IWMI
International Water Management Institute

India's Water Economy: Bracing Up for a Turbulent Future

IWMI-TATA

4th IWMI-Tata Annual Partners' Meet
February 24-26, 2005
Institute of Rural Management, Anand

Program Schedule

DAY 1: 24th February 2005

9:00 - 10:30	Welcoming Remarks: *Lucy Maarse and Arun Pandhi* Report on Review of IWMI-Tata Program: *Tushaar Shah* Inaugural Address by *John Briscoe* **"India's Water Economy: Bracing up for a Turbulent Future"**				
Venue	*IRMA Auditorium*				
10:30 - 11:00			***Tea Break***		
Session Chair	*John Briscoe*	*Ramaswamy Iyer*	*Sunita Narain*	*Ravi Chopra*	*Shashi Kolav*
11:00 - 13:30	Nature of South Asia's Water Economy [1]	Managing Conflicts around Water [2]	Decentralized Water Harvesting and Recharge [3]	Exploring Water Issues in the Himalayas [4]	Groundwate Markets and Livelihoods [5
Venue	***Lib. Basement I***	***CR Comp. # 113***	***ETDC Lecture Hall***	***ETDC Conf. Room***	***Lib. Basemen***
13:30 - 14:30			**Lunch**		
Session Chair	*John Briscoe*	*Deep Joshi*	*Sunita Narain*	*Ravi Chopra*	*Shashi Kolava*
14:30 - 16:00	Nature of South Asia's Water Economy [1]	Understanding Culture Fisheries Revolution [6]	Decentralized Water Harvesting and Recharge [3]	Exploring Water Issues in the Himalayas [4]	Energy-Irrigati Nexus [5b]
Venue	***Lib. Basement I***	***CR Comp. # 113***	***ETDC Lecture Hall***	***ETDC Conf. Room***	***Lib. Basemen***
16:00 - 16:30			***Tea Break***		
Session Chair	*Madar Samad*	*Deep Joshi*	*Norman Uphoff*	*Ravi Chopra*	*Shashi Kolava*
16:30 - 18:30	Tank Rehabilitation [7]	Understanding Culture Fisheries Revolution [6]	System of Rice Intensification [8]	Exploring Water Issues in the Himalayas [4]	Groundwate Energy and Livelihoods [5
Venue	***Lib. Basement I***	***CR Comp. # 113***	***ETDC Lecture Hall***	***ETDC Conf. Room***	***Lib. Basemen***
19:00 - 20:00	**Gujarati Cultural Program**				
Venue	***IRMA Auditorium***				
20:30	**Reception Dinner [IRMA Lawns]**				

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1. Nature of South Asia's Water Economy

Fitting Policy Reform to its Context

Tushaar Shah and Madar Samad

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24th February 2005

11:00 – 13:30; 14:30 – 16:00

Session Chair: John Briscoe

India's state and central governments - and governments of many developing countries of Asia and Africa - are under relentless pressure to reform their water policies and institutions to move towards Integrated Water Resources Management (IWRM). Governments - as in Andhra Pradesh and Maharashtra - are making new water laws; but implementing them is proving an Achilles heel! New water authorities are created; but for them to exercise their authority has become a tall order. River basin organizations are hotly debated; but getting Water User Organizations to do O&M of water infrastructure on a self-sustaining basis is proving a challenge.

Clearly there is a problem. What should be the focus of water reform so that its policies and institutions respond to the country's here-and-now priorities ?

ITP researchers discuss experiences of water reforms in Africa and China, and explore what India might learn from their experiences.

Author(s)	Paper	
Mathew Kurien and Ton Dietz	Irrigation and Collective Action: A Study in Method with Special Reference to Shiwalik Hills, Haryana	Ext. Abstract
Amalendu Jyotishi and Sashi Sivaramkrishna	Hobbes, Coase and Social Welfare: Abstraction of 'Equity' and 'Equality' in Surface Water Distribution	Ext. Abstract
V. Ballabh	Improving Governance in the Indian Water Sector: Synthesis of IRMA Workshop on Governance of Natural Resources	Presentation Only
Ramakrishna Nallathiga	Water Governance in Mumbai	Ext. Abstract
Francois Molle	Irrigation and Water Policies in the Mekong Region	Ext. Abstract
Marcus Moench	When the Well Runs Dry but Livelihoods Continue: Adaptive Responses to Groundwater Depletion and Strategies for Mitigating the Associated Impacts	Ext. Abstract
M. Samad	The Politics of Water Policy Reforms in Sri Lanka	Ext. Abstract
Tushaar Shah	The Nature of India's Water Economy: Fitting Policy Reform to the Context	Ext. Abstract
T. Shah, O.P. Singh and Aditi Mukherji	Groundwater Irrigation and South Asian Agriculture: Empirical Analyses from a Large Scale Survey	Ext. Abstract
Tushaar Shah	Water Poverty and Economic Development: Cross-country Analysis and Implications	Highlight
Tushaar Shah and Barbara van Koppen	Fitting Water Reforms to National Contexts: A Brief Report on Africa Law Workshop	Draft Comment

management contract that embodied elements of participatory irrigation management. Second, the article examines the process by which several of these policy guidelines were implemented by state parastatals such as forest and irrigation departments. The lack of transparency and accountability in procedures of government agencies was evident from our post-project analysis of earthen dam management in the Haryana Shiwaliks. Only eight of the 45 dams that were constructed were functioning when data for this study were collected. The final step adopted by the study was to examine collective action in eight of the HRMS with functioning dams. In this context, we found that watershed groups that were relatively heterogeneous in distribution of nature-based endowments facilitated provision of water from earthen dams by the contractor. We found - although this is not statistically proven, because of small sample size- that contractor-based water provisioning tended to ensure greater success of compliance with irrigation service rules such as payment of user fees, conflict free water distribution, and routine repair of dams. This was in contrast to relatively more homogeneous watershed groups where compliance with irrigation service rules was not as successful.

The construction of household endowment and water interest scores was undertaken to understand the conditions that have made contractor-based water provisioning a relative success. We justified the use of household endowment scores to overcome the over-reliance on caste or land ownership as indicators of group heterogeneity. We argued instead for an approach that combines analysis of process variables (such as rainfed and irrigated land and livestock composition proportionate to household size) with an analysis of socio-economic processes that reflect change over time in process variables. Socio-economic processes may include historically defined power and social exchange relation, accumulation strategies of farmers and differentiation in access to natural resources. In the course of applying nature based water interest scores, we have found that increasing reliance on non-farm income need not necessarily pose a threat to collective action in management of a common pool irrigation system. Further, in the course of applying nature-based household endowment scores we emphasize the importance of specifying what constitutes collective action. A clear specification of what constitutes collective action could enable the use of household endowment and water interest scores to predict conflicts and indicate potential for service provision and compliance with irrigation service rules.

HOBBES, COASE, AND SOCIAL WELFARE: ABSTRACTION OF 'EQUITY' AND 'EQUALITY' IN SURFACE WATER DISTRIBUTION

Amalendu Jyotishi[1] and Sashi Sivaramkrishna[2]

Natural resource management may be perceived as a search for institutions that can ensure simultaneous fulfilment of three goals: productivity (or efficiency), sustainability and equity. In this paper we study the implications of pursuing the goal of equity in the management of surface water resources for irrigation. We do so with an abstract analysis of a "single-settlement-based institution and management system" using Leontif-type fixed production function.

Achieving equity through poverty alleviation of the core-poor has become an important objective of irrigation and watershed development projects. In India, there are almost 300 million rural poor, 70% of them being marginal farmers and landless agricultural labourers. At the same time, as much as 80% of usable water resources go to irrigation, disproportionately benefiting the landed peasantry. With a core-poor bias becoming mandatory in development initiatives, irrigation and watershed projects are being forced to look for strategies that will more directly enhance the benefits that accrue to this segment of the rural population. One suggestion is that, by allocating tradable water rights over water, a common property natural resource can be used as an instrument to improve equity. Several questions need to be raised in response to any such proposal: Who must get rights over the use of water? On what basis do these persons or groups claim their right over water? How do excluded groups including the poor get rights from the present landed elite controlling the resource? What is the nature of rights that can be assigned to landless and marginalized people? Who decides, negotiates and assigns rights over water? What are the implications on social welfare by doing so?

While focusing our attention on these questions, we may overlook a larger question as to whether distribution of water should at all be used as an instrument to achieve a society's distributional goals. Water (except drinking water) is an intermediate good in agriculture and other rural activities, an input or factor of production. Equity in water distribution then cannot be an end in itself; its distribution must be seen as having a significant effect on distribution of outcomes or output. Can we not then achieve distributional goals or social justice through directly taxing and redistributing output or income? With various (economic and political) constraints over redistribution of output, key inputs like land and water assume importance. With land reforms reaching a dead-end, distribution of water is acquiring greater importance as a "second best solution" in achieving distributional objectives of irrigation and watershed projects. Unfortunately, advocating the use of water distribution as an instrument of poverty alleviation is fraught with implicit assumptions of the rural economy and uncertain outcomes.

Any notion of social justice must be based on a clear articulation of two concepts, equity and equality. Not only do we need to conceptualize these terms but also understand how they relate to inputs and outputs. Equity is a subjective or qualitative term and what is acceptable to one community need not be acceptable to another, or even to the same community over a period of time. On the other hand, equality is an objective or quantitative term and is taken to mean equal shares of the whole related to "a directly measurable parameter". In the context of water distribution, this measurable parameter can be taken as size of land holding (proportionate equality) or the individual; in the latter case, every member of society irrespective of land holding and/or occupation gets an equal share of water. Non-traditional systems usually look for equality in water distribution, rather than equity.

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Sharing of water equally does not mean that it is equitable. We have also seen systems that are considered equitable even though water is not shared equally. We can therefore say that equality does not imply equity or vice-versa. It is also important for planners to understand that the concepts of equity and equality are applicable to both: inputs, resources or opportunities and outputs or outcomes. More often than not irrigation and watershed projects are clear on their objectives regarding equality or equity in input distribution without realizing the full implications of such policies on output or outcomes. Social justice, however, ultimately depends on the distribution of outcomes, whether equitable or equal. For several reasons, economists believe that redistribution of income and wealth is better achieved through progressive taxation rather than through reshuffling property rights.

One may apply the Coase theorem to argue that the use of resources will be efficient regardless of the legal rule. This theorem, however, is subject to the condition that there is successful cooperative bargaining and transaction cost is zero or low enough for it not to inhibit private bargaining. In real world situations, successful bargaining cannot be taken for granted. This makes Hobbes theorem relevant: the law should allocate property rights to the party who values it the most. By doing so the law makes exchange of rights unnecessary and saves cost of transactions.

What do these arguments mean in the context of water distribution? Assigning equal rights over water will lead to an efficient solution if private bargaining is efficient. If private bargaining does not succeed, then Hobbes theorem becomes more relevant than Coase theorem. Equity could be more efficiently and effectively achieved through a progressive tax on output rather than distributing water rights equally.

Our concern here is not a simple equity-efficiency trade-off, but the possibility that allocation of property rights, without taking the complexities of private cooperative bargaining into account, could lead to a deterioration of social welfare based on the Hicks-Kaldor criteria and even possibly by the Pareto criterion. Such deterioration in social welfare will have an adverse effect on social justice; the purpose of equal water distribution initiatives will be self-defeating.

In this paper we attempt to understand the implications of equality in water distribution on social welfare with a simple abstract analysis. The analysis shows the possible (theoretical) outcomes of such a policy and is also intended to raise pertinent questions and hypothesis in studying the effectiveness of irrigation and watershed initiatives where rights over water have been redistributed equally. It is not intended to be a criticism of such initiatives.

Some of the corollaries of the exercise are as follows. A "reasonable" solution to the bargaining game depends on the existence of a water market. Even if there exists an efficient water market, equal allocation of water by itself cannot bring about equality in income. The non-existence of a water market may mean deterioration in social welfare under, the Pareto and the Hicks-Kaldor criteria. High transaction cost in cooperative bargaining in water markets could lead to loss in social welfare. Bargaining in labour markets is likely to have lower transaction costs. Forced redistribution of water resources could have a negative impact on wage rates. When endowments are not equal in more than one market, correcting the imbalance in one market alone may not be the second best solution. The lack of water markets would mean that sharecropping is more likely to be the outcome of equal sharing of water. If the transaction cost of imposing a progressive tax on output is more, equity is better achieved with an income or output tax.

The abstract analysis highlights the importance of water markets as well as the possibility of its being linked with other relevant markets in a rural economy in determining equity or equality in distribution of output or income. A study of water distribution initiatives would have to look into the concerns raised in the paper.

WATER RESOURCE MANAGEMENT IN MUMBAI: THE NEED FOR REFORMS IN INSTITUTIONS AND GOVERNANCE

Ramakrishna Nallathiga[1]

Water resources are increasingly becoming scarce across the world, particularly with respect to catering to human activities. This scarcity calls for an efficient utilization of water at all levels in order to meet sustainable development goals. One of the means of achieving this consumptive efficiency is to promote water as an economic commodity with a bundle of goods and services attached with it. This requires making water a priced commodity and ensuring that services relating to its provision, monitoring and cost recovery are in place. This is the case in urban areas. Large cities, in particular, need to embark on such measures to meet with ever increasing demand in addition to the traditional method of supply expansion. Mumbai is one of the large metropolises of India whose population has been burgeoning and water demand has been rising. This paper is a summary of the water resource status in Mumbai and it outlines the need for reforms in urban water resource management in line with the efficiency goals. The general emphasis is on water quantity aspects, but water quality aspects are also linked with water quantity.

The objectives of the paper are as follows:

(I) understanding the current system of water resource management in Mumbai, in terms of water supply vis-à-vis demand, water tariffs and water institutions;

(ii) analyzing the adequacies/inadequacies in the current water management and shortcomings in the current approach towards it;

(iii) overviewing and reviewing the plans and provisions made for water management in Mumbai;

(iv) identifying the areas wherein reforms in water management can be undertaken and providing an argument to support them;

(v) emphasizing the need to make a shift in the current approach and focus on options available for water management.

The study uses a combination of several research methods. Secondary data provides an understanding of the current state of water resources. The plans and provisions for its management were then reviewed in order to understand the approach laid down in them. Literature on certain key aspects of water supply system and its management as well as case studies elsewhere helped us to set the background or context at the same time. The lacunae in current water supply system were better understood through stakeholder meetings with the service provider as well as the general public. Finally, the reform agenda was drawn based on the situation analysis of water resource and examination of the options drawn from experiences elsewhere, and an operational framework for its implementation was also outlined.

Key findings

Water resource requirements of Mumbai city were well planned with the systems created long time ago in order to meet with the future needs; yet, the situation is fragile and it might become grave if the water supply expansion projects do not take off. Although there was no overall deficit like situation of water in Mumbai at present, there is a clear lack of proper management of water, particularly in the areas of demand management and service maintenance. The emphasis made by the MCGM earlier on supply expansion will not be sustainable when the population is growing; it calls for using demand management measures as well. These can be brought-in through water management reforms in its institutions and governance, which will make water an economic good, and, thereby, encourage water conservation efforts at consumption end on one hand while providing incentives to the service provider for providing better service (at a marginal price) on the other. The institutional reforms suggested include: unbundling of service

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delivery and policy & regulation functions of water supply, corporatising the water supply function, outsourcing of non-core services, creation of new institutions and their integration into the overall sector. The governance reforms that are required for some process changes in service delivery include budgeting reforms, accounting reforms, tariff structure reforms, and service and staffing reforms.

The study found that the current approach to water resource management in Mumbai would require a shift from embracing to enhancing water supply availability for consumption to striving for providing water efficiently, equitably and sustainably across space, time and people. This would require undertaking reforms on several fronts, particularly in its institutions and governance. In particular, making water as a serviced commodity would both enhance its economic value and encourage its conservation. It is hoped that the decision makers and policy makers would embark on this. The customer focus, professional service and consumer service orientation in water supply function would enhance the value of goods and services and its provider.

IRRIGATION AND WATER POLICIES IN THE MEKONG REGION: CURRENT DISCOURSES AND PRACTICE

François Molle[1]

In the past several years, water has moved up on the agenda of most Mekong region countries. This is due to several interconnected issues. First, recurring water shortages, although often local and temporary, have instilled a sense of vulnerability. These shortages have typically affected irrigation but in some cases have also threatened urban supply (like in Bangkok, in 1999, which experienced temporary rationing in some areas). These events do more to convince the urban elites that water is an important issue than climatic vagaries affecting the countryside. Second, numerous global initiatives and networking focused on water management (World Water Forums, GWP regional activities, etc.) have also contributed to giving water issues greater public salience. Third, these initiatives have been paralleled by persuasive insistence from development banks most notably ADB and World Bank- that borrowing countries develop regulatory frameworks, water policy, white papers, and water legislation.

Questions that lend themselves to investigation include: how pressing was the need for such reforms and how sound have the steps taken been? To what degree have national bureaucracies and ruling political parties shared this concern to reorder the water sector and added their willpower to the banks' solicitations, and how does this vary from country to country?

All these policy initiatives have a lot in common, partly because water-related problems are broadly similar among countries, partly because the initiatives stem from the mainstream thinking and prescriptions and sometimes fads of the day - that come with the interventions of development agencies. External consultants are generally faced with a difficult task: their terms of reference [ToRs] already specify by and large the path they must follow. ToRs leave little scope for adjustments, should the analysis of the situation reveal that some a priori desirable steps may be disadvantageous, or even counterproductive. Project timeframes are generally very short, despite time being the most important factor in successful policy processes, often resulting in the substitution of local passiveness for strong but short-lived external momentum.

