient. Instead, research on community-based water management options must start by identifying the actual nature and characteristics of communities and water management needs within the local study areas. Once this has been done, an array of secondary research questions will emerge concerning the technical, economic, institutional and social characteristics of potential management options.

Given the above considerations, our research program focuses less on a pre-defined set of research questions and more on a common process and set of tools that can be used to investigate a broad array of much more tightly focused researchable questions as they emerge in the course of the study. This process consists of a broad scoping – or problem identification and definition step (essentially the first phase of the project) – followed by systematic investigation within key topical arenas. This will then lead into a broad set of discussions with key stakeholders. The topical arenas and some of the detailed research questions being addressed within them are outlined below.

TOPICAL ARENAS

Physical Management Issues and Options

This section of the project focuses primarily on the quantitative availability of water supplies in relation to water needs within the study areas. Water quality issues are equally important. Due, however, to lack of data, they could not be addressed within the scope of the project. During the first, scoping phase of the project, water "scarcity" was raised as a major concern by residents within the study areas. The nature of scarcity concerns varies greatly however, between the areas. In Gujarat, for example, naturally low levels of rainfall combined with long-term groundwater level declines are depleting available resources. Water is scarce in an absolute sense and the social impact of this scarcity is compounded by differential access to water – those who can afford to drill ever-deeper wells face little scarcity, others have difficulty even obtaining drinking water. In contrast to this, water scarcity along the Tinau River relates more to seasonal river fluctuations and increasing difficulty in diverting flows into traditional irrigation systems.

Whatever the cause of scarcity, the first response of local populations is to demand an increase in supply through the construction of dams, water harvesting and well drilling. In many areas, however, additional supplies are unavailable or could only be developed at great social and environmental cost. Our analysis in the first phase suggests that demand side management – using locally available supplies more efficiently and equitably rather than the development of new supplies – is likely to be an essential component of any long-term solution.

Based on this preliminary analysis, a key research question during the current (second phase) of the project is: *To what extent could packages of demand side management interventions address emerging water scarcity problems within all study areas?*

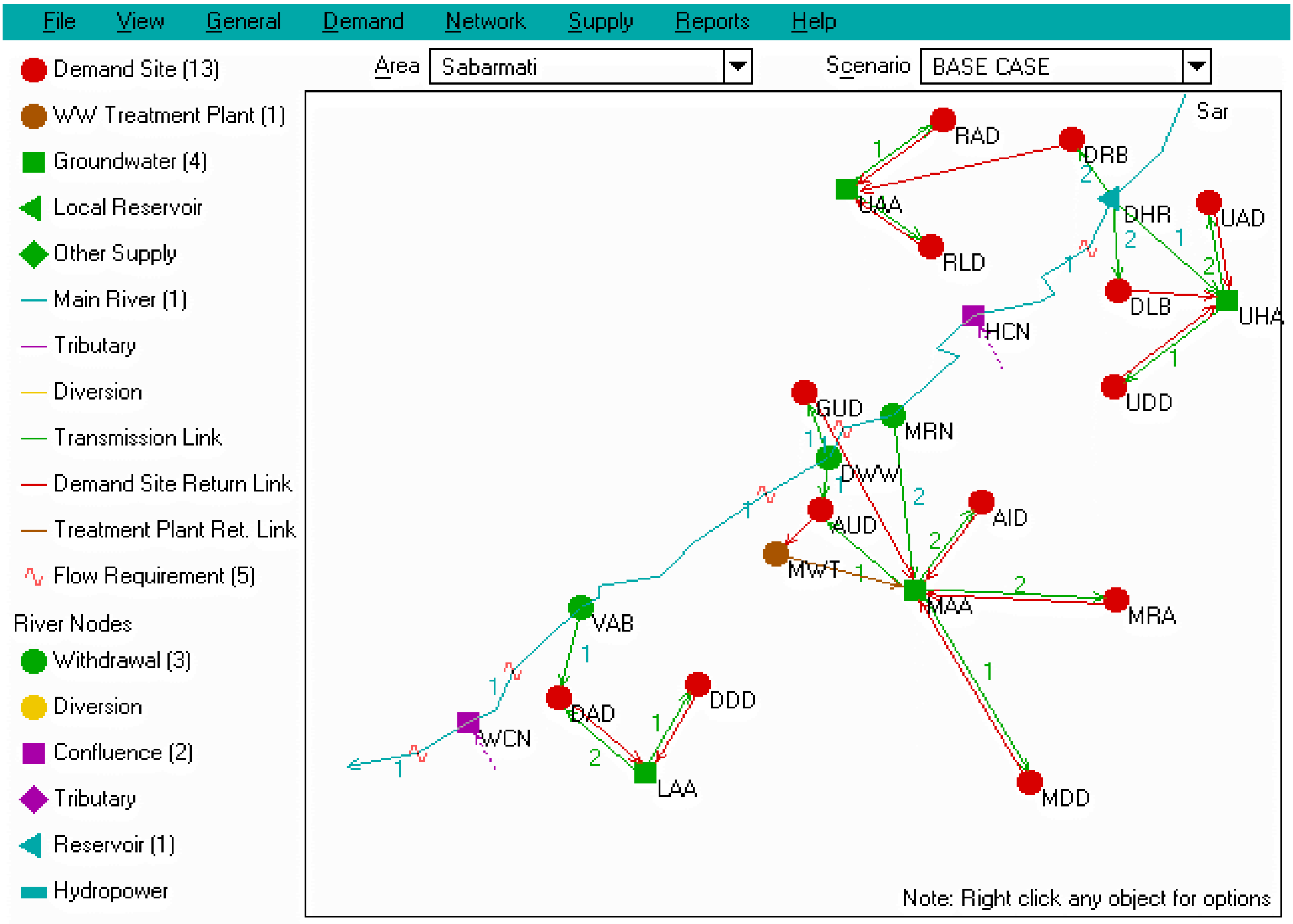
In order to address this, and other water management questions, teams working within each study area are developing water balance models using the WEAP modeling system. This program is not a hydrologic model but more a water accounting system. It was selected for several reasons. *First*, it has a powerful demand-side module that allows analysis of aggregate changes in water demand that can be achieved through packages of adjustments in irrigation technologies, cropping patterns and so on. *Second*, (and more importantly) the model is not a highly complex "black box." Instead, it is relatively transparent and easily understandable by non-specialists. It can also be used to very rapidly analyze the impact of specific management changes such as the effect of new supplies, implication of increase in pollution load or changes in demand due to population or growth factors. Because of these characteristics, the model can easily be used in roundtable discussions with stakeholders to analyze / scrutinize the management options *they* propose. As a result, rather than being a model through which we (the project) conduct analyses and propose solutions, the model can serve as a neutral negotiating framework that enables local stakeholders to understand management needs and identify potential solutions themselves.