Water policy reform processes generally contemplate a blend of the following blanket recommendations and measures:

- Poor water distribution in irrigation networks, epitomized by classical efficiencies between 30 and 40 percent, is addressed by trying to instill greater participation from users through the design of service agreements in which agency and farmers act as service provider and clients, rather than as supplier and recipients.
- Concern for cost-recovery and financial sustainability generally leads to making provision for the levying of a water charge.
- Embracing integrated water resource management (IWRM) leads to putting emphasis on river basin management, leading to proposals for river basin oganizations (RBOs), or other types of interfaces between concerned line agencies and users.
- The need to control uses and users of both surface and groundwater typically calls for establishing a regime of water permits, with registration of users, and sometimes provisions for future formalization and trading of these rights.
- The distinction between operation of the hydraulic network, resource management, and policy-making/regulation is emphasized and leads to proposing three nested layers of institutions with clear and distinct mandates.

It must be noted that except for this last point, and to some extent RBOs, policy reforms focus

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on the distribution and allocation of water rather than on the planning of water resource development. Although this function is supposed to be adequately tackled by the two upper tiers of the above mentioned tripart structure, the mechanisms that preside over decision-making on such issues are largely left unspecified.

This paper documents current irrigation and water policies in the Mekong countries. It reviews successively planning issues, water policies, and legal frameworks, the setting up of water policy "apex bodies", participatory policies, and Integrated Water Resource Management (IWRM)/ river basin management, with some comments on the underpinning of these policies, their discursive dimension, and how they fit the reality of the countries concerned. Its scope remains at an exploratory level: the paper is intended to pave the way for further research on water governance to be undertaken by the Mekong Water Governance network. Although the issue addressed here is extremely vast and complex; and would require the mobilization of a huge literature to be dealt with in a comprehensive manner, it is hoped that this cursory birds' eye view will have flagged major current issues.

ADAPTIVE RESPONSES TO GROUNDWATER DEPLETION AND STRATEGIES FOR MITIGATING THE ASSOCIATED IMPACTS

Marcus Moench[1]

Groundwater overdraft, pollution and quality degradation are widely recognized as major emerging problems in many parts of the world. This recognition has not, however, translated into equally wide management responses. The reverse has, in fact, often proved true. In parts of India, groundwater over extraction and quality declines have been recognized since the 1970s (United Nations Development Program 1976; Bandara 1977). With a few possible exceptions, however, little has been done to regulate groundwater extraction or control degradation of the resource base. This situation is mirrored in many parts of the world.

In this paper, I argue that the lack of progress in implementing conventional management responses to groundwater problems reflect a combination of technical, social, behavioral and organizational limitations that are inherent features in most contexts. Recognizing the importance of an emerging problem or the 'need' for management does not change the fundamental nature of these limitations. As a result, whatever the 'need' for management, alternative or complementary approaches that are adapted to the inherent limitations present in a given context are often essential. In many cases, such adaptive approaches will involve courses of action that fall outside the limits of conventional groundwater management. Furthermore, at least in some cases, adaptive approaches may be more productive than even the best implemented conventional forms of conventional 'water focused' management.

What is an adaptive approach? Research conducted by ISET and our partners in India and other locations (Moench 1994; Moench, Caspari et al. 1999; Moench, Dixit et al. 2003) suggests that adaptive approaches need to be designed in ways that:

- Reflect the social, political, economic and technical context in which groundwater problems are occurring and the types of response - including or excluding conventional management - that are likely viable within that context;
- Respond to inherent limitations on scientific knowledge
- Build off the incentives and courses of action households, communities and regions are already undertaking or have a strong incentive to undertake in response to a given problem
- Be strategic in that they focus on core objectives (livelihoods and environmental values rather than specific groundwater parameters) and key points of leverage rather than attempting to be comprehensive or fully integrated
- Encourage evolution of strategies as conditions change over time.

The above criteria suggest that adaptive approaches can be viewed as including the full array of conventional water focused management techniques while also moving beyond them to encompass a potentially very wide range of activities designed to reduce or eliminate the impact of groundwater conditions on livelihoods and environmental values. Furthermore, the element of change is central. Approaches need to recognize and be able to respond as economic, social, hydrological and other conditions change over time. The core difference between the approaches suggested here and most conventional management is the explicit focus first on core livelihood and environmental objectives rather than groundwater per se; second on the inclusion of response strategies that do not attempt to directly influence groundwater resource conditions; and third on the concept and role of adaptation - that is on the manner in which strategies can be shaped to reflect both change processes and the wide array of conditions present in any given context. This last element - a tautology at present (adaptive approaches are defined as approaches that focus on adaptation) - is explored in detail later in the paper.

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THE POLITICS OF WATER POLICY REFORMS IN SRI LANKA

Madar Samad[1]

Few would dispute the assertion that the process of policy and institutional reforms in developing countries is political . The recent water policy reform in Sri Lanka is a clear example of this phenomenon.

In April 2000, the Water Resources Council and Secretariat (WRS) of Sri Lanka finalized a document titled National Water Resources Policy and Institutional Arrangements. The document outlined the national water policy for the country and was drafted with technical and financial assistance from the Asian Development Bank. The proposed policy had supposedly been approved by the Cabinet of the Ministers of the Government of Sri Lanka. Although the draft policy was not publicly available, copies of the document were in circulation amongst NGOs, various political groups and professional bodies. The draft policy generated widespread and often hostile discussion in the media and various public fora. The most contentious issue of the draft national water policy was the vesting of ownership of all water resources with the state "and managed by the government in partnership with water users" and the issue of transferable water entitlements. These were seen as a strategy to privatize the nation's water resources. Other allegations were that this was a plot engineered by the Asian Development Bank to introduce free market principles to the water sector, plot by foreign multinational companies to take over the country's water resources, to destroy paddy cultivation and so on. In the wake of intense media campaign led by certain NGOs, political parties and some religious bodies, the government at that time distanced itself from the proposed policy document and denied that the cabinet approved the draft water policy.

The Water Policy of 2000 was suspended due to media campaign against the policy rather than public outcry against the policy. The public were virtually passive on lookers in the battle between NGOs, media and government. The population was not made aware of the key provisions of the water policy. Because of the failure of the relevant authorities to educate the public, discussions about the water policy took on an ideological stance rather than on pragmatic issues and problems relating to the water sector. An ignorant public were subjected to various distortions, and alarmist viewpoints; this was clearly shown in the diverse issues that were featured in the media and the issues raised at stakeholder consultations. The content of the policy had key provisions that were clearly beneficial, but the public were not adequately informed of this. This is the second occasion that the national water policy has been withdrawn in response to widespread protests. The reasons on both occasions are the same - no stakeholder consultations.

The paper maps the media cultivation of issues relating to Sri Lanka's national water policy. The analysis is confined to the print media and involves a cross-sectional analysis of about 150 texts that appeared in all major Sinhala and English language newspapers. The issues dealt in the media are compared with public perceptions of issues relating to the water policy as reflected by the records of stakeholder consultations during the process of policy formulation, and the notes taken during the "Wari-Mandapaya" or "Water Platform" arranged by the Ministry of Irrigation at various locations in the country to enable the farmers to discuss irrigation problems with the Minister.

The paper argues that the intense media campaign against the draft national water was led by a small group of persons/organizations and centered mainly on political ideology rather that on pragmatic issues confronting the water sector. The main reason for political ideology to dominate the discussion was the failure of the relevant authorities to effectively communicate key provisions of the water policy to the general

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public. Information asymmetries owing to the lack of public consultations at the conceptual and planning stage made the public gullible to alarmist viewpoints and misinterpretations of the key provisions of the policy by vested groups. This resulted in widespread objections to the secretive nature of the entire process and fear among local communities about the various clauses in the proposed water policy document. Although there were some stakeholder consultations as part of the design process, interest groups and political parties were reactive rather than proactive in the process of defining changes. In late 2003, a water reforms bill that focused on reforming urban and domestic water supply services was again withdrawn by the government in the face intense media campaign against the bill.

Although the reform proposal could not be implemented as a whole under the prevailing political environment, it has had a positive effect in the long process of institutional evolution and change. The reform agenda is now firmly entrenched in the political process. Although there has been opposition to some of contentious issues, there is a widespread convergence of the need for a comprehensive reform for aligning water institutional arrangement with emerging economic and water resource endowment realities. User participation, decentralization, and basin focus are now firmly rooted both in policies and programs. The recent policy statements by government reiterates its commitment to begin implementing the National Water Policy and to restructure existing institutions and government organizations. Already, the government is working on the redrafting of the water policy document as well as repackaging the entire reform proposal by making the necessary adjustments to suit the political economy requirements.

The key lesson that emerges from the Sri Lankan experience is that not only is the content of the policy important, but also the process of policy reform itself. In these cases, the work of the design teams was critical to explaining how and why the reforms took the shape they did and what conflicts they evoked when they were introduced by political leaders. This paper argues that constitution of the policy design teams, what tasks they are asked to take on, and how they carry out these tasks are important determinants of the contents of reform initiatives, the kinds of conflicts that surrounds the introduction of new policies and institutions, and the destiny of reform proposals.

Finally, the paper attempts to compare the Sri Lankan water policy with the Indian national water policy of 2002 and the commentary and discussion in the Indian print media on the water policy. The analysis reveals stark similarities in the key issues discussed in the print media of both countries.

THE NATURE OF INDIA'S WATER ECONOMY: FITTING POLICY REFORM TO THE CONTEXT

Tushaar Shah[1]

This paper argues that Indian discussion on reforms needed in water sector institutions and policies are excessively influenced by global catchwords, such as IWRM and IRBM, and fail to pay sufficient attention to India's ground reality. Cross-country analyses suggest that economic prosperity and HDI value of a country-rather than the magnitude of its water resources-determine the water-welfare of its people. In the long run, much water scarcity is 'economic'; and a key long term challenge is for the country to identify its own 'soft water path' to economic growth.

Water economies of all low-income countries are notoriously informal. In India, for example, 80% of rural people 'self-provide' their domestic and irrigation water requirements; recent NSS surveys show that most rural water infrastructural assets are owned and operated by households. Formal institutions-government agencies, co-ops, community organizations-touch a very small portion of India's rural water economy. However, dependence on formal sector players increases rapidly as rural areas prosper (as in Haryana or Goa) or urbanize.The institutional compact of a country's water economy obtains in two parts: Institutional Environment (IE) which includes water policy, laws and administration; and Institutional Arrangements (IA) refer to norms, rules, and customs evolved by people to govern their water transactions (such as water markets, recharge movement, etc). In general, the poorer a country, the more informal its water economy, and greater the disconnect between IE and IA, and vice versa. In the Indian water economy, for instance, law, water policy, and administration can directly influence only those 12-20 percent of water users who are in the formal sector; governing the informal water economy is a different ballgame in itself.

State can shape the water economy in three ways: it can regulate (by law), tax or withdraw its engagement from activities considered undesirable; and promote through law, subsidize or undertake public management of activities considered desirable. In industrialized countries, the State can effectively use all the six instruments in direct governance of water infrastructure, services and the resource because here the informal sector, if at all, is small, and the water economy is a highly formalized industry. In India, in contrast, legislative and economic instruments will have limited use in, say, promoting water use efficiency or controlling groundwater overdraft, simply because target actors are in the informal sector, largely outside the purview of the IE.

The nature of the Indian state also determines how effectively IE can implement reform. China whose rural water economy is nearly as informal as India's can do more to influence the behavior of its water users than India can because (a) the Chinese water bureaucracy has a strong presence at the village level; (b) the Communist Party provides a strong authority to back its village committees; and (c) the Chinese farmer still continues to pay numerous taxes and levies-including irrigation and power charges at cost, and pays salaries of local public functionaries. The Indian state during Moghul as well as Colonial rule too had all these three features. In contrast, today (a) India's water administration has hardly any presence at the village level; (b) India's panchayats have little coercive authority; and [c] soon after Independence, India abolished most of the numerous taxes and levies the Indian farmer had been subjected to by rulers for centuries; instead, an invidious subsidy syndrome has made it nearly impossible to build and operate infrastructure and services on a financially self-sustaining basis. This is a society-wide syndrome; it is a matter of debate whether it can be changed in hurry, and, more pertinently, whether water sector reform can be a trigger for such change.

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For a long time to come, the key water sector challenge for India will be to make meaningful investments in creating water infrastructure and service provision. In doing this, mobilizing capital has been less of a problem than of evolving institutional models for sustainable operation of these. According to the NSS 50th round data, Indian people today pay just around Rs. 6000 crore/year towards securing domestic water supplies. Town people pay more than village people. But providing 'protected', piped water supply to India's population may entail an infrastructure investment of Rs 250-300 thousand crore; at 10% of capital cost, operating such infrastructure would need Rs 25-30 thousand crores as annual fee. In our surmise, hardly 10 percent of Indians would be willing and able to pay the O & M costs of such infrastructure today. The nature of infrastructure investments needs to reflect what the market can bear.

Until such time as India's water economy gets substantially formalized, the key task is to manage the informal water economy where millions of independent operators rule the roost. IE has largely ignored the play of the informal water economy; but here lie big opportunities for improving the performance of the water economy through indirect strategic instruments. Some of this involves 'liberalizing' the water economy and harnessing the power of incentives. For instance, to improve the O & M and service delivery in public irrigation systems, India has experimented for long with WUAs and PIM but without much success; there is need to experiment with 'bounded service providing entrepreneurs' with appropriate incentives, as in China. The entrepreneurial model has worked well in many parts of India in dramatically raising the productivity of culture fishery, in providing desalinated water in fluoride-infested North Gujarat. Similarly, in controlling groundwater overdraft in western and peninsular India, it is doubtful if laws and water pricing can help; what IE can do is support local communities in their effort to augment local groundwater supplies; and at the same time, regulate groundwater draft by manipulating energy supply. At the macro-level, IE needs to understand and work on broader agrarian and economic policies that create perverse incentives for inefficient use. Changing food procurement and support price policies can do more to remove national distortions in water use patterns than micro-level management.

GROUNDWATER IRRIGATION AND SOUTH ASIAN AGRICULTURE: EMPIRICAL ANALYSES FROM A LARGE-SCALE SURVEY OF INDIA, PAKISTAN, NEPAL TERAI AND BANGLADESH

Tushaar Shah[1], O P Singh[2] and Aditi Mukherji[3]

This paper is a contribution to improving and refining our understanding of the significance and functioning of the groundwater irrigation economy that has emerged, during recent decades, as the backbone of South Asian agriculture and rural livelihoods systems. It summarizes key results of a survey of 2629 well-owners from a geographically representative sample of 278 villages selected from India, Pakistan, Nepal Terai and Bangladesh. For purposes of analyses, survey villages were divided into 12 hydro-economic (H-E) zones, which in turn were further regrouped in several different ways, depending upon the purpose on hand.

The pattern of groundwater development is not in sync with the regional groundwater resource position. Over 50% of groundwater structures we came across in this random survey were built only after 1993, suggesting that South Asia's 'groundwater juggernaut' is still accelerating. 55% of the irrigated land in survey villages is served by 'pure groundwater irrigation'; counting conjunctive use of ground and surface water, tubewell irrigation's contribution rises to 75% of net irrigated area while pure canal irrigation covers 14.5% of irrigated areas encompassed by the survey. For India, the share of pure groundwater irrigation to irrigated areas is higher at 76%; along with conjunctive use, groundwater share rises to over 87%; pure canal irrigation and other sources (drains, tanks, etc.) contribute 4-6% each. Coarse cereals, pulses, oilseeds, and fibers are preferred crops in pure groundwater irrigated areas; paddy-wheat cycle is the preferred pattern in canal and conjunctive use areas.

Unlike in many other parts of the world, such as Africa, there is essentially no 'rainfed farming region' in South Asia; thanks to the spread of wells and tubewells, only 5% of the villages surveyed pursued totally rainfed farming; in most villages, most farming households had irrigated and rain fed plots in varying proportions.

At the sub-continental level, there is a north-south energy divide with the groundwater economy of the Indo-Gangetic basin increasingly dominated by diesel pumps and that in the south by electric water extraction mechanisms (WEMs). There is empirical support for the hypothesis that the diesel pump is the mainstay of the poor and that better off farmers seem better in capturing electricity subsidies on groundwater pumping than small-holders. Farmers have responded to energy pricing and supply policies on a regional scale; in Bangladesh and Pakistan, where electricity subsidies are absent, the balance between diesel and electric pumps is even; in Eastern India and Nepal Terai, where power supply environment is poor or has deteriorated, groundwater development has occurred primarily with diesel pump; in the rest of India, the ratio of electric to total WEMs has been on the rise since electricity subsidies were introduced. Farmers with electric WEMs pump their wells for longer hours/year everywhere compared to diesel WEM owners; however, in regions where electricity supply to agriculture enjoys real subsidy, the former group uses significantly more energy (and likely groundwater) per ha compared to owners of diesel pumps as well as owners of electric WEMs in regions where electricity supply to agriculture does not enjoy subsidies. Summary elimination of electricity subsidies would likely result in reduced yields of wheat but not of paddy; as such, in wheat irrigation, electricity subsidies are not a complete 'social waste'.

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Despite subsidized electricity and canal irrigation, it is the diesel pump which by far explains the most variation in the net irrigated area among 278 sample villages; its relative contribution on the margin to net irrigated area is twice that of electric WEMs and 3.5 times that of availability of canals in a village.