Sabarmati Basin Example

The above approach is well illustrated in the Sabarmati basin in the Gujarat study area. There, with groundwater overdraft in rural and urban areas, declining surface water availability due to pollution and increasing population and water dependent economic activity, the gap between water supply and demand is widening. Using Water Evaluation and Planning (WEAP) system, alternative water management strategies to address water scarcity and pollution problems in the Sabarmati River basin are investigated – in a very preliminary manner. This was done by creating water balance scenarios for the years 2020 AD and 2050 that can be used to compare proposed water management interventions to a base case scenario (1996 AD) in which little management is attempted while demand continues to grow at historical rates.

The following figure shows the WEAP configuration for the Sabarmati River Basin. The configuration shows demand sites, supply sources, network links, confluence nodes, demand site return links and wastewater treatment plant.

WEAP configuration for the Sabarmati River Basin



Current Water Demand in the Basin

The current water demand in the basin is divided into agricultural demand, rural domestic demand, urban demand and industrial demand. The agricultural demand is further divided into 6 sub-sectors. The agricultural demand in each zone is divided into area under various different irrigated crops in each zone which is again sub-divided into percentage area under different irrigation devices such as small border irrigation, furrow irrigation, drip irrigation and sprinkler irrigation. Finally, the actual water use rate per unit area figures (which includes the farm level efficiencies) estimated through field studies were used as water use rate for each irrigation devise for every crop.

Similar subdivisions are made in the rural domestic demand sector within each zone. These are divided into end uses such as human uses and livestock uses in terms of number of users for each end use. The end use "human uses" is further subdivided into devices such as drinking & cooking and other uses. The "livestock use" is further subdivided into devices such as cattle drinking and cattle bathing. Each end use is allocated a specific water use rate.

The urban demand in Ahmedabad is divided into the following sub sectors: west AMC area, east AMC area, western periphery, eastern periphery and Fort Wall area on the basis of the differential water demand and use rates existing in these areas in terms of population of each zone (adopted from a study done by Centre for Environmental Planning and Technology, Ahmedabad). These subsectors are further subdivided into end uses namely drinking & cooking, bathing, washing & cleaning, toilet and gardening (which is applicable only to western and west AMC areas). The end-uses are again subdivided on the basis of water use devises (traditional and low head showers for bathing, traditional and flushing for toilet and traditional and washing machines for washing respectively) expressed as percentages with each one of them attributed with water use rates specific to the devise. Gandhinagar urban demand is categorized in a similar manner except that the sector is divided into subsectors reflecting construction styles (bungalows and flats) instead of zones.

Where industry is concerned, only one demand site is identified in Ahmedabad. This is divided into 3 subsectors on the basis of the industrial zones in and around the city, viz., Odhav industrial zone, Naroda industrial zone and Vatwa industrial zone. The current industrial water use (volumetric) in each zone is taken as water use rate in each zone.

Current water Supplies

The parameters used to determine the current supplies from the local sources (groundwater) were: the monthly pumping capacities of the aquifers (with one modification anticipated in the future year which applies to the subsequent years)[4]; the maximum accessible storage; the initial accessible storage and the annual natural recharge.

The Sabarmati supplies include: the headflows into the Dharoi reservoir which was given as monthly inflows into the reservoir in the base year; the storage characteristics of the reservoir; the net monthly evaporation rates; the initial storage volume; dead storage; the total storage volume; definition of reservoir operation rules

[4] The monthly pumping capacities of the local supplies (groundwater) in WEAP modeling were reduced in the year 2006 for the areas where the category of groundwater exploitation is grey/dark and was increased in the area where it is white. This modification is made assuming that some legislative measures will be enforced by the year 2006 to control groundwater extraction in grey/dark areas. In the same time, farmers will be encouraged to use groundwater more in the areas, which fall in the white category.

(top of conservation level, top of buffer pool and the buffer zone coefficient) and the future modifications in the reservoir storage characteristics.[5]

Network Losses

The network parameters are used to determine the actual supply requirement for each demand site and reflect monthly variation of the demand across the years, the losses at the demand site and the conveyance losses in water distribution. The network data used in the model are: monthly demand variation coefficients (to apportion the yearly demand into monthly demand values) and the percentage losses at the demand site and the reuse rates; the transmission losses from supply sources to demand sites, and the capacity of the source to transmit; percentage losses in transit from withdrawal nodes (Dharoi reservoir node and the mid recharge node) to aquifer which are treated as conjunctive use links; capacities of waste-water treatment plants (capacity and the annual load factor and the decay and removal rates in percentages).

The findings of model are as follows:

- **The WEAP analysis shows the urgent need for water management interventions:** A first cut analysis for future water supplies and demand using WEAP shows that in the absence of water management interventions, the gap between demand (supply requirements) and supplies could increase to 1017 MCM (*due to supplies reducing by 23 percent and supply requirement increasing by 26 percent over the period 1996-2020 AD*) by 2020 AD and to 1875 MCM (*due to supplies reducing by 15 percent and supply requirement increasing by 63 percent over the period 1996-2050 AD*) by 2050 AD.

- **The extent to which demand side options could help address the water scarcity situation in the future is quite large**. This would require large-scale adoption of efficient irrigation water use technologies such as drips, sprinklers and efficient conveyance systems in the fields, and efficient water use technologies in the domestic and industrial sector. WEAP modeling indicates that these interventions could reduce the gap between the supply and the demand by 324 MCM and 1005 MCM in 2020 AD and 2050 AD respectively. In other words, this means that this *Option* would make good roughly one-third of the gap projected for 2020 AD and more than half the projected gap for 2050 AD.

- The modeling also indicates that **conjunctive management of groundwater** could be another positive option to consider. This Option would entail the recharging surplus monsoon flows diverted from the Sardar Sarovar reservoir. The available supplies due to this *Option* would increase by 157 MCM and 156 MCM by 2020 AD and 2050 AD respectively. While this is less than what could be achieved through demand management, it still represents a significant contribution towards addressing water scarcity problems.

[5] The capacity of Dharoi reservoir is gradually declining due to sedimentation. It is anticipated that by the year 2026, desilting operations would have taken place to restore the original designed capacity of the reservoir.

- Modeling also suggests that **a combined approach** incorporating demand management, network improvement to reduce conveyance losses, and conjunctive management of groundwater by recharging surplus monsoon flows diverted from the Sardar Sarovar reservoir, seems to be the best option. This option would reduce the gap between demand and supplies by 349 MCM and 930 MCM in 2020 AD and 2050 AD respectively. This compares slightly on the higher side with the results obtained through adoption of efficient conveyance and use system. But there is significant build up in groundwater storage in the Middle Alluvial aquifer in the basin. This shows that groundwater levels will be at a higher level in this alternative option as compared with the former. In other words, there will be improvement in the "*groundwater resource sustainability*" and increase in "*resource accessibility* " scenario in this aquifer zone. Other benefit is the reduction in energy consumption for groundwater extraction.

Economic Analysis

The WEAP modeling process discussed in the foregoing section generates an array of management options that can be used to address water scarcity in each area. At the most basic level, the financial viability of each option and how the economics of management employing different packages of options compares with the economics of other management approaches are among the central research questions that the project collaborators are in the process of addressing. Beyond this, however, the emphasis on the demand side management discussed above necessitates analysis of the economic incentives users might face to reduce the amount of water they use.

Economic analysis of demand side management options focuses on two components. The first component focuses on the direct economic or financial incentives users face in relation to water. This involves analysis of, for example, the costs of pumping along with subsidies and other economic factors that affect crop choice (and therefore water demand). Beyond these direct financial incentives, however, dialogue with users and policy makers during the first phase of the research indicated that few users or policy makers have much concept of the inherent value of water. In many cases, such as, for example, when groundwater overdraft is allowed to proceed unchecked, society essentially assigns a zero future value to water. In other cases, such as in the construction of extremely expensive drinking water schemes, the effective value assigned to water is extremely high.

Our results during the first phase of the project suggested that research to define the value of water could play a key role in catalyzing social awareness of demand-side management needs. As a result, a key research question in the current phase is: *What is the total economic value of water and what values associated with water are not reflected in market valuations or captured by standard economic analyses.*

Valuing water is complicated for several reasons. First, free markets for water rarely exist and, as a result, the current market value of water can’t be observed directly. Second, prices for water established through market mechanisms do not represent many of the “in situ” and third party values associated with instream flows, poverty alleviation, and so on. These are often public goods and would, as a result, be poorly reflected in market transactions. A variety of economic methods have been developed to value water. The National Research Council summarizes these in the recent book on Valuing Ground Water: Economic Concepts and Approaches.[6] This book covers a range of potentially applicable methods including: (1) Derived demand/production cost estimation; (2) Averting behavior methods; (3) Hedonic pricing (based on values implicit in the pricing of other goods such as irrigated versus unirrigated land); (4) Market price and negotiated transaction values; and (5) contingent valuation. Each of these methods has advantages and disadvantages and can best be employed under a relatively limited range of conditions. In addition, none of the methods captures the full value of the public goods or *in situ* services produced by water.

Despite their limitations, the above methods are useful in evaluating aspects of the value of water and we are currently in the process of finalizing a set of tools to do this in each study area. Economic valuation, however, only reflects one component of the overall social, cultural and environmental value associated with different patterns of water allocation or development water. In addition, many water management options involve tradeoffs between the values of groups with differing abilities to pay and market engagement. As a result, non-economic mechanisms for valuation are an essential complement to economic mechanisms in order to ensure values are equitably reflected. For this reason, the research program is currently in the process of developing mechanisms to identify and evaluate the wide array of "values" associated with water in each study area. These mechanisms may be as simple as developing a matrix listing of non-economic values or more complex mechanisms utilizing, for example, life-based measures.

Social and Institutional Analysis

As previously noted, the objective of the social and institutional analysis component of the project is to *evaluate the capacity of existing organizations and institutions to enable community-based water management approaches and, where these appear insufficient, to evaluate potential avenues for catalyzing change.*

Organizations and many of the social institutions present in each study area were surveyed during the first phase of the project. The results of this are presented in detail in *Rethinking the Mosaic.* Following completion of this book at the beginning of the project's second phase, an intensive institutional analysis workshop was held. This research was used to explore a wide array of analytical frameworks and specific methods for institutional analysis that would enable the collaborative group to meet the above objective. Based on this we have decided to focus the research on four institutional dimensions:

1. The role of meso and macro organizations in defining the context in which management occurs and in supporting the implementation of management actions;
2. The incentives macro institutional structures (laws, policies and national markets) create for organizations at micro (local), meso and macro levels to initiate different types of management activities;

[6] National Research Council (1997): Valuing Ground Water, National Academy Press, Washington, D.C.

3. The role local and regional water markets and the informal rights systems on which they are based play in creating incentives for or against different types of management; and
4. The viability of local organizations as management actors in relation to the array of management options identified.

A set of targeted research questions is associated with each of the above institutional dimensions. We will, however, focus here on the local organizations because that is the primary focus of this workshop.

In evaluating the viability of local organizations as management actors, we are using the IAD (Institutional Analysis and Design) framework developed by Elinor Ostrom and others as a primary tool [Institutional Analysis: Readings and Resources for Researchers, vol. 5, compiled by Steve Langill for IDRC, 1999, #68-90]. The basic hypothesis (or assumption) is that local organizations are likely to be able to manage water resources effectively when the IAD criteria indicating the viability of local organizations are met. The IAD framework is a form of institutional analysis that focuses on rules and incentives and how they affect outcomes. It is heavily grounded in game theory (the prisoners dilemma) and comes out of the broad array of recent research on common-pool resources. In it the basic unit of analysis is the "Action Arena," or the social space within which individuals interact. The action arena consists of:

- A set of participants
- A set of allowable actions for participants
- The information participants have with regard to situation -- how well the situation is understood;
- Outcomes that can result from action situation
- Technologies linking actions to outcomes
- Costs and benefits of actions & outcomes for each participant.