Groundwater irrigation in South Asia is largely supplemental, with tubewells providing 30-50% of the total crop water requirements; when return flows are accounted for, ET from groundwater applied is even less. This probably explains how an estimated 200-225 km3 of groundwater pumped in the region is able to provide life-saving irrigation on 65-70 million ha of gross irrigated area.

Pump irrigation service markets-commonly referred to as groundwater markets-- have declined in western and southern India (compared to the 1980's) but continue to boom in eastern India, Bangladesh, Nepal Terai, and the Pakistan Punjab; at the sub-continental level, extrapolation from the survey results suggests that some 6.5 million WEM owners irrigate an estimated 5 million ha of net cultivated area belonging to groundwater buyers. Far from an expropriating 'water lord', the average South Asian water seller is a small farmer with more fragmented holdings (compared to non-sellers) who sells water to make his WEM viable.

South Asia's informal groundwater economy includes manufacturers of pumps, pipes and other components and service providers such as owners of boring rigs, pump repairers, and such like most of whom operate in the unorganized cottage sector; this makes it difficult to intervene in this diffuse economy. Our survey however shows that about 20 leading manufacturers of pump brands, who have penetrated the pump markets of South Asia, can potentially be important formal sector partners to improve energy and water use efficiency in the South Asian groundwater economy.

Finally, contrary to conventional wisdom, farmers surveyed were much more concerned about the high energy cost of pumping groundwater and the unreliable supply of electricity than about groundwater depletion, salinity, or reduced aquifer yields.

2. Managing Conflicts around Water:

Towards Practical Protocols

Rakesh Tiwary

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24th February 2005

11:00 – 13:30

Session Chair: Ramaswamy Iyer

As water becomes scarce, conflicts around it abound. Among individual users. Village communities. States. Nations.

An important part of 'bracing up for future water scarcity' is to evolve and popularize practical protocols for managing, mediating, resolving conflicts.

ITP also brings to the discussion table more case studies on managing water conflict. **Ramaswamy Iyer** leads the discussion; **Meredith Giordano**, IWMI's Director of Research, and **Mark Giordano** bring some international experience to the discussion.

Author(s)	Paper	
Meredith Giordano and Mark Giordano	Transboundary Water Conflicts: Cross Studies	Presentation Only
Ramaswamy R. Iyer	Inter-State Water Conflict: Fresh Thinking Required	Presentation Only
Rakesh Tiwary	The Dynamics of Conflict over Transboundary Waters: Analysing The Indo-Bangladesh Case	Highlight
Dinesh K. Mishra	Breaching of Embankments or Breaching of Trust: A Case Study of the Kosi Embankments	Ext. Abstract
F. A. Shaheen	Indus Water Treaty: Scrapped or Abrogated?	Ext. Abstract
R. Doraiswamy and Biksham Gujja	Levels of Conflict around Water in South India: Case Studies	Ext. Abstract

BREACHING OF EMBANKMENTS OR BREACHING OF TRUST: A CASE STUDY OF THE KOSI EMBANKMENTS

Dinesh kumar Mishra[1]

The Ganga, which acts as the master drain for most of the Bihar state, flows in an easterly direction and stretches 432 kilometers across Bihar, bisecting the state. North Bihar, the plains located north of the Ganga, is interspersed with eight major river basins; the Ghaghra, the Gandak, the Burhi Gandak, the Bagmati, the Adhwara group of rivers, the Kamala, the Kosi, and the Mahananda. All these rivers descend down into the plains from Nepal.

Himalayan rivers contain large amounts of sediment during the monsoon. Heavy downpours in the mountains scour the slopes and turn the swift waters into a muddy brew. As they reach the plains and lose momentum, the rivers deposit their loads and begin to meander.

Rivers like the Kosi, 'Sorrow of Bihar' as the British called the river, have been notorious for changing course. Available records suggest that the river was flowing about 160 kilometers east of its present coursesome 200 years ago. The 'credit' for setting up an example of flood control in post-independence India must go to Bihar. The state began a massive program to tame its rivers in 1955 with the embanking of the Kosi.

Embankments are earthen walls created between the people and the rivers and this is an ancient technology. The first embankments that were constructed were probably on the Hwang Ho in China in the seventh century BC. These were followed by the Yangtze in the first Century. In the recent past, we had embankments on the Mississippi in the USA (18th century). Embanking of the rivers is a controversial technology as we see below.

Embankments prevent a river from overflowing its banks during floods but they also prevent the entry of floodwater. This leads to a major problem as the embanked river is no longer able to fulfill its primary function draining out excess water. With the tributaries prevented from discharging into the river and accumulated rainwater finding no way out, the surrounding areas quickly become flooded. The situation is aggravated by seepage from under the embankments. Areas outside the levees remain waterlogged for months after the rainy season because this water has no way of flowing out to the sea. Theoretically, sluice gates located at these junctions should solve the problem but, in practice, such gates quickly become useless. As the bed level of the main river rises above the surrounding land, operating the gates lets water out instead of allowing outside water in. When the sluice gates have failed, the only option left is to also embank the tributary. This results, then, in water being locked up between the embankments. Moreover, no embankment has yet been built or can be built in future that will not breach. When a breach occurs, there is a deluge.

Proponents of embankments, however, have tried to rationalize the jacketing of rivers thus: forcing the same quantity of water through a narrow area, as happens in the case of an embanked river, increases the water velocity thereby increasing its eroding capacity. The increased velocity of water dredges the river bottom and transports the sediment out preventing the rise of riverbed levels, increasing the carrying capacity of the river and reducing the extent of flooding. These were the arguments put forward by engineers in independent India when they resorted to massive embanking of rivers in the Ganga and the Brahmaputra basin. Unfortunately, there has been little evidence to date that this theory is actually being substantiated anywhere on Indian rivers. The technical debate, however, continues.

Politicians take advantage of this inconclusive debate and engineers just toe their line. It was in this background that embankments along the rivers were constructed in independent India. The British engineers refrained from constructing embankments as this did not suit the rulers then. The Kosi embankments, extend from Birpur

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(District Supaul) to Koparia (District Saharsa) on the east (125 kilometers) and from Hanuman Nagar, in Nepal, to Ghonghepur in Saharsa district of India (126 kilometers). Their construction was almost completed by 1959 but extensions were proposed on it, from Bhanthi to Ghonghepur, on the western side by four kilometers and from Mahishi to Koparia, on the eastern side by 33 kilometers. This work continued up to 1964. Thus, it took about 8-9 years to complete the embanking part of the project.

There are some 386 villages trapped within the Kosi embankments that spread over four districts and thirteen blocks. The area of the entrapped land is to the tune of 150,000 hectares over which a population of around 8,00,000 still lives.

However, before the embankments could be completed, the Kosi started attacking them and the first breach of the embankment took place in 1963, just before the work on the embankments could be completed. The first major breach of the Kosi occurred in Nepal (Dalwa) just across the Indo-Nepal border, in 1963, on the Nepalese side. The last breach so far had also occurred in Nepal, near Joginia, in 1991. It created a political stir in the state of Bihar that led to the resignation of the Water Resources Minister of the state. One can see the difference in the attitude of various stakeholders as the Kosi posed the problems before the people, engineers and the politicians. It is a journey from cooperation between the two countries to mutual suspicion as far the flood problem of the Kosi is concerned. There have been breaches in the embankments in 1968, 1971, 1980, 1984 and 1987. All these breaches took place in the Indian territory.

The policy of flood control that was adopted after the independence was more in keeping with providing immediate succor to the people and there was lot of adhocism in it. Since, it was aimed at providing immediate relief, it resulted in adoption of 'outdated technologies'.

Much of experience of flaws and bad impacts of embanking were known from the Mississippi in USA and the Hwang Ho basin in China but the unlearnt lessons and connivance of the vested interests forced the people to accept the results with a pinch of salt. Total lack of accountability in maintenance and repairs of the embankments have added insult to injury. The embankments have become not only a source of irritation between Nepal and India, they have also become a bone of contention between the people living within the embankments and those living in the so called protected countryside. The bed levels of the rivers have gone up and the rivers are releasing waters into their catchment instead of draining them out, the basic function of the river.

The alternatives to construct high dams in Nepal are equally fraught with dangers. The time has come for an honest debate to define the limitations of flood control technology and looking for time tested people's wisdom infused with scientific innovations. Sooner this is done, better it is. This article takes stock of the events before the breaches occurred and their aftermath and leads one to think about the flaws in controlling the rivers and their floods.

INDUS WATER TREATY: SCRAPPED OR ABROGATED?

F. A. Shaheen[1]

Growing scarcity of water resources, increasing population, and poor water management in developing countries have resulted in increasing demand for water resources. Increasing scarcity of water has led to the desire for control of water resources, which in turn becomes a ground for breeding conflicts. Conflicts over the use of water between states become severe when they are typically agrarian based economies. The Indus Water Treaty (1960) between India and Pakistan is one of a few examples in South Asia of the settlement of a major, international river basin conflict.

The Treaty fixed and delimited the rights and obligations of India and Pakistan in relation to each other concerning the use of the waters of the Indus system of rivers. Indus, an international river basin, is the largest, contiguous irrigation system in the world, with a command area of about 20 million hectares and annual irrigation capacity of over 12 million hectares. The Indus system of rivers comprises three eastern rivers (Sutlej, Beas, and Ravi) and three western rivers (Indus, Jhelum, and Chenab). Under the Indus Water Treaty (IWT), waters of the eastern rivers stand allocated to India and those of western rivers largely to Pakistan. The treaty which was carried out in the best interest of nation has, however, deprived Jammu and Kashmir (J&K) of using its own water resources and thereby severely affecting the development process in the state. The treaty made Punjab prosperous by using the water of eastern rivers for agriculture and power generation and on the same has put J&K behind by an estimated Rs 6500 crore annually. The losses are not there in the agricultural sector alone but on a much higher scale in the generation of hydropower which has an otherwise estimated potential of 20,000 MW. The state's rightful riparian rights have been snatched in the so-called national interest without the state being consulted at the time of treaty or compensated for the consequent loss.

Under the treaty, J&K can use only limited waters of the Indus, Chenab, and Jhelum for power generation and lift irrigation. It cannot build reservoirs or dams on these rivers to store water for irrigation and power without the prior approval of Pakistan. Nor can it construct any barrage for irrigation. The treaty imposes limits on the storage capacity that the state can create. It can only store 0.40 million acre feet (MAF) on the Indus in Ladakh, 1.50 MAF on the Jhelum in Kashmir, and 1.70 MAF on the Chenab in Jammu.

The state's agricultural potential has also been worst hit. There has been only a marginal increase in the irrigation infrastructure. In 1950-51, the state could irrigate 2, 61,000 ha but in 2000-01, the state irrigated only 3, 05,970 ha through various sources. As a result, the state has now rationed population of 86.14 lakh people dependant on supply by the consumer affairs and public distribution department which procures rice from outside the state. Besides this, a good percentage of population also purchases rice from private dealers. The foodgrain import graph of state shows a sharp increase in overall imports. J&K, according to an estimate, could have increased its area under irrigation by one lakh acres had the state freedom to harness its available water resources. In case of the Kashmir valley, only 0.5 MAF could be stored under general storage on the Jhelum basin and that too not directly on the waters of river but on various streams that form its tributaries. And for every new irrigation scheme, the state has to seek permission from the Indus Commission. The Irrigation and Flood Control Department of the state has proposed 12 new irrigation schemes for Baramulla, Kupwara, Anantnag, and Budgam districts on the various streams which are awaiting approval.

Being a state with a dearth of plain agricultural land, the state would be enormously benefited by a proper irrigation infrastructure. This would help

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bring large acres of Karewa land (highlands specific to the uneven terrains like that of J&K) across the countryside under cultivation. This has, over the years, given rise to groundswell against the "unjust treaty" which though has made Punjab prosperous by letting that state use freely the water of its rivers for irrigation and power production. On the other hand, these very sectors have stagnated in J&K. What is regarded as more galling is that though New Delhi compensated Pakistan for the loss of the pre-partition canal network of central Bari Doab and Dipalpur, J&K received nothing. The Nehru dispensation gave financial aid of Rs 83.3 crore to Pakistan to undertake development works like building storage reservoirs, link canals, tubewells, drainage, and hydroelectric installations. Pakistan, in addition, received over Rs 300 crore at the time from the United States, Britian, West Germany, Australia, Canada, New Zealand, and World Bank as aid.

One way to compensate J&K for losses could be a favourable sharing ratio for power generated from centrally funded projects in the state. However, so far the approach of New Delhi has not been encouraging. For example, in the case of the Salal Project, experts assert that the central government has recovered its capital cost way back in 1982 but power sharing continues to be on the existing ratio. That is, J&K gets a royalty of only 12 per cent from the project. This is despite the fact that against the capital investment of the central government, the state has provided all important water and land resources for the project. Moreover, in the case of the Salal project, one of the provisions agreed upon was that when capital cost of the project was recovered, the power plant would be handed over to the state. So there is a case for the transfer of centrally funded power projects, not only on the principle of complete recovery of capital investment but more so as a compensation for the losses incurred by the state as a result of the treaty.

During the recent secretary level talks in Islamabad between India and Pakistan on the controversial Wullar Barrage or Tulbal navigation project, political leaders from Pakistan Punjab demanded that the Pakistan government should buy water from India to meet the requirements of the province. They also demanded that the government should scrap the Indus Water Treaty. On the other side, there is a growing consensus among the political parties of J&K to scrap or abrogate the treaty since it has over the period sounded a death kneel to the state's economy and has acted as impediment to development. During a recent state assembly session, the People's Democratic Party (PDP) passed a resolution demanding setting up the barrage and sought compensation from the centre for the losses it suffered because of the Indus water treaty. The J&K state assembly members also lashed out at Pakistan for strangulating Kashmiri's by sticking to the Indus Water Treaty which has taken a heavy toll of state's economy.

While the new found bonhomie between India and Pakistan has successfully put political issues on the backburner, the fight on water rights is set to become acute in the coming year. It might even surpass the political disputes between the two neighbors. The main reason for this is growing industrialization in both countries, coupled with depleting water levels and mounting power scarcities. The Baghliar and Wullar Barrage issues currently being discussed at the expert level are, therefore, just a tip of the iceberg. The recent secretary level talks by India and Pakistan over the construction of Baghliar dam on the Chenab river ended in failure. Pakistan has now approached the World Bank for arbitration.

With water sharing promising to be the new international quarrel area of the 21st century, India and Pakistan have already got a readymade point of friction. Because of growing population, industrial growth, and mounting water problems accompanied by the overall fall in the waters of the Indus basin owing to climatic change, there is a need to either abridge or abrogate the old treaty, particularly looking to the current political and economic situation in Jammu and Kashmir. The time has come for a fresh look on all the water sharing issues between the two nations for the common benefit and put behind bars all the political issues and do justice to each and every area / region of the Indus basin in terms of equity in water resources of the Indus basin.

LEVELS OF CONFLICTS AROUND WATER IN SOUTH INDIA: CASE STUDIES

R. Doraiswamy[1] and Biksham Gujja[2]

Water has become a vital resource for political stability, economic growth, social order and sustainable development. Of late, water tensions are brewing over shared rivers, inter-basins, intra basins, tanks, big dams, canals, distributaries, sub-distributaries and pipe outlet level. In other words water conflicts exist in different sizes of water bodies and at all levels of irrigation systems for various reasons. Conflicts over sharing water can be seen among individuals, individuals and state, between states and nations. Existing legal frameworks (e.g. by allocating river water to states) and the alternative practices (watershed development, water harvesting) are not reducing the conflicts. Water conflicts in no way increase water resources, instead they only cause heavy expenses on the part of individuals and state. They also pose serious threat to the society . There are serious repercussions on eco-systems. In a way water conflicts are primarily leading to more and more water withdrawn, polluted, diverted from the natural system ,leading to less and less water for ground water recharge, etc. Competition for water by agriculture, rural and urban drinking, industry, eco-systems, citizens, fisheries, tourisms, politicians, etc. adds to the multi dimensions and complexity of water conflicts. Water conflict is increasingly becoming a political tool to settle scores and mislead the people from the main current issues. The violation of Supreme Court order by some of the State governments in terms of water conflict is becoming a fashion for various reasons. Attempts are being made by several individuals, informal and formal organizations, research institutions, NGOs, state and nation to address and resolve ever-increasing water conflicts through dialogues, judiciary, treaties, etc. However, these are found to be in piecemeal cases. Thus, there is a need for holistic understanding of nature of the water conflicts despite regional and local specific characteristics.

This paper deals with various levels of water conflicts in water bodies ranging from pipe outlet to interstate level. The study is taken up in the wake of the widespread conflicts in water bodies causing negative impacts on environmental, social, political and economic fronts. The study is initiated to give a different dimension to addressing water conflict as such than merely looking at specific case of water conflict. The available literature on water conflicts to a large extent focuses on specific conflicts like the long pending conflict over Cauvery waters in South India.

This paper discusses water conflicts at various levels of water bodies and hydro geologically includes water conflicts in tanks, major and medium irrigation systems and rivers. In terms of political boundaries the paper covers water conflicts at village, district, project, sub-basin, basin and interstate level. The issues documented include conflicts over water in terms of irrigation, pollution, river link, institutions and policy reforms. The attempts to resolve these water conflicts under existing social normative framework i.e. legal pluralism is given in the paper to understand the mechanisms, which enables to make policy intervention to resolve the water conflicts. Success stories of handling water crises are documented to project the rule making mechanism in overcoming scarce situations. Often the cost of raising the conflict or generating the conflicts (by neighboring states, for example) may be much more expensive than the benefits they would have got by getting their perceived 'fair share of the water'.