As described by Ostrom, [Ostrom, 1993 #213] IAD criteria for successful management of common-pool resources within an action arena consist of:

- <u>Clearly defined boundaries</u>: Unless the boundaries of both the resource and the user group(s) are clearly defined, institutions for the management of common pool resources are unlikely to be successful.
- <u>Proportional equivalence between the benefits and costs of management</u>: Unless participants view the benefits from management as sufficient relative to the costs, management is unlikely to succeed.
- <u>Collective choice arrangements</u>: Wherever management requires group action, arrangements for making collective decisions are essential.
- <u>Monitoring</u>: Effective monitoring of resource use and management actions is essential in common-pool situations in order for all participants to develop the assurance that their management efforts are not being undermined by free riders, individuals who benefit but do not contribute to management.
- <u>Graduated sanctions</u>: Sanctions must be available as a deterrent to individuals who violate collective decisions. Furthermore, these sanctions should be graduated to reflect the severity of infringements.

- Conflict resolution mechanisms: Differences of opinion and other conflicts are common in the management of any common-pool resource. As a result, mechanisms for conflict resolution are essential.
- Minimal right to organize: In many situations, governments or legal traditions limit the ability of groups to organize for resource management purposes. In order for management institutions to develop, however, users must have the right to organize.
- Nested Enterprises: In many cases management actions are required at a variety of levels. Nesting is, as a result, essential so that management can be scaled to the level necessary.

Institutional arrangements for the management of local water resources through local organizations can be evaluated by the presence or absence of the above design features. As a result, part of the research involves a survey of existing local organizations and institutions in each study area and evaluation of their water management capabilities in relation to the above criteria. In addition to this the project involves work with local stakeholders on the conceptual development of institutions that could meet the above criteria. This is, for example, part of the work VIKSAT is currently doing through the Sabarmati Basin Stakeholder Forum and other organizations in the project will be initiating this as the research project progresses.

VIKSAT initiated the Stakeholders' Forum for Sabarmati River Basin in order to pave way for a comprehensive broad-based institutional arrangement that would be able to influence the management decision-making in the context of the basin waters. The fact that the forum has stakeholders including the government agencies is very encouraging. The Stakeholders Forum work for Sabarmati Basin did not constitute part of IDRC supported first phase. However, the concept is an outcome of the IDRC research. The Gujarat Ecology Commission supported the Stakeholders Forum work for a year through its COMNEAF window of the World Bank. The second phase of this project has the objective of catalyzing the debate on water management options among the stakeholders.

PROCESS USED TO ADDRESS QUESTIONS

Some of the specific tools used in the research program have been noted above in the context of the different research arenas. In most cases the field methodologies and the tools involve the array of modeling, participatory rural appraisal, and survey techniques found in most interdisciplinary research toolboxes. From our perspective, however, the most unique and important part of our research toolbox is not the specific modeling, mapping, interview, survey and other "methods" employed[7] but the process in which they are embedded. As a result, this section will focus on the overall research process.

There are two elements of the research process that we would like to emphasize here. The first relates to the collaborative process between the partner organizations involved in the project. The second is the way research is conducted in the field.

[7] Tools of this nature are developed and applied as needed to answer specific questions. Some of these tools are joint, others are developed to answer specific questions in individual field areas.

Interactive Partnership

The research project involves five organizations working in close collaboration. The capabilities of these organizations vary greatly. The Madras Institute of Development Studies and Institute of Development Studies in Jaipur have strong academic social science research capabilities in the Indian Social Science tradition. In contrast to this, VIKSAT is much more of an action research oriented NGO. It has substantial field presence and experience implementing participatory resource management projects in both forestry and water sectors. It also has a mix of social science and technical water management capabilities including substantial modeling experience. Nepal Water Conservation Foundation and ISET have much more technical knowledge with regard to water management and are currently deeply involved in global debates over the institutional sociology of water management organizations.

The above mix of capabilities means that each of the partnering organizations brings a different set of perspectives to the research process and generates different sets of insights. In order to integrate these perspectives and benefit from the diverse capabilities of the involved organizations, the research process has been designed in a highly interactive manner. Coordination, methodology development and writing activities are designed as intensive "workshops" in which all participants bring their current work and key issues are intensely debated. The design of our methodology development and writing workshops provide the best illustration of this.

Where methodology workshops are concerned, we do not follow the usual process in which an individual "team leader" develops a specific methodology that all the other partners implement. Instead, an array of potential methodologies is identified whose relative merits and advantages are jointly debated by all collaborators. This is the starting point for intensive work to develop and finalize the methodology that will ultimately be applied to collect specific data. Similarly, where analysis and writing are concerned, participants do not write up the results of their own research and then submit them to a team leader for editing and integrating into the final product. Instead, each of the participants prepares rough drafts of their main work in advance of an intensive (10 day-2 week) writing workshop. These initial drafts are then presented to other participants at the beginning of the writing workshop. The presentations are followed by substantial joint analysis and writing time during which all project participants draw on insights from each-others research as they develop and revise their own work. The end result is a much more collaborative and integrated set of analytical products than if they had been produced in isolation by the individual organizations. We believe this process of cross-fertilization and sharing between disciplines, organizations and regions is a core tool in the research process itself and will lead to a substantially better informed set of products than would otherwise be the case.

Stakeholder Process

A collaborative process mirrors the engagements among the partner organizations in the research project with stakeholders in each of the case study regions. The research process is envisioned as an interactive dialogue with local water users that will eventually lead to water management approaches that benefit the local area – as well as informing global debates over water and community-based management. The interactive process has been taken furthest in the case of NWCF's research in the Marchawar irrigation system (which forms part of the study area) and VIKSAT's initiation of a Stakeholders Forum for the Sabarmati Basin. These cases are described in more detail below.