The sample cases studied are categorized into interstate, project/distributary, and tank systems. Interstate conflicts are Krishna River Basin,

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Mukkali Weir across Bhavani River in Kerala, Rajolibanda Diversion Scheme and diversion of Mahadayee and its tributaries. The project level conflicts are Paddy cultivation and migrant farmers in Upper Krishna Project and Old and New ayacut in Bhavani Sagar Dam in Tamil Nadu. Conflicts at tank system are Nagaram Tank in Andhra Pradesh and deprivation in the tank system in Belagumba tank and efficient tank system in tank institution in Karnataka.

The general characteristics of water conflicts are that the water conflicts exist irrespective of political, administrative boundary i.e., village, Mandal, Taluk, district and State. The literature survey shows that conflicts exist across National & International level as well. Village communities normally referred as homogenous groups do have strong cases of water conflicts. Water conflicts exist at micro level like pipe out let level, which comprise even an area of 90 acres and at macro level like interstate or river basin level. In the latter case, water conflict is more from the perspective of hydro-geological than merely the political boundary.

Water conflicts are of varying nature, intensity and magnanimity of the conflict from present day- petty case to long pending unresolved conflicts. Petty cases are the ones, which emerge on the current issues influenced by the circumstances that get resolved quickly. Classic examples of such conflicts are the violation of rotation system in a pipe outlet or the confusion over opening and closing of gates in the tank system. There are certain cases of water conflicts that are more than petty cases. These water conflicts take reasonably longer duration to get resolved.

Water conflicts take place among users of water for some purpose like, among farmers in agriculture and between users for one purpose to another like agriculture and industries, Industries and environment, agriculture and environment, between government department and water users, etc.

Analysis throws open a spectrum of reasons for water conflict at various levels of water bodies. Although the study has not gone into a detailed analysis of each case, an attempt is made in this section to highlight some of the reasons that are responsible for the type of water conflicts. These reasons are entitlement or water rights, multi disciplinary approach, scarcity by design, mismatch between design and practice, regional imbalance, allocation of water, centralized authority, information and communication technology, big dams and other water bodies, comprehensive water policy, agriculture extension, weak parameters, research and development, politicization of water, civil society, tribunals and dialogue, political in-equilibrium, enforceable law, common property, technology, nature, public interest litigation and multi stakeholders platform.

Water conflicts arise because of number of reasons that are social, political, legal, economic, or ecological. Water related issues are dynamic and are influenced by spatio-temporal factors. Reasons responsible for water conflicts are in most cases interdependent and inter related, which calls for integrated and holistic approach. It is learnt that even when all the above reasons are well addresses there are chances of water conflicts erupting. Thus, there is a need to develop institutions that can regularly derive strategies to address the water conflicts. One such effective mechanism is though constructive dialogue of multi-stakeholders with an integrated approach on items like research, legal, political, social, economic, institutions environment, livelihoods, etc.

3. Decentralized Water Harvesting and Groundwater Recharge Blending Hydrologic and Social Perspectives

R. Sakthivadivel and M. Dinesh Kumar

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24th February 2005

11:00 – 13:30; 14:30 – 16:00

Session Chair: Sunita Narain

Community-based rainwater harvesting and groundwater recharge have assumed the character of a mass-movement in many parts of western India, especially, the Saurashtra region of Gujarat. Good empirical analyses of the impact of these are, however, hard to come by. Anecdotal information galore; but we know little about the impacts of these activities on local hydrological regime or on basin water productivity.

ITP presents early results of a slew of new, systematic impact studies in progress at 4 locations in India. The focus is on assessing trade offs between harvesting water at community level and maximizing its efficiency at the basin level.

Sunita Narain of the Centre for Science and Environment leads the discussions; **Marcus Moench** of the Institute of Social and Environmental Transition and **David Molden** of IWMI comment.

Author(s)	Paper	
R. Sakthivadivel	Artificial Recharging of Aquifers in India: A Synthesis	Ext. Abstract
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ARTIFICIAL RECHARGING OF AQUIFERS IN INDIA: A SYNTHESIS

R. Sakthivadivel[1]

Artificial recharging is the planned, human activity of augmenting the amount of groundwater available through works designed to increase the natural replenishment or percolation of surface waters into groundwater aquifers, resulting in a corresponding increase in the amount of groundwater available for abstraction. In India, this method has been in use for quite some time and its historical evolution is briefly outlined. It has been used for many beneficial purposes although the primary objective of this technology is to preserve or enhance groundwater resources. A variety of methods developed and applied to artificially recharge groundwater in urban and rural sectors has been reviewed. Various artificial recharge experiments have been carried out in India by different organizations, and have established the technical feasibility of the artificial recharge of unconfined, semi-confined and confined aquifer systems. However, the most important and somewhat elusive issue in determining the utility of this technology, namely the economic and institutional aspects of groundwater, has not been adequately addressed and needs further studies. The recharge process is complex, and, due to the numerous factors affecting the process is only partly understood. Studies on artificial recharge techniques are mostly site-specific and descriptive in nature, which gives little insight into the potential success of implementing this technology in other locations.

It is estimated that by prudent artificial recharge schemes and waste water recycling, about 25 % of India's water requirements in 2050 can be met. Both measures provide water at local scale, where people live and engage in productive activities. In the near term, rainwater harvesting and artificial ground water recharge where people and community can directly participate as in the recharge movement in Gujarat must be given thrust and focus by all concerned with India's water. The gestation period for such projects can be a few months to a few years and, because of the distributed nature of this activity, it is only through the involvement of local communities that sustainable ground water augmentation can take place. This strategy is also evident from the importance given by the Government of India in water conservation and use through watershed development.

Groundwater recharge schemes should continue to remain as peoples program. Without people's participation, the program is unlikely to survive. It is only peoples involvement that would ensure critical components like quality of works; preventing undesirable contractor's entry into partnership with government; sustainable maintenance and supervision; speed of implementation and cost efficiencies. Intensive efforts should be made to elicit support from reputed NGOs, spiritual bodies, charitable organization, donors, industrial houses, and spirited individuals who have unquestionable interest in the region and the well being of the people to promote, participate in and provide for the scheme. Involvement of panchayat administration up to district level is also necessary. An aggressive campaign approach is needed to educate and motivate rural collectivities using promotion tools like Jal-Yatra as was done highly effectively in Saurashtra.

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RAINWATER HARVESTING IN INDIA: SOME CRITICAL ISSUES FOR BASIN PLANNING AND RESEARCH

M. Dinesh Kumar[1], Shantanu Ghosh[2], Ankit Patel[3], O. P. Singh[4] and Ravindranath[5]

The practice of "rainwater harvesting" (RWH) dates back to ancient times. It is as old as human civilization. Some of the earliest known rainwater harvesting works were practiced in the Middle East, and Egyptian and other African deserts, while recent studies correlating palaeoclimatological evidences and archeological and historical records show strong evidences of heightened human efforts for rainwater harvesting in response to climate change starting from as early as 4500 BC in ancient India. India has a long and rich tradition of rainwater-harvesting with different techniques practiced in different parts of ancient India over different time periods. The past two decades are characterized by a boom in water harvesting. They are markedly different from the traditional ones in two ways; first from the context; and second from the purpose. As regards the context, they are able to use recent techniques and technologies and management tools, while the traditional ones, represented the best engineering feat of those times. The modern water harvesting systems are at best miniatures of the large water resource systems that use advances in civil engineering and hydrology. As regards the purpose, they are employed as resource management solution, and not as resource development solutions. The limited Indian research on RWH/artificial recharge so far had focused on engineering performance of individual structures. While a lot of anecdotal evidences on the social and economic gains exist, there is little understanding based on empirical work of: [a] the impacts of water harvesting activities on local hydrological regime in terms of net water gain; [b] basin level impacts on overall basin water balance; and [c] economic imperatives from a long term perspective.

The paper does not aim at analyzing the physical performance or hydrological impacts of water harvesting. Instead it takes a different approach. The paper has the following objectives: [1] discuss the critical issues in rainwater harvesting not only from a micro perspective from also macro perspective; and [2] the issues for research in water harvesting and recharging. The major findings are emerging from an extensive review of the research on water harvesting in India, and a macro analysis of the critical issues in rainwater harvesting from the point of view of hydrological opportunities, economic viability and socioeconomic impacts when scale considerations are involved. [1] Macro level hydrological analysis shows that rainwater harvesting solutions offers extremely limited potential in terms of its ability to reduce the demand-supply imbalances and provide reliable supplies in water scarce regions. The reason being: (a) significant part of these regions are characterized by low mean annual rainfalls, high inter-annual variability in rainfall, with high potential evaporation and larger share of evaporation occurring during rainy season, reducing the runoff potential and increasing the occurrence of hydrological stresses; and (b) another significant part is characterized by medium rainfalls, with medium inter-annual variability, but "medium to high evaporation", making surface storage difficult. [2] A large part of the water-scarce regions, which fall under the "medium rainfall-medium to high evaporation" regime are underlain by hard rock formations such as basalt, crystalline rocks and other consolidated formations such as sandstones. The percolation tanks, the most preferred recharge structures, are likely to have low efficiency in these hard rock areas and also areas having silty clay and clayey

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soils. In high rainfall, and medium evaporation regions which experience high reliability in rainfall, the overall potential and reliability of water supplies from RWHS would be high. [3] Inefficient recharging in hard rocks is due to lack of integration of groundwater and surface water use. In these regions, planning of recharge schemes should consider surface water impoundment of all the available excess flows, than direct recharge. This should be followed by water use programming to create underground storage for incoming surface flows. However, this is not followed. [4] Many water-scarce regions have water demands which far exceed the supplies, with vulnerability to hydrological stresses, that they would require exogenous water. [5] Economic evaluation of water harvesting/groundwater recharge systems poses several complexities due to the difficulty in quantifying the inflows, the storage and recharge efficiency, and the economic value of the incremental benefits, which are social, direct economic and ecological or environmental. [6] Scale considerations are extremely important in evaluating the cost and economics of water harvesting/groundwater recharge structures because of the integration of catchments at the level of river basins. The economics of water harvesting cannot be performed for structures based on their individual benefits and costs, when the amount of surplus water available in a basin is limited; but on the basis of incremental benefits. Further, higher in degree of basin development, higher will be the marginal cost and lower would be the marginal benefit. [7] The basins which experience high inter-annual variability in the stream flows are many and cover significant areas in India. In such basins, the trade off between hydrological impacts of water harvesting and economic benefits is likely to be large. With increasing storage capacity of RWH systems, the economic viability becomes poorer as the average cost of water harvesting per unit volume of water increases. [8] In "closed basins", there is apparent trade off between local benefits and downstream benefits. U/S diversions reduce the prospects of storage and diversions systems d/s. [9] In many important basins, there is an apparent trade off between maximizing overall benefits for basin communities in terms of enhancing the gross value product of water, and maximizing the local benefits of water harvesting. This is owing to the fact that in these basins, water from well-endowed regions with low water demands is being diverted to poorly-endowed regions with high water demands, enhancing its social and economic value. [10] Extensive review of existing literature on RWH shows that the past studies did not involve "scale considerations" in analyzing the physical and economic impacts of water harvesting. The scale considerations should include both space and time. Space considerations are important as water harvesting only follows large water development projects in many river basins in India. Temporal considerations are important almost everywhere due to high inter-annual and inter-seasonal variability in rainfall and erratic nature of monsoons.

Future research on water harvesting/groundwater recharging should focus on basin level marginal impacts and benefits to capture the scale effects, apart from covering different hydrological regimes, and typical rainfall years. This can help proper targeting of investments in water harvesting. Making water harvesting more effective calls for enhanced knowledge of catchment hydrology, basin-wide water accounting and water balance studies, improved efficiency of utilization of green and blue water for crop production, and "wet water" saving.

for the Yennehole river basin (327 km^2) located in the coastal district of Udupi in Karnataka. NITK model with parameters fixed a priori was applied on the daily basis for the period from 1 January 1993 to 31 December 1998. Daily catchment average rainfall was computed by the Thiessen polygon method and daily PET was computed from climate data using the FAO-56 Penman-Monteith equation and assumed to be spatially invariant. Model performance was evaluated by comparing daily values of simulated and gauged flows. 1993 was considered as model warm-up year and simulated and observed flows for the remaining period only were used to compute the correlation coefficient (R), root mean square error (RMSE), and Nash-Sutcliffe model efficiency.

It is apparent that simulated streamflow responses to daily rainfall events more or less follow the pattern of observed flows. While medium flows are reasonably well simulated, the ability of model to simulate peak flows and low flows appears limited. Given that the model structure does not incorporate use of rainfall intensities to simulate flood flows, the result is only to be expected. Also, it is known that measured flows during flood events are less accurate on account of being extrapolated from stage-discharge curves. Overall model performance indicates slight underestimation. For the simulation as a whole comparison of simulated and observed daily flows yielded a correlation coefficient (R) of 0.8745, root mean square error (RMSE) of 14.63 mm/d and Nash-Sutcliffe of 72.61 per cent. These statistics are indicative of reasonably accurate simulations, especially considering the fact that no efforts were made to calibrate the model.

In present study, a simple catchment-scale conceptual hydrological model has been developed whose parameters may be estimated a priori from satellite data and GIS analyses. Using this so-called 'identifiable' parameters approach in a humid tropical river basin, we demonstrate that reasonably accurate simulations of daily streamflow time series and water balance components can be obtained at ungauged locations. Further research is necessary to test the general applicability of the model in several more catchments in diverse hydroclimatic settings. However, preliminary results presented in this paper are extremely encouraging because there appear to be only a few crucial parameters controlling the process of conversion of rainfall into runoff at the catchment scale.

The Indian hydrologic research community must focus on development of such simple yet scientifically-based tools for hydrologic predictions in ungauged basins. The success of water management policies in India will be determined to a large extent by availability of accurate hydrological information and it is imperative that the community of hydrologic practitioners in India adopt the best possible tools within the constraints imposed by input data availability. The topic of predictions in ungauged basins provides a perfect opportunity for initiating a much-needed dialogue between researchers and practitioners thereby paving the way for bridging the gap between hydrologic science and practice

Water Balance Studies from Deccan Basalts in Central-West India, with Special Emphasis on Groundwater Balance Components: Some Preliminary Observations

Himanshu Kulkarni[1], Uma Badarayani[2] and Vinit Phadnis[3]

Crystalline rocks commonly referred to as 'hard rocks', underlie around 60 per cent of India's landmass. Porosity and permeability in such rocks are a result of weathering and fracturing, rather than inter granular openings. Weathering and fracturing patterns in these rocks are variable, in their geometry, thickness and alignment. Hard rocks generally store and transmit less water than sedimentary rocks. The Deccan Volcanic Province in central-west India is a unique hydrogeological setting representing a major hard rock groundwater regime. Groundwater resources within this basalt-dominated province are largely controlled by the type of basalt, its degree of weathering, and the nature and intensity of fracturing. Hydrogeologically, the Deccan basalts are quite inhomogeneous in nature with highly variable conditions controlling groundwater occurrence and movement. The Deccan basalts cover a vast expanse of central-west India, estimated to be more than 5,00,000 km^2. Their thickness is not only considerable (several hundred metres, on average) but also variable from place to place.

Regionally, the Deccan basalts can be described as rocks possessing low porosity and permeability, with little prospects for large-scale groundwater occurrence. However, on a watershed or aquifer scale the hydrological and hydrogeological inhomogeneties of these basalts create a very complex environment for the accumulation and movement of water, especially groundwater. Because of such inhomogeneities, it is commonplace to find good groundwater supplies in one location against very poor supplies in another within tens of metres from each other. The scale factor, therefore, is strongly linked to the inhomogeneity in the conditions governing the behaviour of water, especially groundwater. Superimposed on the geological controls that change from place to place is the typical physiography and highly variable rainfall pattern of the region.

The Deccan basalts of west-central India offer a unique hydrological setting for water balance studies. Covering an expanse of over 500000 km^2, these basalts constitute one of the largest 'single' lithological expanse in the country. Regionally, the basalts are described as rocks possessing low porosity and permeability, with little prospects for large-scale groundwater occurrence. However, on a watershed or aquifer scale the hydrological and hydrogeological inhomogeneties of these basalts create a very complex environment for the accumulation and movement of water, especially groundwater.

Deccan basalt aquifers, by virtue of their highly variable weathering characteristics and fracture patterns, respond differently to recharge and discharge stimuli, both natural and artificial. For instance, even within a small river basin, recharge of individual aquifers can be variable, depending upon the local characteristics of the basalt lavas. Similarly, discharges in the form of base flows can be significantly different in adjoining watersheds, again depending upon processes of recharge and more significantly the amount of groundwater abstraction in catchment areas. Transmissivity and storage coefficient values can vary over several orders of magnitude in basalt aquifers even within a microwatershed.

The variability in the hydrological and hydrogeological characteristics of basalts makes water balance estimation highly complex. This complexity is especially apparent considering different scales of water balance measurement and computation and degree of generalization in such computations. In the Deccan basalt region, river basin studies and measurement have been generally limited to rainfall-runoff calculations. However, even a basic rainfall-runoff calculation

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can become redundant if issues like storages and releases from minor, medium and large irrigation tanks are not considered. As one studies water balances on larger scales, i.e. microwatersheds and individual structures like tanks (percolation and irrigation tanks) and check dams, one comes across specific inputs like measurement of absolute evaporation and net evaporation, evapotranspiration, stream flows (separation of base flows from surface runoff), and last but not least, the natural and induced infiltration.