Marchawar: Institutional Strengthening

Using insight from the research, the principal researchers of NWCF are involved in institutional strengthening of the Water Users Association (WUA) at Marchawar. As per the 1992 Irrigation Policy, the WUA has been entrusted with management responsibility of the irrigation system. The irrigation system was funded and built by the UNCDF, which started in the late 1970s with the assumption that the Tinau River had sufficient water resources to irrigate a command area of 7,200 ha (gross), 5,766 (net). The command area of the system has been revised several times because the flow of the Tinau was much lower than assumed. Presently, the system provides supplemental irrigation to about 2,815 ha

The project started as a major activity of the Department of Irrigation, which implemented it by employing a contractor to build the pump house, the sedimentation tank and the main canal systems. In the subsequent stages, to construct the distributaries and tertiary canal networks including support facilities, the Department of Irrigation employed expatriate and Nepali consultants.[i] The joint implementation and management arrangement with the private sector was an interesting features incorporated into organization of the project. Incidentally these activities occurred after the advent democracy in Nepal in 1990.

In 1992 HMG Nepal introduced the new Irrigation Policy. According to the provision of the policy, the management of Irrigation System has been handed over to Water Users Association in the early 1998. As per the agreement the pump house and the sedimentation tank are under the ownership of the Department of Irrigation, while rest of the system is under the ownership of the WUA. The operation and maintenance of the pump house was contracted out to a private industry. Cleaning the intake of silt, debris deposits, recovering costs through water tariff are the responsibility of the users group. Part of the operation and maintenance cost is borne by the DOI while the rest is borne by the WUA.

Regionally, Marchawar is a "tail-end system" to the other water user systems that use the Tinau River. Like any surface-irrigation scheme, differences in availability of water and services to the head-reaches compared to "tail-enders" are evident. The notions of priority "rights" to water both within and between system are issues that needs to be defined in the future; an issue that the WUA is focusing on. One of the main issues facing the irrigation system is the question of tariff to be raised for irrigation water. The monthly electricity expenditure for pumping water is about Rs 300,000/month. But this amount varies depending upon the monsoon. The annual water charge raised at Rs 6/*Katha*/year is about Rs 1,19000, which still requires an equivalent monthly income of about Rs 9,000.

The sustainability of the irrigation system is dependent on the raising of tariff to meet part of its operating cost. This is so because the under the agreement with the Department of Irrigation, the WUA has to bear 10 percent of the cost of pumping while the department meets the rest. Even the 10 percent amount would be substantial that needs to come from the tax that irrigators would have to pay. The WUA as an outcome of the engagement with the principal researchers has approved an elaborate governance procedure, which also spells out tariff for *khariff* and *rabi*, under what circumstances it could be revised, including punitive measures for defaulters. Because the WUA is still seeking to establish its legitimacy among the users, it would be some time before its governance begins to address all the challenges. Yet the members of the WUA recognize the challenges and show concerns to get the management on a smoother footing.

Another challenge is the quality of water. The continued lowering of the quality of Tinau, particularly in the dry season is an emerging problem and may exacerbate problem faced by irrigated agriculture. Pollution, for reasons of religion, may also lead to socio-political schism in the area. It is important to create capacity at local level to monitor industrial effluent in river through survey. Outside expertise needs to be consulted as and when needed.

The ongoing dialogue the WUA has formulated an elaborate procedure that set the governance of the system including the tariff. Discussions are continuing about the financial and economic cost of pumping water.

Sabarmati Basin Stakeholders Forum

Given the diverse nature of physical problems across the Sabarmati River Basin, the solutions to water scarcity and pollution problems will be different for different areas. Further, the effectiveness of any water management solution depends on a range of physical, social and economic parameters, which again vary widely across the Basin. Therefore, the already known water management interventions will have to be combined with the prevailing physical and socio-economic settings in the Basin.

Further, it should be borne in mind that water management is not purely an engineering activity, but equally a social activity. The water management needs and priorities are different for different stakeholders[8] and are often *conflicting and demanding*. In order to achieve water management goals for the basin, proper understanding, cooperation and compromise on the part of each stakeholder group is imperative for appropriate decision-making. Therefore, new institutional avenues have to be explored to evolve stakeholders' participation in planning & implementing Basin plans.

At the same time, the local options need to be scaled up significantly so that they have a significant impact. However, basin level management is essential to give the concept legitimacy, practicality and effectiveness. Thus, the above approach envisages stakeholder subgroups at local level *federating* into a basin level forum- the Stakeholders Forum.

[8] water users from agriculture, industry, domestic sectors and government, semi-government agencies

Identification of Stakeholders

Identification of stakeholder groups to represent the wide range of water problems and issues is a stupendous task. Further, identifying appropriate representative mechanism is again a complex issue. To begin with, the Sabarmati basin is divided into three sub-basins[9]. Within each sub-basin, the stakeholders are segregated based on water use sector, i.e., agriculture, domestic (rural and urban) and industrial.

The various water supply agencies/ government departments comprise an important group of the Stakeholder community. These include: Narmada and Water Resource Department supplying irrigation water; Gujarat Industrial Development Corporation supplying water for industrial water use; Gujarat Water Supply and Sewerage Board supplying water for domestic use through rural water supply schemes and group water supply schemes in rural and urban areas of the basin; the Gujarat Water Resource Development Corporation; the Ahmedabad Municipal Corporation supplying water for Ahmedabad Urban use; and the Gujarat Pollution Control Board.

Agricultural Sector

Within the agriculture sector, the Sabarmati basin is characterized by a range of water users, depending upon their geographical location and the source of irrigation water. In the Dharoi sub-basin the users include farmers sourcing irrigation water from groundwater through public and private Water Extracting Mechanisms (WEMs) and from surface irrigation schemes and tanks. Primarily, there are two reservoir projects, Dharoi and Harnav in the Dharoi sub-basin. The command area of the Dharoi reservoir project covers 45,548 ha. and 11,130 ha in Sabarkantha and Mehsana district respectively. The stakeholder group has representation from among the beneficiaries of the surface irrigation project, as also from the district agriculture credit cooperative societies which are fully dependent on groundwater.