Computation of groundwater balances in the Deccan basalt calls for a correct understanding of the basalts that underlie the surface in a small microwatershed. A single watershed may constitute one or more aquifers or one aquifer may be contiguous underneath two or more watersheds, although our experience in the Deccan basalt points to the former configuration in a majority of cases.

This paper highlights some important findings during the estimation of water balances and also attempts to illustrate the differences that can result for estimating any single parameter using water balance calculations on different scales. The paper uses some preliminary results from an ongoing study in the Kolwan valley (Walki river basin) from Mulshi taluka of Pune district in Maharashtra.

The paper, in addition to discussing some of the above mentioned factors, using studies in the Deccan basalt, hopes to take a step further in understanding how water behaves in some parts of the Deccan volcanic province where water balance attempts have been made using primary data on various aspects of the hydrological cycle.

predicting the runoff and sediment yield. These selected prameters were mathematically associated with the rainfall and fed to a BPNN model to develop a trained and tested ANN model. Finally, all these observed and simulated hydrological responses with respect to the geomorphologic parameters were coded in VBA to develop different scenarios on hydrologic responses leading to the DSSWHR interface.

Using the developed WMET interfaces within ArcGIS, geomorphological parameters were estimated for the two watersheds. The BPNN model was developed after training and testing the available data for prediction of runoff and sediment loss using the screened parameters; viz. (drainage area ratio) RA, (bifurcation ratio) RB, (drainage length ratio) RL, drainage factor (Df) and Relief ratio (RR) are associated with the rainfall (R) as RRB, RRA , RRL , RRR and RDf to predict the runoff. We observed that Geomorphology based Artificial Neural Network (GANN) models performed well when compared with the observed runoff and sediment yields with R2 (Coefficient of determination between the predicted and observed values) ranging from 0.85 to 0.95 and model efficiency (E) from 0.74 to 0.82 for peak runoff rate and R2 from 0.78 to 0.93 and E from 0.71 to 0.76 for sediment loss. The performance indicators (R2 and E) approaching one indicated better model performances. Finally, the influence of the geomorphological parameters on watershed hydrology were developed as a DSSWHR and watershed prioritization was decided based on runoff and sediment yield, erosion status (eg., high hypsometric integral value indicates more proneness to erosion) and interpretation on the limiting ranges of the geomorphologic parameters. Based on these, We concluded that the Banha watershed of India requires more attention to conserve soil and water through construction of soil and water conservation structures at appropriate locations than the St-Esprit watersheds of Canada, which is a stabilized flat watershed not much prone to erosion. This finding was also confirmed from the observed sediment and runoff data from the watershed outlets.

It can be concluded that the developed ArcGIS® based interfaces are useful in estimating the geomorphological parameters from watershed geo-databases. The process is efficient, quick, and accurate, and is the first of its kind to be developed so far. Further, screening of the parameters and use of ANN modeling for prediction of runoff and sediment loss is an efficient approach with minimal input data requirement and can be used as a replacement of data intensive conceptual models. Finally, the developed DSS as an interface with ArcGIS® has resulted in generating the possible scenarios on runoff, sediment loss and water yield behaviour of the watershed based on the geomorphologic parameter values and prioritizing the watersheds for management activities.

WATER HARVESTING AND GROUNDWATER RECHARGE IN THE WEST COAST OF INDIA: MYTH AND TRUTH

S.G.Mayya[1]

It is often expressed in various platforms that the static groundwater level and reserves in the coastal region towards west of Western Ghats in peninsular India has dropped resulting from groundwater mining. This apprehension is mainly attributed to over-exploitation of through indiscriminate sinking of borewells through various schemes of the government. Further, it is also said that there is no effort for recharging of groundwater reservoirs. It is argued that natural replenishment of groundwater is not enough to build up the groundwater table. It is interesting to note the argument that deforestation is also one of the primary reasons for the groundwater drought in the region and the siltation in the river basins and rivers has brought down the recharging capabilities. This argument is advocated to the extent of alarming the people that the present situation may lead to contamination of groundwater by saline water from the sea.

As a measure to protect the coastal region from this calamity, individuals, NGOs and the Governmental agencies have taken in large scale educating the public in artificial recharge techniques. Conventional methods of groundwater recharging, such as spreading, recharging pits, percolation tanks, infiltration trenches are advocated at all possible platforms. Rainwater harvesting techniques which are effectively practiced elsewhere are also promoted in large scale. Demonstrations of theses water harvesting techniques are held in schools and public places in the coastal region sponsored by both NGOs and Zilla Panchayats. The basic argument is that natural replenishment taking place is insufficient.

Well, it is true that inspite of having annual rainfall, to the order of more than 3500 mm, in the region, it often experiences acute shortage of drinking water, particularly during the summer months of March to May. It is also true that large quantity of water flows to the sea during monsoon months. The groundwater table fluctuates alarmingly reaching a low ebb to the extent of more than 20 m in some places. It is also true that borewells are sunk indiscriminately, even in areas very close to the sea. It is also true that deforestation takes place and sand accumulation in river beds is a continuous phenomenon.

However, it is rather very difficult to accept the reasoning for this natural phenomena of groundwater fluctuations. Hence, the methods of rainwater harvesting and techniques of groundwater recharge proposed to be practised in the region are in question and being debated.

Is it really true that natural replenishment of groundwater does not take place sufficiently ? Is it true that groundwater table is constantly declining ? Is the salinity intrusion in the rivers a grave problem in the region, because of insufficient recharge ?.

How deforestation can be linked to the drinking water problem in the region ? Do sand and silt deposits in the river beds adversely effect groundwater recharge ? None of the above arguments appear to have either scientific basis or physical and logical support. It is very difficult to find proper justifications for these arguments. Then, what are the ground realities.

If one is concerned with the water resources, surface or subsurface, in the coastal region, it is very essential to consider topographical /geological features along with hydrological and geomorphological characteristics of the river basins. It is equally important to study the rivers and river basins including soil behaviour. The coastal region flanked by high Western Ghats on the eastern side and the Arabian sea on the west,

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has very undulating terrain with highs and valleys of laterites or lateritic soil. The rivers originate in the high ranges of ghats with scarp outcrops, fall down foot hill and flow through the midland before joining the Arabian sea. The rivers are invariably joined by another tributary or main stream at the estuary, running almost parallel to the sea for a considerable distance along the coast. The region receives heavy monsoon rainfall spread over 3 to 4 months. The soil in the region gets saturated within first 2 weeks of rainfall. As a result, the replenishment of aquifers takes place, raising the water table, which in some area crosses the ground surface. The observations of the water table made either in the open wells or in the borewells in the region, clearly indicate this phenomena, defeating the argument that groundwater recharge in the region does not take place sufficiently. However, high gradient of the river basin towards its outlet at the sea, makes the surface flow to recede quickly during the post-monsoon period. The porous lateritic deposits in the region helps the subsurface lateral flows to maintain the same characteristics as that of surface flow. Laboratory investigations show that the hydraulic conductivity in the horizontal direction in lateritic formations is more than twice than that in the vertical direction. As a result, groundwater from unconfined aquifers quickly drain to Arabian sea, brining down the groundwater table.

Further, it could be observed that large quantity of sand deposits in the river bed. However, there is no silt deposition and hence no delta formations. Though the seawater travels to a considerable distance upstream during high tide in the summer months, the subsequent monsoon flow leaches the soil in the bed and banks, thereby avoiding accumulated effects of salt water. Afforestation though it helps in prevention of soil erosion and facilitates sustained infiltration of water for a long period, it does not help much in to be practiced in the coastal region.

Since, sufficient natural replenishment of groundwater takes place every year during monsoon, including the year of low rainfall, the conventional techniques of groundwater recharge may not be necessary. Obviously, during this period, roof water harvesting will be a wasteful exercise. Infiltration pits or some such techniques of groundwater recharge will only facilitate increased soil erosion.

It is necessary to reduce lateral flow from unconfined aquifers in the lateritic deposits, to maintain the groundwater table high for a longer period. The existing vented dams across rivers/streams are found to be very useful in this regard. Further, series of subsurface barriers of lateritic soil and clay mix, at carefully located places in the river basin may be more successful and, efficient in reducing the outflow. It is necessary to have more surface storage structures rather than recharge structures. The existing tanks and ponds are to be looked into as storage structures and not as recharge structures.

Given the background of these realities, it is a myth that natural replenishment of groundwater during monsoon is insufficient to avoid water crisis in the summer months. Adopting recharge/ rainwater harvesting techniques during the monsoon period will not be of much use. The problem of the coastal region on the west coast of peninsular India, is one of reducing ground water outflow from the aquifers to the sea rather than recharging the same. Advocating, conventional recharging or rainwater harvesting techniques which are successful elsewhere, may not be a wise decision to be practised in this coastal belt, as these methods are site specific.

4. Exploring Water Issues in the Himalayas Studies from Kashmir, Uttaranchal and the North-East

Sanjoy Hazarika and FA Shaheen

[iwmi-tata@cgiar.org]

24th February 2005

11:00 – 13:30; 14:30 – 16:00; 16:30 – 18:30

Session Chair: Ravi Chopra

Inspite of the physical, cultural and resource richness, hills in general, and the Himalayan region in particular, remain woefully underdeveloped and under-studied. With the aim of filling this obvious gap in ITP's research portfolio, this session marks ITP's foray into the mighty Himalayas and pools together knowledge and experience of people working on social, economic, cultural and political aspects of water management.

The session covers water management and policy issues from three regions and presents a bouquet of research led by FA Shaheen in Jammu and Kashmir; Development Centre for Alternative Policies (DCAP) in Uttaranchal; and former New York Times reporter and founder of the Centre for North East Studies and Policy Research, Sanjoy Hazarika in the North East. **Ravi Chopra**, Director of the People's Science Institute, Dehradun leads the discussions.

4(a). Water Issues in the North-East: Studies from the Brahmaputra

Brahmaputra is India's largest and world's fifth largest river. Between Tibet and the Bay of Bengal this mighty river (the only one with a masculine name), traverses some of the richest cultural and biological landscapes of India. With 32% of India's water resource potential and 41% of its total hydropower potential, Brahmaputra river basin in North-eastern India holds the key to the country's water future.

Author(s)	Paper	
C. Mohanta and R. K. Goswami	Nutrient flux cascade to the Northern Indian Ocean (Bay of Bengal) from the Brahmaputra Catchments: Biogeochemical Evaluation of C, N and P	Ext. Abstract
Arup Kumar Sharma	Reservoir Operating Policy Considering Flood Mitigation: A Necessity for Northeastern part of India	Ext. Abstract
Nayan Sharma and R. N. Sankhua	Exploratory Use of Artificial Neural Network and Remote Sensing for Management of Bank Erosion in Brahmaputra	Ext. Abstract
S. Baruah and SP Biswas	Arresting Aqua-Terrorism: Viable Alternatives	Ext. Abstract
R. Wangkheriakpam	Water Management and Potential Ethnic conflicts in Northeast India	Ext. Abstract
S. Hazarika and S. Sharma	The Brahmaputra: Livelihoods and Policies, as if People Mattered	Ext. Abstract

4(b). Water Issues in War-torn Kashmir

Jammu and Kashmir is well endowed with water resources. The state has some of the largest fresh-water lakes in the region. It has large areas under snow-peaked mountains and glaciers. It is the origin of three mighty river systemsChenab, Jhelum and Indus and their tributarieswhich drive the agrarian economies of north-western India and Pakistan. Yet, Jammu and Kashmir itself is facing growing water scarcity and ecological degradation. Glaciers are depleting; and its vast biological capital is eroding.

Kashmir was once a lively hydraulic society with elaborate irrigation systems, which now lie in a decrepit state. Militancy and war are also taking their toll on the water infrastructure of the state. What are the water management issues in this critical region?

Author(s)	Paper	
F. A. Shaheen	Indus Water Treaty: Scrapped or Abrogated?	Ext. Abstract
Falendra K Sudan	Participatory Watershed Development in Jammu and Kashmir: Experiences of Integrated Watershed Development Project (IWDP), Hills-II	Ext. Abstract
F. A. Shaheen	Ecologic and Economic Valuation of Wullar lake for sustainable development	Ext. Abstract
F. A. Shaheen	Asia's largest freshwater lake vanishing: problems and remedies	Ext. Abstract
J. Prabhakara	Water resources development and utilization scenario in Jammu province: problems and perspectives	Ext. Abstract
F. A. Shaheen	Comparative management performance of government and farmer managed irrigation systems in Kashmir	Highlight

4(c). Water Policy Issues in Uttaranchal State

Agriculture is of critical importance in Uttaranchal as with only 16% of the total geographical area, it supports 75-80% of the 60-65 million people and forms the nucleus of most economic activities in this hill state. While development of agriculture in the state has been long understood as a challenging and complicated task, the importance of protecting and maintaining existing cultivated area has somehow become obfuscated. As a result, cultivated and irrigated areas and productivity have been declining, denying local population their legitimate sustenance.

What should be an appropriate Irrigation Policy for the state? What kind of institutional, policy and legal frameworks will be needed? What can be the role of Panchayati Raj Institutions? DCAP reviews the current physical and management status of irrigation in Uttaranchal and tries to address some of these key questions.

Author(s)	Paper	
Development Centre for Alternative Policies	Review of Irrigation Policy of Uttaranchal State	Presentation Only

NUTRIENT FLUX CASCADE TO THE NORTHERN INDIAN OCEAN (BAY OF BENGAL) FROM THE BRAHMAPUTRA CATCHMENTS: BIOGEOCHEMICAL EVALUATION OF C, N AND P

Chandan Mohanta[1] and R. K. Goswami[2]

Early signs of global change would appear in places of biogeochemical hot spots like the Brahmaputra basin, which is located the transitional zones between different climatic regions and different distinct ecosystems, that of the cold dry climate of the Tibetan plateau and the warm tropical climate of the Assam-Bangladesh plains, where temperature contrast will occur earlier than other regions. The thermal and dynamic influence of the Tibetan plateau not only plays a significant role in the evolution and formation of the Asian monsoon circulation; it affects climatic modulation of organic matter fluxes through the Ganges-Brahmaputra as well.

Over the past few decades, combustion, agriculture and deforestation in the Northeast region have grown having significant effects on the natural cycles of Carbon, Nitrogen and phosphorus (C-N-P). With a relatively much higher population growth, the region has become a significantly potential C-N-P source. Although the relative magnitudes of anthropogenic and natural fluxes are still uncertain, it is apparent that C-N-P cycles are strongly influenced by fluxes from human activities in the region. Much of the unfavorable change of local ecological climate is linked to continuing deforestation and increasing land denudation in the basin as indicated by the present study. However, the seasonal jumps, high inter-annual variability and rapid change on decadal or larger time scale of the monsoon over the basin would require further research to establish such links conclusively.

Sporadic monsoon pulses of enormous water and sediment discharge from the Ganges-Brahmaputra are phenomenon of significant relevance to the biogeochemistry of the Indian Ocean. Impact on the trace metal and nutrient fluxes are perhaps the most important of the myriad of natural and human induced interactive forces.

It is necessary to understand the natural and anthropogenic mobilization rates of C-N-P in the Brahmaputra system and their environmental responses. This study, based on laboratory analyses of sediment samples collected from 38 locations over the basin for particulate nutrient concentrations, indicates that the high soil erosion and sediment discharge in the river watershed, apart from being naturally induced, is also perturbed by human activities, affecting the biogeochemical fluxes of C-N-P to the Indian Ocean.

Based on actual measurements, the flux of particulate organic carbon (POC) through the Brahmaputra River at a downstream location (at Pandu) was computed as 6.3×10^6 tons/year. The flux of particulate phosphorous and nitrogen were calculated as 8.4×10^4 tons/year and 8.5×10^5 tons/year respectively. These figures for C, N and P in the Brahmaputra are comparable to recent concentrations in some other major rivers of the world experiencing human interference.

Current uncertainty about the future effect of the Brahmaputra on the ecological and biogeochemical processes of the Indian Ocean is increasing. 95 percent of the nearly 1600 million tons of average annual sediment load (one of the highest in the world) of the Brahmaputra-Ganges system is injected to the Bay of Bengal during the northeast monsoon. This translates into an episodic pulse of a significant percentage of the global dissolved and particulate riverine C-N-P load. Unlike most other parts of the world, sediment discharge in the Brahmaputra basin has remained high due to lack of dam and reservoir construction. Rather the sediment discharge of the Brahmaputra has also been re-evaluated to be

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larger than previously estimated. Although historical data for the Brahmaputra basin is not available for comparison, some of the current figures for C, N, and P are comparable to recent concentrations in few major rivers with pronounced human interference. Thus, the present C, N and P concentrations in the northeast region may already reflect anthropogenic contributions.

Relative to rivers without significant anthropogenic influence (e.g. Amazon, Yukon), concentration of inorganic N and P in highly populated drainage basins (e.g. Po, Rhine) shows large increases. The Brahmaputra River, although not indicating such high concentrations currently, its deviation from a pristine state is noticeable, particularly in the case of phosphorus concentration.