In the second sub-basin, namely the Hathmati, there are three groups of irrigation schemes: a) Hathmati dam & pick up weir and Raipur weir (Kharicut canal); b) The Guhai dam; and c) The Fatehwadi canal (Vasna Barrage) scheme. In addition, there are farmers who are fully dependent on groundwater. Other representative farmer groups belong to the command area of these projects. In addition, members of agriculture credit cooperative societies also comprise another stakeholder group.

The third sub-basin is characterized by predominantly irrigated areas, which is important from the viewpoint of source of irrigation. In this basin, the area irrigated through surface irrigation schemes and the surface tanks are quite large compared to the groundwater-irrigated area. This basin has four irrigation projects: a) The Watrak; b) Mazam; c) Meshwo dam and Raska weir ; and d) The Waidy project. The stakeholder group represents the command area of the above projects. The district agriculture committees in the district falling under these sub-basins constitute potential members.

Another strong stakeholder member comprises the group of the farmers from the northwestern part--predominantly dependant on groundwater--in the Dharoi sub-basin. VIKSAT has been working in close association with farmers of 17 villages in Satlasana

[9] namely Dharoi, Hathmati and Watrak

taluka. Consequently, a federation called *Gadhwada Jal Jameen Sanrakshan Sangh* of village level organisations (registered as Tree Growers Cooperative societies) was formed. This federation has a potential role in the Stakeholders Forum.

Another group representing farmers from the pollution affected Kalambandi area, which comprises 11 villages in Mater taluka of Kheda district, joined the Stakeholders Forum.

Industrial Sector

As mentioned in the foregoing, there is a huge concentration of industries in certain pockets of the Sabarmati basin. 84 out of the total of 106 large industrial units are concentrated in the three districts of Ahmedabad, Mehsana and Gandhinagar within 20% of the basin's geographic area.

There are three major Industrial estates — Naroda, Odhav and Vatwa — which are important from the point of view of water consumption, located in and around Ahmedabad city. Each of these estates has an industrial association named after the industrial estates. Representatives from these associations have been met and information on their membership and other details collected. These representatives have evinced keen interest in associating with the Stakeholders Forum.

Urban domestic sector—Ahmedabad & Gandhinagar city

In the Urban cities, one does not find the coherence and social milieu as in rural areas. The problems too are quite complex. Thus identifying representatives in city areas is a tricky issue. The key stakeholders for Ahmedabad and Gandhinagar cities included eminent persons associated with the field of water management, research and academic institutions, individuals who displayed concerns for water problems, representatives of water supply, regulatory and monitoring agencies. During its meetings, the group looked at various options for the urban water problems, including pollution aspects. A Working Group of *Ahmedabad Urban Stakeholders Forum* was formed to discuss future strategy and evolve an action plan. It came out that rainwater harvesting should form one of the key thrust areas while policy influencing should also be done simultaneously.

Rainwater Harvesting

VIKSAT experimented with rainwater harvesting during the summer of 2000. Through its interactions with press, VIKSAT has generated awareness and the need for conserving rainwater as a local option. A working model was built in its own campus and a few others developed within the urban areas. Simple models such as open pits and recharge pits were promoted. For instance, a simple recharge pit constructed in a factory in Naroda industrial area on the lines of soak pit concept, of dimensions 4m x 4m x 5m absorbed 1.2 million liters at a conservative estimate. That this was during July 13-15, 2000 when Ahmedabad received an unprecedented 400 mm of rainfall (almost 50% of annual average) was quite encouraging.

Stakeholder sub-groups, Perceptions of Problems and Solutions

As part of the stakeholder approach, several meetings were organized with a number of groups in different areas in the basin and from various sectors of water use. The gist[10] of issues pertaining to water scarcity and pollution in their areas, as emerged through discussions with these groups, is presented below:

Part of Basin (Agriculture sector)	**Problems**	**Reasons**
N-W (Mehsana, Banaskantha)	Excessive Fluoride; seasonal groundwater scarcity; excessive groundwater salinity; groundwater depletion ; untimely canal water supply; insufficiency in canal water;	Over-application of irrigation water, water intensive crops; availability of electricity during night time;
S-W (Pollution Affected Group of 11 villages) (Kheda)	Polluted water in canal system; drastic decline in crop yield; groundwater to great depths is unusable;	The Industrial waste finds its way into canal water; polluted canal water is used in fields; use of hybrid seeds; use of chemical fertilizers
East (Sabarkantha)	Seasonal scarcity; potable drinking water non-availability; untimely availability of canal water; increase in land salinity; non-availability of adequate canal irrigation water; water logging conditions;	Over-application of water; mis-management of canal water; groundwater; excessive groundwater salinity; non-filling up of surface irrigation structures; silting of surface irrigation schemes; interception of runoff in catchments of irrigation schemes; availability of electricity during night time;
Central (Ahmedabad	Groundwater depletion; excessive groundwater salinity; polluted water in canals; untimely availability of canal water; reduction in land fertility; surface water bodies are polluted	Upcoming farm houses in great numbers; over application of irrigation water; availability of electricity during night time; use of chemical fertilizers; use of hybrid seeds; partially treated sewage from Ahmedabad joins river; thermal power stations waste join river;

[10] The abstract of problems & reasons and recommendations/solutions discussed by stakeholders during various meetings is attached as Annexure.

South (Kheda)	Water-logging; untimely availability of canal water; reduction in land fertility; insufficiency in availability of canal water;	Over-application of canal water; availability of electricity during night time; water intense crop; chemical fertilizers; use of hybrid seeds;
Industrial sector	**Problems**	**Reasons**
Vatwa, Odhav, Naroda, Narol Estates, Sabarmati thermal power station, Gandhinagar thermal power station	Insufficiency in water availability; mixing of water of supply network with drainage water; cost of managing CETP is high; increasing problems with fly-ash disposal	Distribution losses are high; constraints in increasing selling price of supplied water; great quantum of water (about 10 times the ash generated) is required for carting the fly-ash to ponds; cost of energy required for supplying water has increased; effective management of CETPs is as high as 50-60 percent of capital cost.
Urban Domestic sector	**Problems**	**Reasons**
Ahmedabad & Gandhinagar city	Groundwater depletion; increased groundwater salinity & fluoride content; inadequate AMC supply;	High distribution losses; water supply is not metered; high water salinity inhibits proper functioning of meters; water charges are on percentage of property worth and not on volumetric basis; rise in number of private tubewells (especially in the western part of city); Insufficient water availability at infiltration/ french wells in Sabarmati river; significant water lost in transmission from Dharoi to A'bad city (165 km of river stretch); high water use rates in pockets of A'bad and G'nagar cities; low ground - water recharge; assured continuous energy availability leading to greater extraction.

Solutions/Recommendations of the stakeholder subgroups

Physical

Agriculture Sector

Groundwater recharge programme, low cost micro-tube, mini-sprinklers, sizes of borders; reducing losses in canal distribution; reduction in use of chemical fertilizers; promoting organic/bio-fertilizers through proven technologies for generation of same; transfer of Mahi river water to Pollution Affected Areas;

Urban Sector

Roof water harvesting in urban areas; re-use of wastewater after SAT; installation of water meters; reuse of treated sewage waste for agriculture; augmenting of AMC supplies from Narmada/Kadana; effectively operating the Sewage treatment plants (renovating the old ones with construction of proposed ones); improving the distribution network; technology for reducing end-use economizing water use; improving conveyance efficiency in transporting water from Dharoi to AMC's off-take well-points.

Industrial Sector

Recycling in industrial use; adopting dry fly-ash disposal technology; improving the network (for not allowing waste water to enter the fresh water supply network); Installation of and effective operation of CETPs.

Incentives

Agriculture Sector

Availability of electricity during daytime; access and control on required quantum over distribution of surface water; promoting (excess of used quantity from entitlement) selling of groundwater among users.

Disincentives

Agriculture Sector

Groundwater licensing; volumetric based entitlement of groundwater; increasing canal water charges; reduction in subsidies.

Urban Sector

Separate electric meters installed for water lifting pumps coupled with differential charges based on varying slabs of consumption; slab based tax to be levied on private water suppliers.

Industrial Sector

Effectively operating the CETPs; slab-based tax to be levied on private water suppliers; appropriate effluent treatment pricing to industries by the CETP's operating agency.

Institutional Linkages

Research institutions with stakeholders' sub-groups; NGOs with stakeholders sub-groups; specifically a) close interaction of ATIRA with industrial associations (industrial stakeholder sub-groups); b) agricultural universities & NGOs (involved in agriculture water use research) with agriculture stakeholders sub-group; c) PRL, NEERI & NGOs with urban stakeholder sub-group.

ACHIEVEMENTS & LESSONS BEYOND THE SITE

The immediate and most tangible achievement of the project has been the publication of the book *Rethinking the Mosaic*. Although we do not perceive publications as achievements in themselves, we *do* count this book as an achievement in several senses. First, the book articulates new perspectives on water management that are different from those present in global water management debates. As a result, we believe it represents a substantial addition to understanding of community-based water management issues and opportunities. Second, the book and associated research activities have catalyzed dialogue within the government in Nepal and at local levels in other case study regions on the importance and relevance of community-based water management strategies. **The methodology of the Nepal part of the Mosaic is being replicated in a number of basin analysis undertaken in the in-house exercise by Nepal's WECs.** To highlight the Nepal case, the book has led to an invitation from RONAST (the Royal Nepal Academy of Science and Technology) for ISET and NWCF to assist in formulating a national water research strategy. Support for development of such a strategy has received explicit support from the Prime Minister and this is a major factor behind RONAST’s invitation to ISET and NWCF. While this support is a far cry from actual implementation in the field, it does represent a substantial opening at the governmental level. Third, from a capacity building perspective the book is a high quality publication and the process of producing it has increased the ability of all partner organizations to communicate key insights in a highly professional manner to key audiences.

Beyond the book, development of the collaborative research process is an achievement. This project represents one of the first examples of practical collaboration between Indian and Nepali organizations outside the government on shared water issues. This type of collaboration is important because intergovernmental dialogue tends to focus on large-scale debates, such as shared river basins, which are highly politicized and often deadlocked. Such debates provide little opportunity for the development of innovative approaches that could address the basic water management needs on both sides of the international border. The development of cross-border collaborations and the identification of water management strategies that fall “outside the box” of traditional water management approaches thus represent a major achievement in themselves.

Finally, although the research is far from complete (the second phase has only just begun), conclusions from the first phase indicate major new avenues for catalyzing effective water management. In specific, the results of the first phase highlight the importance of social auditors and information in enabling effective water management at community, regional and national levels. This result suggests that one of the more effective mechanisms for encouraging the sustainable management of water – and other natural resources – may lie not in direct management interventions but in activities such as increasing access to information and the encouragement of alternative voices. This is very similar to findings in the health and population control arenas. There, women's education – rather than direct investments in infrastructure – are now well known as critical points of leverage for reducing birth rates and increasing health status. This type of insight may represent the beginning of a fundamental change in water management approaches. Demand for water management is a social construction. Education and information are the key factors in the social construction of demand. Effective management will follow where demand has emerged – not where external organizations are pushing solutions to problems of their own definition.

APPENDIX I: CURRENT PROJECT ACTIVITIES AT IDS-JAIPUR

IDRC Phase II work in Banganga River Basin
(IDS Jaipur)

Introduction

Natural resource management is an important issue that affects all particularly the rural poor. Everyone's well being, indeed livelihoods, depends directly and indirectly on natural resources. In recent years, degradation of these resources (land, vegetation and water) and the environment has increasingly become the focus of attention because of their harmful impact on people's lives. Water scarcity, air and water pollution, deforestation, and soil degradation, all of these natural resource degradation problem hamper people's ability to earn a living or reduce the quality of their lives.