Nutrient input from the Brahmaputra to the coastal zone of the Indian Ocean will undoubtedly increase, owing to intensive and extensive fertilizer application under way, coupled with population growth. The input materials, to deal with what would happen to the coastal region, program is needed to survey, monitor and understand the changes of the biogeochemistry of the Bay of Bengal. Particular attention needs to be paid to the land- coastal ocean ecosystem, which will be heavily impacted by growing regional human population and their activities.

nutrient and sediment, will be involved in the physical, chemical, biological, and sedimentological processes of the coastal region and be exchanged with the open ocean. So far, little is known about the processes on the Indian Ocean shelf, which control the fate of those materials. To track these changes, to understand the processes and to find measures to deal with what would happen to the coastal region, program me is needed to survey, monitor and understand the changes of the biogeochemistry of the Bay of Bengal. Particular attention needs to be paid to the land- coastal ocean ecosystem, which will be heavily impacted by growing regional human population and their activities.

In conclusion, the outlook for Brahmaputra basin in the coming years is that it has the potential to effect the environment of the Bay of Bengal significantly in terms of C-N-P cycling as well as that of the world. In turn, both global and regional changes will overprint the internal perturbations of C-N-P cycling in the area and lead to both positive and negative feedbacks to change.

RESERVOIR OPERATING POLICY CONSIDERING FLOOD MITIGATION: A NECESSITY FOR NORTH-EASTERN PART OF INDIA

Arup Kumar Sharma [1]

The north eastern region of India accounts for about one-third of the water resources potential of the country. However, development of this huge water resource potential has remained limited so far and on the other hand the region is suffering from disastrous floods almost every year. The high degree of temporal and spatial variations of available water makes the problem of harnessing water resources quite complex and calls for strategic planning and management. This part of India is the best example of the reality that merely having huge amount of water cannot help and can rather hamper development. More important is the amount of utilizable water and not the available water in a year. It is interesting to note that out of 586.60km^{3}of yearly available water of the Brahmaputra basin, only 24.0km^3 has been assessed as utilizable. This is basically because of the fact that, out of the available water, 477.5km^3 of water flows through the river system during the monsoon period. Therefore, to achieve benefit from the available water and to minimize the flood havoc, we must make provision to store the monsoon flow for use in the non-monsoon period. Improving ground water storage, increasing surface retention in the form of ponds, and construction of reservoirs are some of the options to achieve the above objective. Watershed management practices in the form of bund, pond, vegetative treatment, etc. can minimize surface erosion and surface runoff to some extent and can therefore contribute towards flood moderation at watershed level. Large-scale benefits in the form of power generation, irrigation, navigation and recreation can be achieved by constructing storage reservoirs. A reservoir if planned and operated properly can moderate the flood peak to a great extent.

To utilize the available water as well as to mitigate the flood hazard, a number of dam projects such as Pagladia, Tipaimukh, Dibang, Lohit, and Kynsi have been proposed in this region. However, these multipurpose dam projects may not be able to mitigate flood hazard and can rather worsen the situation if flood mitigation is not considered as one of the prime objectives during development of reservoir operating policies. A monthly/ten-daily operating schedule prepared on the basis of average monthly/ten-day inflow, while definitely reducing the monthly/ten-day outflow from the reservoir, may fail to reduce the flood peak on the downstream of the reservoir. This is because, if power generation is kept as the prime objective, the operating policy will be adopted to keep the reservoir head as high as possible. This may lead to a situation where the reservoir is already full when the flood is coming. This situation will compel the authority to release the inflowing flood to the downstream. Adoption of daily operating schedule on the other hand is also difficult because of many other practical constraints such as gate operation and flow forecasting. Therefore, providing a storage space particularly to absorb flood is essential if one wants to have flood moderation as one of the objectives of multipurpose reservoirs.

Better operation of a reservoir for avoiding artificial flood situation will be possible if reasonably accurate flow forecasting can be made at appropriate time. A mathematical model developed for simulating flood movement through the basins and channels from rainfall events occurring in the upper catchments can help. A model of this kind can be used to forecast the inflow at the reservoir site to facilitate prior release from the reservoir, if necessary, to make room for absorbing the inflowing flood.

Again it is seen that several reservoirs have been proposed in different tributaries of the Brahmaputra river. While a good operating policy

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for a single reservoir can ensure flood benefit in the Lohit, Dibang, and Subansiri reach the confluence of the Subansiri-Brahmaputra simultaneously, the flood level of the Brahmaputra may rise significantly. Therefore, while making a large release from a reservoir, releases made from the other reservoirs and the time of travel of those releases must be taken into consideration for avoiding adverse flood situation.the downstream of that reservoir, a coordination in the operation of all the reservoirs located in different tributaries of a river is also necessary to avoid artificial flood because of adverse combination of releases made from different reservoirs. For example, if large releases made from the reservoirs located on the Lohit, Dibang, and Subansiri reach the confluence of the Subansiri-Brahmaputra simultaneously, the flood level of the Brahmaputra may rise significantly. Therefore, while making a large release from a reservoir, releases made from the other reservoirs and the time of travel of those releases must be taken into consideration for avoiding adverse flood situation.

Benefit from a reservoir can be increased significantly by using an efficient operating policy. Experience has shown that use of long series of past record leads to development of a better operating policy. Use of synthetic data is therefore gaining popularity. New techniques like Artificial Neural Network (ANN) have been used successfully for developing synthetic stream flow required for development of efficient operating policy. New heuristic optimization techniques like Genetic Algorithm have also been found to give better policy compared to commonly used existing techniques. Therefore, it is advisable to adopt the most efficient operating policy after a detailed analysis of different policies by using different techniques.

The basic objective of this paper is to highlight that to achieve optimal benefits from the available water and to minimize damages due to flood, some of the important issues as discussed above should be considered during planning and operation stages of proposed multipurpose reservoirs. This is particularly important for the reservoirs of the northeastern part, as erroneous planning and operation of reservoirs can even worsen the flood situation in some localities. Due emphasis should be given towards the use of latest available techniques in the development of reservoir operating policy.

Exploratory Use Of Artificial Neural Network And Remote Sensing For Management Of Bank Erosion Of The Brahmaputra River

Nayan Sharma[1] and R N Sankhua[2]

The Brahmaputra is the largest river in the Indian subcontinent and ranks fifth in the world in terms of discharge. The specific yield from its catchment area is one of the highest in the world due to very high rainfall on a narrow drainage basin. Relentless stream-bank erosion along with flooding in the densely populated riverine region of the Brahmaputra basin in the Indian province of Assam has become one of the causative factors for impoverishing a large segment of agrarian population every year. About 18 square kilometres of prime inhabited land is lost every year to river erosion in the Brahmaputra basin. Furthermore, unrelenting bank erosion has caused channel widening creating navigation bottleneck zones in the Brahmaputra owing to inadequate draught during non-monsoon months. For efficient management of bank erosion spanning over hundreds of kilometres along the Brahmaputra, the need has arisen for a scientific tool which can aid systematic monitoring of bank-line changes, help prioritization of erosion zones, and facilitate maintenance of navigation for all-weather fairway.

Artificial neural networks (ANN) have been considered to be appropriate particularly in situations where the physics of the problem is not yet properly understood and thus cannot be fully explained by mathematical functions or relationships, as in the case of the changing morphology of the braided Brahmaputra river. ANN is an information processing technology that uses an approach entirely different from conventional algorithmic programming or regression analysis. It is a flexible mathematical structure, which is composed of many non-linear computational elements operating in parallel and arranged in patterns reminiscent of biological neural networks of the human brain.

In this study, the simulation of intricate river plan-form variability of the Brahmaputra is attempted using artificial neural networks (ANN). The ANN model is developed by feed-forward back-propagation training algorithm with suitable input and output neurons along with one layer of 102 hidden neurons. The number of hidden neurons has been obtained after several runs of the network with different number of neurons. Appropriate GIS applications are resorted to extract bank-line information for incorporating in the ANN model.

This research is focussed on evolving erosion and deposition simulation model of the Brahmaputra river. Towards this end, one set of Survey of India toposheets (1965) and four sets of digital satellite images of IRS LISS-III sensor, comprising 32 scenes for 1990, 1997, 2000, and 2002 have been used. A segment of the data base for channel geometry and satellite-derived plan-form has been deliberately left out from the model training phase for its use later in model validation.

Using ERDAS Imagine digital image processing software, the satellite images were geo-referenced with respect to the 1:50,000 scale Survey of India toposheet. The geo-referencing was done by hardcopy map on digitising table using second order polynomial with root mean square errors (RMSE) less than 0.5 pixel and the nearest neighbourhood re-sampling technique to create geo-referenced image of pixel size 23.5mx23.5m. Subsequently, other images were also registered with the geo-referenced image using image to image registration technique. The 622.73 km long main river has been divided into 100 strips of equal base length for convenience. Base lines of 89.88^0 E longitude and 25^0 N latitude have been taken as fixed reference lines for measurement of bank-line parameters. The areas enclosed by strips were calculated.

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The derived data from the satellite images for 1990, 1997, 2000 and 2002 were analysed and the bank-lines were digitized for all the above years; and then the above derived data were fed to the ANN model. The arc lengths of both left and right banks for all the above years were found by using Arc Info GIS software. The years 1991 and 2001 have been taken for comparison of erosion and deposition along the left bank. The dimensionless parameters, a1 ...a100, are the ratios of area of a strip and sum of area of all strips and l1...l100 are the ratio of length of arc of a strip and total length of bank-line.

Month and year have been taken as input neurons, as the output parameters are to be computed for different years. For training, validation, and testing, the ratio of the dimensionless output parameters a1 ..a100 and l1 ...l100 have been calculated to feed into the two ANN models. The validation process consists of error analysis, defined as the difference between observed and estimated values of each set of outputs (learning, validation and testing sets). A high value of RMSE will indicate a deficiency of generalization because of bad selection of number of hidden neurons or weak learning process. For evaluation in the present case, the network is first trained with all the pairs selected for the learning process. Then one of the pairs is eliminated from the set and the network is trained. The eliminated pair is used as the validation set. The network is trained till RMSE value of 0.001 is achieved. This order of error has been set in the present study as this gives a realistic estimate of the output. A passing reference has been made in the paper on emerging new research directions for evolving cost-effective anti erosion measures for the Brahmaputra. Methods like submerged vanes, board-fencing, toe pile, dikes, and polymer rope gabions have potential applications warranting further R&D initiatives. The study has revealed that conjunctive application of ANN and remote sensing techniques have the prospects to be powerful simulation tools for predicting morphological changes in the Brahmaputra and other rivers. With periodic updating, the ANN models developed can be advantageously used for monitoring and management of bank erosion, prioritization of zones for bank protection, and navigation in the Brahmaputra.

ARRESTING AQUA-TERRORISM: VIABLE ALTERNATIVES

Sanchita Boruah [1] and S. P. Biswas[2]

The north-eastern Himalayan region is well known for excessive rainfall. An entirely dry month is rare, except in the western part where December and January usually remain dry. About 75% of the rainfall is received during the southwest monsoon (June-August). The mean annual rainfall is 1991 mm with a minimum of 1400mm and a maximum of 2500mm. Precipitation in the hills above 2500m is in the form of snow, which generally falls in the month of November to February and sometimes up to March. High rainfall causes an almost continuous percolation of water through streams and as a result, the soil has very low water holding capacity. Humus content is poor in hill slopes because the organic matters are washed away in heavy rainfall assisted by steep slopes and loose texture of the soil.

Innumerable and diverse type of water bodies have made the northeastern part of India home for over 300 species of aquatic fauna ranging from tiny colourful wetland species to gigantic freshwater dolphins of the Brahmaputra. The floodplain lakes (wetlands) of the Brahmaputra and Barak river basins in Assam are globally recognized for their aestheic and biodiversity values as they provide an unique habitat for a good number of indigenous food and ornamental fishes. About 60 species of ornamental fishes belonging to 39 genera and 20 families have been recorded from the floodplain lakes of Upper Assam. Of these, Botia dario, Chaca chaca, Channa barca, Colisa fasciatus, Glossogobius giuris etc. are widely acclaimed species and fetch high prices in domestic and overseas markets. Till the early 1970s fish was the easiest available commodity for most of the villagers in the Assam valley. As such, people hardly gave any importance to aquaculture. However, the scenario has changed very fast during the last three decades and consequently, many of the hitherto common species have disappeared. People of the region have to depend on imported fish to meet the ever growing demand. The prime causes of the depletion of the natural stock are terrorist like destruction of aquatic biota and habitat shrinkage. Not only fish, other types of biota like *ghorial* and dolphin have either vanished from the region or are on the verge of extinction.

Large rivers like the Brahmaputra cover different types of climatic zones, landscapes, and bio-geographic regions. The hydrodynamic characteristics of a river are dependent primarily on the size of the river and the climatic and drainage conditions within the catchment area. Description of the habitat reach (riparian ecotone) of the four tributaries and the main river (the Brahmaputra) reveals that except the reaches of the Subansiri and the Noa-Dihing, the riparian zone of the Brahmaputra and its tributaries is unstable and subject to bank erosion on one or both sides. The fast flowing section of the river is characterized by rocky substratum and relatively stable bank. The soil is alluvial with high percentages of sand and low nitrogen and phosphorus. Frequent changes of the river course coupled with heavy siltation of the riverbed, especially in the upper reaches, have a great bearing on the faunal composition of the river. As the river continuously widens with every passing year, the average depth of the river simultaneously decreases and water is distributed among numerous channels. As a result, water cover for giant fishes and other mega fauna like river dolphin becomes inadequate during the dry season. Shallow channels are sometimes totally dried up during summer. Thus, the river dolphins and turtles, which were abundant a couple of decades ago, now can be seen occasionally during rainy months and then only in selected spots. At present, residential population of river dolphin is noticed only at Dibru-Saikhowa in upper Assam,

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Kukurmara near Guwahati, near Dhubri in lower Assam, and at Lalmati Dohr near Silchar in southern Assam. In the event of the construction of dams in the upstream, the situation will further worsen, as there will be less water in the downstream, particularly during the dry season. Many of the problems of river management today relate to land use changes, water resource developments and industrial expansion which have altered the pattern of runoffs, quality of river water, and the load of sediment delivered to river channels. Erosion control structures like dams, embankments, and spurs provide temporary solutions to flood problems. Construction of dams in the highly seismic northeastern Himalayan zone is definitely a highly risky proposition. This practice should be used as a last resort because of the design and construction expenses. The structure takes the erosive force of the water and can reduce the remaining slope. Moreover, structural measures for flood control often proved detrimental as far as biodiversity conservation is concerned. Therefore, non-structural means which involve a number of possibilities ranging from flood-warning systems to phytoremediation that can control or mitigate flood related problems. The advantages of non-structural measures are that they are easier to implement, sustainable and less expensive.

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Water availability, food production, biodiversity, population and economic growth, and climate change are linked in a complex way. Changes made by engineers on the rivers have made a severe impact on the bio-diversity as there was no knowledge of the hydrological impact on the biological or ecological environment. There is a need to do an environment impact assessment according to the notification of 1994. The evaluation criteria should include assessment of the effect on the productivity of the surrounding soil, loss of genetic resources, and loss of or damage to habitat in both up and downstream, and should be developed in consultation with experts and stakeholders. A feasibility study that takes into account the ecological and economic and social impacts at regional level will definitely turn out to be a boon for the entire basin. Setting up equilibrium between eco-hydrology and proper management of the rivers would result in balance of economic development and biodiversity conservation.

WATER MANAGEMENT AND POTENTIAL ETHNIC CONFLICTS IN NORTH-EAST INDIA: CASE STUDIES FROM MANIPUR

Ramananda Wangkheirakpam

Manipur state is marked by sharp ethnic and territorial boundaries, and has several disputes on water within its boundary. It shares its problems with neighboring Indian states and with neighboring countries. All together 32 officially recognized communities co-exist in 21,327 sq. kms. Myanmar is in the western side, Nagaland is in the north, Mizoram and Assam to its south. Two main rivers Barak and Manipur, not only traverse through areas inhabited by different communities but also pass through other states (as in the case of Barak) and end their journey in different countries. Any water management effort in the state is now under the close scrutiny by ethnic communities, neighboring states, and by neighboring countries.

Types of Water Related Conflicts

1. *Conflict between Ethnic Communities and Government*

This part deals with how there can be conflict between ethnic communities and government when traditional systems are not acknowledged. The Loktak multi-purpose Project submerged more than 50,000 ha of seasonal agricultural land. No compensation was given to affected farmers. As a result several peoples' movement were launched for compensation, and now to de-commission the Ithai Barrage itself. The Barrage and the project have been even considered as a colonizing element of the Indian government. Despite the failure of the project, one main contention between the government and the local people is the failure of both the government and NHPC of the traditional commons that once governed the lake. In any future water projects, it is absolutely necessary that local norms and systems are taken into consideration.

•Construction of the Mapithel Dam which began in the early 1980s is still in not completed. The reasons are varied, but two obvious reasons stand out. One is the resistance from indigenous communities, and the second being the underground group NSCN (IM) whose goal is to create an independent Nagaland. A forced project can have serious security implications including non viability of projects.

2. *Inter Ethnic Conflicts.*

Ethnic identity may not be the sole source of violent conflict or war, but to ignore it or belittling the relationship between ethnicity, water, and conflicts can sometimes mislead the public or those attempting to reduce tension or conflicts. Understanding this relationship also will greatly save resources that may be otherwise spent on resolving conflicts.