Historically, government policies with a variety of objectives have had important effects on natural resource management. The most visible outcome of 50 years of development in rural India is deterioration and depletion of natural resources across the country and Rajasthan is no exception. The situation has reached to the extent that the most critical production resource `groundwater' is being extracted from aquifers at two-to-three times of recharge consequently groundwater table is depleting fast (1 to 3 meter per year). The other resources are in bad shape as evident from the facts that vegetation has almost vanished, forest areas are turning barren lands, grazing lands are without blade of grass, and fertility of soils depleting. Consequently rural populations migrate to urban areas in search of employment and livelihood. Despite all efforts and tall claims of concerned government departments, namely, Watershed Management, Forest, Soil Conservation and Rural Development, the real impact at grassroots level has been far from satisfactory. Examples of true success involving meaningful community participation and changed equation and relationships are rare. This is not surprising since the programs lack both the strategic visions at the top and the understanding and enabling environment at the bottom. Now there is need for new policies and management based on micro level experiments so that natural resources can be made more productive and sustainable serving the needs of its growing population with greater efficiency.

Water was easily available in the region 10-15 years ago. But overexploitation has depleted aquifers. The groundwater table in these areas has fallen below 30 meters. The stress is felt most where there are two to three consecutive below average rainfall years.

Water related disputes are gradually increasing in rural areas. They are expected to surpass land disputes in the next 10 years. It is quite clear that the government cannot supply water to every village in rural India when it fails to supply water in cities, where political pressure to provide civic amenities is much greater than in villages. If the government fails people have to take the matter in their own hands. Rainwater harvesting is the only solution.

Frequent droughts do work as a catalyst in increasing awareness about the importance of rainwater harvesting to deal with water scarcity. The people are realizing the importance of water management. However, one good rainy year makes them short sighted.

Water harnessing is the key to overall development of the Banganga River Basin. The depleting ground water table is the major problem besides degeneration of forest, declining fertility of soils and mismanagement of all natural resources. The direct implication of this is reflected in increase in number of migrants from the area, and decline in agriculture productivity, consequently, increased rural poverty. Interventions made by Tarun Bharat Sangh(TBS) to address all these issues and attain sustainable development in the region were:

I. Construction of Water Harnessing Structures

Construction of new Johads and repair maintenance of old water harnessing structures. Different sizes of Johads were constructed in the catchment area of Banganga river basin. Johads can be classified in broad three categories - (i) Small Johads (construction cost varying between Rs.10,000 to Rs.50,000); (ii) Medium Johads (construction cost varying between Rs.1 lakh to Rs.3 lakh) and; (iii) Large Johads (construction cost varying between Rs.3 lakh to Rs. 10 lakh). Johads were constructed on cost sharing norms. As Johad construction requires mainly local resources, i.e. soil/mud, pebble, labour, etc. Since mud and stones are extracted from common land, it goes unaccounted and is not included in cost contribution norms for each family. Villagers contribute in three forms: cash, kind and labour. TBS follows a clear guideline for Johad construction in a village. TBS contributes only the external resources required for construction, such as, cement, concrete, iron, bricks and diesel for tractors. Villagers' contribution varies between 40 per cent to 90 per cent. Cost of labour mostly comes from the villagers as voluntary contribution except any skilled masonry required for construction (particularly in medium and large Johads). Masonry (skill) labour cost is mainly provided by TBS while tractor for lifting mud by villagers. But diesel for tractors is provided by TBS. Second and third types of Johads are generally made of cement and concrete and are few in numbers. Conservation of water and construction of check dams on private fields, anicuts and water harnessing structures were also taken up simultaneously. The direct visible outcome of these structures is rise in groundwater table, increase flow in rivulets more water in Banganga River and increase crop production in the Basin.

II. Forest Protection and Tree Plantation

Besides, construction of this water harnessing structures the other major activities under taken was mobilization of people to under take afforestation programme in the forest area and barren lands and protection of existing trees and vegetation. This was materialized by undertaking "Pad Yatras" (Rallies and Marches) in the villages located in the Banganga basin. These Marches were carried out from head to tail reach of the basin in different times of the year. Support was solicited from villagers who had already experienced the benefits of water harnessing structures and protection of forest areas. These villagers became model for rest of the population.

III. Village Self-Reliance

Marches were also organized on the issue of village self-reliance. The objective was to make people aware of the importance that each household must get food grain and seed for whole year i.e. each and every household should become self sufficient and get out of the clutches of poverty. Organizing a Gram Kosh (Village Fund) in each village strengthened the idea. The objective of creating a Gram Kosh was to ensure financial independence of the village institution in the long run. Such initiatives towards financial autonomy can strengthen future development activities at the village level. This Gram Kosh keeps stock of food grains, to be provided to any needy household at any time in a year and is repaid back after harvesting season.

IV. Formation of Gram Sabha

All these activities were possible only because of strong Gram Sabhas (Village Committee) in each village taking active interest in natural resource management. The Gram Sabha is an informal body comprised of representative from each household in a village and has a shade different from the Gram Sabha denoted under the Panchayati Raj Act. It is obligatory for all households to attend Gram Sabha meeting held twice in a month and decide about the management of village natural resources.

V. Formation of `Jal Sansad' (Water Parliament)

Since administrative and political boundaries of a village do not coincide with the hydrological boundary of village(s) i.e. the water flows from one village to other and ultimately forms a river. Therefore, management of water resources cannot be an affair only of a single village but of a river basin. It entails inter village cooperation to efficiently manage water resources. This problem was handled by creating an organization at river basin level, namely, Jal Sansad (Water Parliament). This idea was tried for Arwari River by forming a small river parliament comprising of 70 villages. It was a unique experiment in the country.

In the IDRC Phase II we are trying to evaluate the following:

1. Local Organization Analysis

- What makes a new local organization grow and become effective?
- What are the causes of conflict between existing and new organization?
- How equitable and efficient are new organisations – gender economic differences.
- What are the implications of land and forest management organization?

2. Water Rights Analysis

- What are the implications of gaps in the formal legal frameworks for local used based organization?

Fieldwork in the sample villages is on. We had detailed discussions with TBS workers and villagers. Side by side data collection work for WEAP model is in progress. We are applying WEAP on Shakawati River basin also and finding serious problem. To resolve we have contacted VIKSAT and are hopeful to find solution.

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[i] The private sector was represented by a consortium of East Consult from Nepal), Euroconsult from Denmark and Delft Hydraulics.