•Kakching Ethei: The Kakching irrigation canal, locally known as Kakching Ethei khong, is a 10 km long canal dug and maintained wholly by farmers of the Kakching area of Thoubal district in Manipur. This water diversion from the Sekmai River has enabled three crops in a year earning Kakching the title "Granary of Manipur". Upstream tribes now demand that the downstream Meetei community reaping the benefits of the river pays them water (river) tax. This has strained the relations between the communities.

3. *Inter-state Conflicts*

While conflict between states is yet to raise its ugly head, there are already signs and processes in place. In the case of the Tipaimukh dam on the Barak river, conflicts can arise in 'sharing' of water between Assam and Manipur. One might note here that conflicts between states might not happen for a long time because they do not have the resources to implement large projects.

4. *Transnational Water Conflict*

Any intervention on the Manipur and Barak rivers has transnational implications. While there is already the Ithai barrage built on the first river, the Tipaimukh dam is being planned on the Barak river. Till now there has been no complaint from Myanmar, but in the case of the Tipaimukh dam there are already protests in Bangladesh.

•Tipaimukh Dam : The proposed Tipaimukh dam across the Manipur river has become a point of contention between India and Bangladesh, particularly because India has clearly not informed its intention to dam the Barak river. Relations between the two countries are already sour over the issue of the Farakka Barrage and people in Bangladesh have made it clear that no dam can be raised in India without the consent of the downstream communities. An almost nationalistic reaction from Bangladesh is a road march "Tipaimukh Dam? No!" planned from 23 to 25 February 2005. While there has been no violence or overt conflict between the two countries, with increasing scarcity of water in the future, the possibility of violent conflicts may become real.

5. *Conclusion*

This paper has made an attempt to highlight four kinds of water related conflicts in the Indian state of Manipur. All these conflicts are borne by three factors: insensitivity of the government and lack of tools to govern multi-ethnic territories; disability to think beyond narrow nationalistic conception of boundaries, and fear of small ethnic communities of being overwhelmed by others and their attempts to protect their interests.

For any water management project, proper guidelines on negotiations and conflict resolution must be in place. If such processes are not in place, incidences of violence will probably increase as environmental scarcities worsen and might even have serious implications on security, financial resources, disintegration of regions and human relations.

THE BRAHMAPUTRA: LIVELIHOODS, POLICIES AS IF PEOPLE MATTERED

Sanjoy Hazarika[1] and Sanjay Sharma[2]

The Brahmaputra, earlier known as the Tsang-po in Tibet, and a number of its tributaries such as the Lohit and Manas, have their origins in Tibet and Bhutan. The main stem of the Brahmaputra also flows into Bangladesh as do the Teesta and the Barak. These are international rivers, water bodies which have upper, middle, and lower riparians in different countries. Bangladesh, after all, has not less than 52 rivers which flow into it from India.

Each riparian, especially Bangladesh, is extremely sensitive to what it perceives as a possible potential threat by the other to divert, dam, and otherwise use and exploit the resources upstream with little positive impact for itself. It is our argument that cooperation, joint scholarship, and building better understanding, especially with Tibet, Bangladesh and the north-east, is one of the major ways of bringing the rural marginalized into the process of growth and development, through a participative process that enables all stakeholders and civil society to benefit.

Apart from this larger picture, it is also our argument that the government's campaign to "develop" the north-east pays little attention to its water resources except seeing these exploitable commodities with a proposed network of dams, hydro power stations, large pondage, and irrigation benefits. There is another aspect to this: it is reflected in the relentless effort to "engineerize" solutions to problems which have their roots in environmental, social, and other issues. Thus, various departments of the government of Assam, for example, rush to build more and more embankments and "porcupines" and bamboo structures aimed at bundelling or reducing the impact of river currents on shorelines and banks. But there has not been a detailed, structured, logical debate on the efficacy or otherwise of such structures in a river of the scale and size of the Brahmaputra and its various tributaries, which are independent large rivers in their own right. There is little transparency in these departments on how and where they spend their money, the process of contract award, and virtually no review of their functioning or accountability. Access to information is difficult.

Last year (2004), according to the state government, over 300 embankments which were either over-age or poorly built gave way during the floods, carrying away people, property, and livestock. The result was the highest toll and the worst floods in decades. But there are not even the stirrings of an effort to seek new strategies to deal with the problem, apart from knee-jerk and ad hoc reactions.

In 1982, the centre created the Brahmaputra Board to look at the water resources of the region and ways of tapping it. But the board is moribund and ineffective. It has gone for years without a fully functional chief and has never been given the funds to be truly autonomous and conduct its work professionally. After the 2004 floods, the Prime Minister announced a high-level committee to suggest long-term ways of tackling the problem of floods in Assam and other states of the region. One of the proposals is to set up a new regional Water Resource Management Authority but its specific goals and charter, independence, funding, staff, and specialists are still unclear although the Prime Minister himself has remarked that it could be on the lines of the Tennessee Valley Authority (TVA). But these are still early days.

What would be of critical importance to such a new body is its effectiveness in coordinating with other water management/resource/research institutions of the central and state governments as well as its transparency on issues of public significance.

It is especially important to note what the TVA's former director declared as its principal constituencies and strengths (emphasis ours): "One of TVA's greatest strengths has been its

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2 Coordinator, C-NES study on Brahmaputra

strong base of local constituencies including grassroots support; state and local governments; special interests (such as distributors, industrial and environmental groups); other federal agencies; and the Tennessee Valley Congressional Caucus. The TVA Caucus is composed of congressmen and women from the TVA region."

interests (such as distributors, industrial and environmental groups); other federal agencies; and the Tennessee Valley Congressional Caucus. The TVA Caucus is composed of congressmen and women from the TVA region."

What is important to emphasize is the approach which appears to be open, democratic, inclusive, and involves both grassroots activists and environmental groups. This is in stark contrast to that of the government of India's various water management agencies and ministries for decades.

Information is difficult if not impossible to get on basic water issues from the ministry. The core issues therefore are transparency and access to or right to information, both are now becoming increasingly important matters of public concern and which are being openly debated in different parts of the country. We have to start thinking out of the box. Only then will innovative and sustainable changes, based on local realities and pragmatism develop.

This approach is missing in the context of the north-east and particularly the Brahmaputura and its tributaries. All work is ad hoc and policies, if these can be called that at all, are knee jerk. There is no transparency; the NGO movement is scattered, unsustained, and largely ineffective. Public participation in planning and preparation is low. Although rural communities are the worst affected, much is left to the whims of government and its public works departments which begin work with a semblance of energy closer to the time of high water.

Other papers in this session will deal with the problems of river basins, reservoirs, and dams on the rivers of the north-east. Our effort is to give a perspective from Ground Zero — and look at ways rural populations can be empowered to use water resources for resource building, livelihood generation, and income growth. We do so from our experience in the field and advocacy at the policy levels. We advocate strong early warning systems, platforms, and shelters, and a participative process of planning and implementation which restores dignity to those who are hit by floods and river bank erosion. Indeed, one of the most frequently heard comments in Assam during the floods is that, while people can cope with floods, they are unable to handle the greater threat of erosion.

Thirty years ago when a former chief minister of Assam declared that the people of the state had no choice but to "live with floods", he drew a furious outcry from across the state and the media. But 30 years down, Assam and its neighbourhood are still living with floods and conditions for the rural population have become worse, not better even though Assam has the largest length of embankments in the country : 4,500 km! Yet, only 1.5 million hectares of 32 million hectares of flood-prone areas are protected!

The Centre for North East Studies and Policy Research is conducting a three-year program supported by the Sir Dorabji Tata Trust (2002 onward) which seeks to develop participative and sustainable planning for improving incomes and livelihoods for rural populations along the river in a range of aspects with focus on inland water transport and dairying. There are five researchers, about 20 research sites, and approximately 2,000 respondents spread across six districts of Assam: Dhubri, Darrang and Kamrup, Jorhat, Dibrugarh, and Dhemaji. All the sites are flood prone, a number of them are affected by erosion, and the respondents are primarily rural residents.

This participative socio-economic study, which involves villagers at the sites, has looked at the prevailing status of resource utilization, demographic and livelihood patterns, and problems and prospects of the processes of social development. It has identified bottlenecks in the various sectors and regards the introduction of a fleet of improved locally-built vessels, the development of high water platforms, improvement of agriculture and dairying as being as crucial as tackling of river bank erosion and channel migration.

Inland water transport is the core of the study

which also looks at dairying. The carrying capacity of vessels and the economics of transportation, engine capacity, markets at the ghats and the dependence of these markets on the stability of the ghats are also being looked into. Researchers have reviewed the operation of the ghats and vessels, reflecting the perceptions of stakeholders.

The project examines in detail the following areas: relationship between dairy and agriculture, animal management, training of farmers, marketing, data on passengers and goods, movement of ghats, erosion, sanitation, floods, conservation, and boat census.

INDUS WATER TREATY: SCRAPPED OR ABROGATED?

F. A. Shaheen[1]

Growing scarcity of water resources, increasing population, and poor water management in developing countries have resulted in increasing demand for water resources. Increasing scarcity of water has led to the desire for control of water resources, which in turn becomes a ground for breeding conflicts. Conflicts over the use of water between states become severe when they are typically agrarian based economies. The Indus Water Treaty (1960) between India and Pakistan is one of a few examples in South Asia of the settlement of a major, international river basin conflict.

The Treaty fixed and delimited the rights and obligations of India and Pakistan in relation to each other concerning the use of the waters of the Indus system of rivers. Indus, an international river basin, is the largest, contiguous irrigation system in the world, with a command area of about 20 million hectares and annual irrigation capacity of over 12 million hectares. The Indus system of rivers comprises three eastern rivers (Sutlej, Beas, and Ravi) and three western rivers (Indus, Jhelum, and Chenab). Under the Indus Water Treaty (IWT), waters of the eastern rivers stand allocated to India and those of western rivers largely to Pakistan. The treaty which was carried out in the best interest of nation has, however, deprived Jammu and Kashmir (J&K) of using its own water resources and thereby severely affecting the development process in the state. The treaty made Punjab prosperous by using the water of eastern rivers for agriculture and power generation and on the same has put J&K behind by an estimated Rs 6500 crore annually. The losses are not there in the agricultural sector alone but on a much higher scale in the generation of hydropower which has an otherwise estimated potential of 20,000 MW. The state's rightful riparian rights have been snatched in the so-called national interest without the state being consulted at the time of treaty or compensated for the consequent loss.

Under the treaty, J&K can use only limited waters of the Indus, Chenab, and Jhelum for power generation and lift irrigation. It cannot build reservoirs or dams on these rivers to store water for irrigation and power without the prior approval of Pakistan. Nor can it construct any barrage for irrigation. The treaty imposes limits on the storage capacity that the state can create. It can only store 0.40 million acre feet (MAF) on the Indus in Ladakh, 1.50 MAF on the Jhelum in Kashmir, and 1.70 MAF on the Chenab in Jammu.

The state's agricultural potential has also been worst hit. There has been only a marginal increase in the irrigation infrastructure. In 1950-51, the state could irrigate 2, 61,000 ha but in 2000-01, the state irrigated only 3, 05,970 ha through various sources. As a result, the state has now rationed population of 86.14 lakh people dependant on supply by the consumer affairs and public distribution department which procures rice from outside the state. Besides this, a good percentage of population also purchases rice from private dealers. The foodgrain import graph of state shows a sharp increase in overall imports. J&K, according to an estimate, could have increased its area under irrigation by one lakh acres had the state freedom to harness its available water resources. In case of the Kashmir valley, only 0.5 MAF could be stored under general storage on the Jhelum basin and that too not directly on the waters of river but on various streams that form its tributaries. And for every new irrigation scheme, the state has to seek permission from the Indus Commission. The Irrigation and Flood Control Department of the state has proposed 12 new irrigation schemes for Baramulla, Kupwara, Anantnag, and Budgam districts on the various streams which are awaiting approval.

Being a state with a dearth of plain agricultural land, the state would be enormously benefited by

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a proper irrigation infrastructure. This would help bring large acres of Karewa land (highlands specific to the uneven terrains like that of J&K) across the countryside under cultivation. This has, over the years, given rise to groundswell against the "unjust treaty" which though has made Punjab prosperous by letting that state use freely the water of its rivers for irrigation and power production. On the other hand, these very sectors have stagnated in J&K. What is regarded as more galling is that though New Delhi compensated Pakistan for the loss of the pre-partition canal network of central Bari Doab and Dipalpur, J&K received nothing. The Nehru dispensation gave financial aid of Rs 83.3 crore to Pakistan to undertake development works like building storage reservoirs, link canals, tubewells, drainage, and hydroelectric installations. Pakistan, in addition, received over Rs 300 crore at the time from the United States, Britian, West Germany, Australia, Canada, New Zealand, and World Bank as aid.

One way to compensate J&K for losses could be a favourable sharing ratio for power generated from centrally funded projects in the state. However, so far the approach of New Delhi has not been encouraging. For example, in the case of the Salal Project, experts assert that the central government has recovered its capital cost way back in 1982 but power sharing continues to be on the existing ratio. That is, J&K gets a royalty of only 12 per cent from the project. This is despite the fact that against the capital investment of the central government, the state has provided all important water and land resources for the project. Moreover, in the case of the Salal project, one of the provisions agreed upon was that when capital cost of the project was recovered, the power plant would be handed over to the state. So there is a case for the transfer of centrally funded power projects, not only on the principle of complete recovery of capital investment but more so as a compensation for the losses incurred by the state as a result of the treaty.

During the recent secretary level talks in Islamabad between India and Pakistan on the controversial Wullar Barrage or Tulbal navigation project, political leaders from Pakistan Punjab demanded that the Pakistan government should buy water from India to meet the requirements of the province. They also demanded that the government should scrap the Indus Water Treaty. On the other side, there is a growing consensus among the political parties of J&K to scrap or abrogate the treaty since it has over the period sounded a death kneel to the state's economy and has acted as impediment to development. During a recent state assembly session, the People's Democratic Party (PDP) passed a resolution demanding setting up the barrage and sought compensation from the centre for the losses it suffered because of the Indus water treaty. The J&K state assembly members also lashed out at Pakistan for strangulating Kashmiri's by sticking to the Indus Water Treaty which has taken a heavy toll of state's economy.

While the new found bonhomie between India and Pakistan has successfully put political issues on the backburner, the fight on water rights is set to become acute in the coming year. It might even surpass the political disputes between the two neighbors. The main reason for this is growing industrialization in both countries, coupled with depleting water levels and mounting power scarcities. The Baghliar and Wullar Barrage issues currently being discussed at the expert level are, therefore, just a tip of the iceberg. The recent secretary level talks by India and Pakistan over the construction of Baghliar dam on the Chenab river ended in failure. Pakistan has now approached the World Bank for arbitration.

With water sharing promising to be the new international quarrel area of the 21st century, India and Pakistan have already got a readymade point of friction. Because of growing population, industrial growth, and mounting water problems accompanied by the overall fall in the waters of the Indus basin owing to climatic change, there is a need to either abridge or abrogate the old treaty, particularly looking to the current political and economic situation in Jammu and Kashmir. The time has come for a fresh look on all the water sharing issues between the two nations for the common benefit and put behind bars all the political issues and do justice to each and every area / region of the Indus basin in terms of equity in water resources of the Indus basin.

PARTICIPATORY WATERSHED DEVELOPMENT IN JAMMU AND KASHMIR: EXPERIENCES OF INTEGRATED WATERSHED DEVELOPMENT PROJECT (IWDP), HILLS-II

Falendra K. Sudan[1]

The paper examines the participatory processes adopted under the Integrated Watershed Development program (Hills-II), Jammu and Kashmir by giving special emphasis to methodological aspects of people's participation, cost and benefit sharing mechanisms, and common property resource (CPR) management, and analyzes the environmental and economic impact of participatory watershed development. The study is confined to two sub-watersheds of Akhnoor (Jammu district) and Ramnagar (Udhampur district) of Jammu and Kashmir. To analyse the participatory processes, data and information has been collected from members of 3 village development committees (VDCs) each from Akhnoor and Ramnagar. For the collection of primary data and information on environmental and economic impact, a purposive sample of 20 per cent of the households from twelve villages (six each from 'project' and 'non-project' areas) have been selected using stratified sampling technique. Care has been taken to include both forested watersheds villages and agricultural watersheds villages to make a comparative study. To begin with, the participatory social development functionaries have conducted PRAs for the base line survey in which needs assessment, resource availability, priorities and constraints have been identified. Subsequently, project functionaries have facilitated the formation of VDCs in a general body meeting of the community in selected villages. With the formation of VDCs, community involvement in watershed development and protection has increased significantly, which have resulted in social mobilization and confidence building among the rural community. VDCs have implemented demand driven activities within the framework of the project design. Village development plans (VDPs) have been prepared by the respective VDCs along with user groups on the basis of demands and priorities put forward by the village communities. The system of financial management adopted by the VDCs has not been reportedly satisfactory. At present, there is lack of development of more balanced partnerships between IWDP functionaries and VDCs, which is reflected in the imbalance in power and control between IWDP and VDC. The project has not made any attempt to give a legal status to the VDCs created and none of the VDCs has been registered so far. The project in association with VDCs has created assets through closing degraded forest land, village common lands (VCLs), and constructing water-harvesting structures. Recently, election for panchayats have been held, which would also pave the way for motivating the beneficiaries in cost sharing. Over the period, the proportion of costs shared by the beneficiaries has improved and is reportedly more than 25 per cent. The benefits from assets created have started accruing to the population of adjacent areas. To maintain these assets and ensure benefits sharing, the project in association with VDCs has formed user groups. The Constitution, number of members, and the method of benefit sharing have been different for each user group and devised by the group for its sustenance and establishing linkage with VDC.

There are perceptible environmental and economic gains to the farmers after the initiation of participatory watershed management. The land values have increased in both forested as well as agricultural sub-watersheds in the range of 10-15 per cent. The effect of regeneration of vegetation along with soil and water conservation measures on hill-slopes and wastelands was substantial. In Shivaliks, the run-off soil loss on barren hills was 23. 70 tons per hectare in the baseline period,

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which fell to 9.65 tons per hectare after treatment. The progressive reduction in soil loss and sediment yield as a result of quick recovery of vegetation on hill-slopes and lands adjoining the foothills has resulted in improving surface and ground water regime.

As a result of the improved soil moisture regime, increase in supplemental irrigation resources, and increased use of fertilizer (including cow-dung), irrigation intensity and cropping intensity have improved. The difference in irrigation intensity was 2.94 per cent and 13.14 per cent respectively in forested and agricultural sub-watersheds in project area with VDC and without VDC. The productivity of selected crops is comparatively higher in agricultural sub-watersheds than forested sub-watersheds in project area. The livestock population has declined significantly after the project completion. Due to creation of closures on VCLs and s, the average collection of fuel wood per household has declined to the tune of Rs. 1957.25 per annum in project area. The crop yield of major crops was significantly higher in project area than non-project area and the difference in crop yields of maize, paddy and pulses respectively stood at 1.45 quintal, 1.65 quintal and 0.39 quintal per hectare, respectively. Besides, a significant differential in milk yield has been recorded between project area and non-project area and the difference in milk yield of cows and buffalo stood at 1.0 kg and 1.31 kg, respectively. The difference in number of sheep per household and wool yield was also quite significant and stood at 2.5 sheep and 1.18 kg of wool, respectively. The performance of CPRs was reportedly remarkable. Fodder collection from CPRs has also gone up significantly in monetary and volume terms. at 1.0 kg and 1.31 kg, respectively. The difference in number of sheep per household and wool yield was also quite significant and stood at 2.5 sheep and 1.18 kg of wool, respectively. The performance of CPRs was reportedly remarkable. The fodder collection from CPRs has also gone up significantly in monetary and volume terms.

User participation in pre-project planning such as information gathering, identification of resources to be protected, and targeted groups to be involved, and the design of the regulations related to monitoring and enforcement has substantial bearing on the sustainability of participatory watershed development. Thus, it is suggested to recognize poor villagers not only as beneficiaries of participatory watershed development, but to assign them the status of stakeholders in real practice and provide them opportunities to participate not only in the conservation and protection phase, but equally in the pre-project phase. Wider linkages are essential between local groups and development institutions, which will ensure institutional sustainability. Among others, links are needed with credit institutions, with agencies providing development investments, and with institutions of local government, particularly panchayats. To achieve this, project promoted structures have to incorporate the concerns and leadership of the panchayats without losing the advantages of local user control and management of common property resources.

ECOLOGICAL AND ECONOMIC VALUATION OF WULLAR LAKE FOR SUSTAINABLE DEVELOPMENT

F. A. Shaheen[1]

Today, most planning and development decisions are made on economic grounds and, more and more, on the basis of the forces at play in the free-market system. While this new paradigm has its own limitations and dangers, it would be unrealistic to ignore it and to base our quest for the conservation and wise use of wetlands on a completely different set of values. Hence, wetland goods and services must be given a quantitative value if their conservation is to be chosen over alternative uses of the land itself or the water which feeds the wetlands.

The Wullar lake, known as Asia's largest freshwater lake, has become an environmental mess due to growing anthropogenic pressure, human greed, and unwise practices followed by the people in the catchment. The lake was given the RAMSAR status in 1990, but still no visible measures to restore its lost legacy are seen on ground. To justify its conservation, a valuation study is carried out which identifies the important structures, processes, and functions of the lake and tries to explore the ecologic-economic interface besides employing total economic value (TEV) framework to quantify all the use and non-use values of the lake.

The total economic value of the lake accounts to a sum of Rs 219 crore per year besides other indirect use values which may be far higher than the direct use values. Value of timber produce has a major share (about 82 per cent) in the total economic value. Fish production contributes about 16 per cent of TEV. Waternut and nadroo (Nelumbo rhizomes) contributes almost same share to the total economic value. Other products have a very meager share to the TEV of the lake. More than 50,000 people living round the periphery of the lake are directly dependent on the lake for their livelihood.

The values of wetlands are frequently not given sufficient consideration in decision-making, resulting in threats that can lead to the degradation and destruction of wetlands. The goal of the project for which the valuation was carried out was to sustain and enhance the benefits of the lake to local communities. The aim of the economic valuation study was to value annual benefits of the lake and to suggest implications of these values for the management of the lake.

The study found the lake worth Rs 219 crore per annum in terms of the benefits which are transacted in market or have a market value. These direct benefits accrue to surrounding population. Other important benefits from the lake which cannot be quantified in monetary value such as flood absorption basin, water quality improvement, natural reservoir for power plants, etc may be far higher than the marketed product benefits. Not only does the lake supply the people with a number of important resource outputs (fish, timber, nadroo, forage, etc), but also performs an unusually large number of ecological functions which support economic activity. In addition, the lake forms an important site for both resident and migratory birds (waterfowl).

Benefits derived from the lake and important functions carried by it clearly justify its conservation. The major threat to the lake is heavy siltation. The lake's size is shrinking day by day due to continuous siltation from the inflow of the Jhelum river and other tributaries. The built-up land is reclaimed by the people and water storing capacity of the lake is decreasing.

Looking at the importance of the lake, the government should take measures for its conservation on priority basis. TEV and other important functions provided by the lake justify the budget allocation for the management of the lake.

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ASIA'S LARGEST FRESHWATER LAKE VANISHING: PROBLEMS AND REMEDIES

F. A. Shaheen[1]

Jammu and Kashmir (J&K) is famous the world over for its lakes and wetland systems, ranging from the largest natural freshwater Wullar lake to the largest brackish or salt water Pangong lake in Asia. The lakes and the wetland system of the state are, however, under serious threat because of human greed, onslaught of mindless urbanization, and encroachments.

Among all these lakes, the Wullar lake has a distinct position and status. It is known as one of the Asia's largest freshwater lakes. It sustains the livelihoods of a large section of population in the valley. It provides fish, waternuts (Trapa natans), lotus (Nelumbo nucifera) rhizomes, fodder, timber, water, etc. Besides this, it acts as an important flood absorption basin and natural reservoir for power plants. It also performs vital ecological functions. The lake was declared as a RAMSAR site in March, 1990 because of its importance as a permanent winter habitat for waterfowl. Once spread over 252 sq. kms, the emerald green lake has effectively shrunk to 24 sq. km of water body. If the reclamation process continues with the same pace, can we be able to see the magnificent lake after four to five decades? Is the Asia's largest freshwater body going to disappear forever?

The lake is plagued by a number of problems such as encroachment, anthropogenic pressure, sewage and sewerage disposal, weed infestation, deteriorating water quality, catchment problems, sedimentation, excessive willow plantations, shrinking area etc., among which siltation is the major one. The lake has experienced considerable deterioration and decline in the last century, especially, in the last few decades. The principal factor responsible for its shrinking area is siltation. The major deposit of silt into the lake comes from the Jhelum river, the only perennial source of water inflow into the lake. The river and its tributaries drain almost the entire Kashmir valley before entering into the lake and deposits silt load before leaving the lake.

All human settlements around the lake body have conventional raw sewage and sewerage disposal systems. Most of the effluents from houses are directly drained into the lake or its feeding channels and nallahs. Even the municipalities of adjoining towns dump tonnes of refuge, particularly used polythene bags on the banks of the lake, which poses a great threat to its health. This increases the chloride content of lake water and is indicative of the organic pollution of animal origin. Unless scientific alternatives for sewage and sewerage disposal are provided to these settlements, eutrophication of the lake on account of nutrient inflow, especially of nitrogen and phosphorus, will continue at an alarming level.

Siltation and an extraordinary increase in the NPK level have significantly changed the composition of the lake because of the invasion of many weeds. The marshy and shallow zones of the lake are infested with weed growth of which more important are Nymphoides peltat, Salvina natans and Potomogeton species; the comparatively deeper invaded by Ceratophyllum demersum, Myriophyllum spicatum and Trapa bispinosa.

The lake has been facing encroachment on many fronts. As the periphery of the lake gets silted up, the villagers reclaim it either by plantation or by paddy cultivation. In this process big villages and human settlements have mushroomed around the lake or the erstwhile lake body. A vast area of silted up land has been taken over by the Forest Department in order to protect it from private encroachment. The forest department generates revenue worth crores from this lake area by way of plantation. Innumerable long chains of

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embankments and roads have been built in the interior of this magnificent wetland disturbing its very configuration The population of these villages/towns in the direct catchment of the lake has risen to several lakhs, whose entire pressure is being borne by this lake directly or indirectly.

Willow plantations have been raised around and within the lake which deteriorate water circulation and enhance siltation besides adding biomass from its foliage. These plantations, *inter alia*, act as barriers for heavily silt, check the

velocity of the current and force it to discharge the sediment load completely into the lake, thus causing siltation at an alarming rate. It is high time not only to stop further plantations but to remove them gradually in a scientific manner.

The activities carried out in the catchment have a direct bearing on the lake ecology. The root cause of the degradation in the catchment is tremendous increase in population, both human and livestock. Impact of population growth is reflected in the form of excessive pressure on forests, encroachment, overgrazing, faulty land use, and unscientific agricultural and horticultural farming practices. Unmindful of the ecological and environmental consequences, these forests forming the principal catchment of the lake have been overexploited. Besides the tilling of slopes across the contours and other faulty agricultural practices, changing the land-use status, and excessive use of fertilizers and pesticides in agricultural and horticultural fields have changed the chemical composition of lake water. Ruthless deforestation coupled with all aforesaid adverse factors have exposed the slopes and enhanced soil erosion. The entire surface runoff with all the slit and sediment accompanying it finds direct entry into the lake.

Keeping in view, the great magnitude of problems involved in the catchment and main lake body, there is an immediate need of a comprehensive multi-dimensional action plan with both short term and long term objectives. The primary objective of management here is to strike a healthy balance between the conservation of the lake and its economic use on sustainable basis which can be achieved by the closely coordinated and integrated working of three principal actors:

(a) Applied ecologists and conservationists especially in the eco-management of the catchment, the governing factor in the conservation of lakes and wetlands.

(b) Scientists for the main lake body to guide the managers in the change detection and the balanced development of aquatic flora, fauna, fisheries, and avifauna by ensuring water quality and a balance between inflow and outflow of the water.

(c) Administrative and engineering agencies for such basic activities as demarcation, delineation, removal of encroachments, checking of sewage and sewerage by engineering methods from point source, raising of peripheral bunding, fencing and protections, and permitted eco-friendly development activities like eco-tourism, eco-friendly farming, and other economic aspects.

Lakes and wetlands representing dynamic and living aquatic eco-systems can in no case have isolated engineering or administrative solutions. Nor can they be treated like any other urban development activity. Efforts at management and conservation of this important lake have been initiated as late as the mid 1990s. Grants on annual basis were made available by the Government of India; however, these were very meager, compared to the magnitude of the problem at hand. The approach has remained only an isolated one without an impressive impact. Political will and coordinated legal, administrative, and scientific measures coupled with earnest management and conservation strategies on a comprehensive scale are needed to restore the lake to its pristine glory.

WATER RESOURCES DEVELOPMENT AND UTILIZATION SCENARIO IN JAMMU PROVINCE: PROBLEMS AND PERSPECTIVES

J. Prabhakara[1]

Over several centuries, our forefathers succeeded in bringing 140 m ha of Indian land under agriculture. Since independence another 23 m ha has been added to the net sown area, bringing 51% of the geographical area under the plough. This is more than 10% of the actual cultivated area of the whole world, supporting 18% of world's population and 16% of livestock, but with only 4% of world's fresh water resources. However, India is committed to raise food production from the current level of about 200 MT to 300 MT by the year 2020 from the same or reduced area. As far as surface water resources are concerned, India has 7% of all the utilizable flow of all river basins in the world, but only on 2.3% of world's land, and thus three times luckier than the rest of the world. The state of Jammu and Kashmir is still luckier, for, if the area illegally occupied by the neighboring countries is excluded; the state possesses more than twice the proportion of surface water resources to land as that of rest of India.

The state of Jammu and Kashmir, with its four main agro-climatic divisions, rich soil and diverse natural resources, special horticultural and other crops, has a unique place in the agricultural map of India. In order to fall in line with the national level endeavors at achieving a second agricultural revolution, it is about time that the state must set a reasonable target for enhanced agricultural production by 2020 and work towards achieving that goal. Jammu province, having three of the four agro-climatic divisions of the state and relatively higher production potential for agricultural crops, has an equally higher responsibility to contribute towards achieving the set target. This paper is an attempt to make broad inventorization of the natural resources of the Jammu region (especially surface water resources) and analyze the strengths and weaknesses in the current pattern of utilization and management of available resources so as to optimize them for enhanced agricultural production and productivity through fine-tuning of the available technologies. The paper concentrates on the major issues of development and utilization of surface water resources in the low-altitude sub-tropical plains of the Jammu province possessing vast potential for agricultural production.

The level of development of surface water resources for irrigation in this sensitive border state has been encouraging, particularly under the constraints of terrain conditions, inadequate power generation and supply, and other restrictions imposed like the Indus Water Treaty, 1960. In addition, the low-altitude sub tropical plains of the Jammu province possess a vast potential for agricultural production, thanks to 'ideal climate' for round-the-year cropping, rich natural biodiversity, and rich soil endowments. They also house the two major irrigation projects of the Ranbir canal (CCA=38,623 ha) and the Ravi-Tawi canal system (CCA = 32,485 ha) accounting for 71% of net irrigated area of the province. The gross cropped area of the province is 61% of that of the state. Notwithstanding all these strengths, crop production and productivity levels of the region are not at all comparable with other neighboring states and regions with similar natural endowments.

The paper envisages to highlight the constraints to enhancing agricultural production and productivity, scenario of utilization of the created irrigation potential in different sectors, and opportunities for optimal utilization of available land and water resources for achieving a breakthrough in overall agricultural production and productivity in the light of encouraging results from on-farm water management research endeavors in command areas conducted since

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1990 by WMRC, SKUAST-J. It also attempts to prioritize the future research areas in resource conservation and management including diversification of crops and cropping systems by tapping the vast potential for sub-tropical fruits, vegetables, medicinal and aromatic plants, condiments, spices, floriculture, etc. through watershed development and management methods with active participation of stakeholders. Drastic change in the attitude of the state government in judicious use of rich surface water resources as well as harnessing and management of rain-water and concomitant drafting as well as implementation of a sound water policy have been suggested as remedies for the present poor management of rich water resources.

5. Groundwater, Energy and Livelihoods

Aditi Mukherji and Avinash Kishore

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24th February 2005

11:00 – 13:30; 14:30 – 16:00; 16:30 – 18:30

Session Chair: Shashi Kolavalli

In 1999-2000, India's 81 million land owning families had over 20 million tubewells and pump sets among them. On average, every fourth landowning household has a pump set and a well, and a large proportion of non-owners depend on pump set owners for buying their irrigation water, supplied through local, fragmented groundwater markets. In the first part of this twin session, the changing nature and livelihood implications of groundwater markets are discussed.

Most of India's State Electricity Boards are in a bind on the country's energy-irrigation nexus. The second part of this session discusses the political economy of power subsidy to agriculture and the viability of alternatives to metering, including one proposed by ITP.

5(a). Groundwater Markets and Livelihoods

The nature of groundwater economy and water markets is rapidly changing across India. Water markets have become most prolific in eastern India where groundwater development had been slow and halting to begin with. The 54th round of National Sample Survey shows that more than two-third of the irrigators in Bihar, Uttar Pradesh and West Bengal rely on purchased irrigation.

This sub-session brings in latest field evidence from Bihar, Uttar Pradesh, West Bengal, Rajasthan and Karnataka as well as results from NSSO surveys to examine these trends.

Author(s)	Paper	
Aditi Mukherji	The spread and extent of irrigation rental market in India, 1976-77 to 1997-98: What does the National Sample Survey data reveal?	Highlight
S. C. Deepak, M. G. Chandrakanth and N. Nagaraj	Groundwater Market Providing Efficiency in Water Use in Agriculture in Karnataka	Highlight
N. Nagaraj, A.H. Suvarna Kumar and M. G. Chandrakanth	Institutional and Economic Analysis of Groundwater Markets in Central Dry Zone of Karnataka	Highlight
Dalbir Singh	Who Loses and who Gains in Groundwater Market Game in Water Scarce Regions: The Case of Rajasthan?	Ext. Abstract
M. Dinesh Kumar	Impact of Water Prices and Volumetric Allocation on Water Productivity: Comparative Analysis of Well Owners, Water Buyers and Shareholders	Highlight
Anjal Prakash	Sharecropping, Migration and a New Phase in Water Markets: The Case of Sangpura Village in North Gujarat	Highlight
Ranjan Kumar Sinha and Amalendu Kumar	Water Markets and Groundwater Economy in Bihar and Jharkhand	Ext. Abstract
R.P. Singh and D. R. Singh	Structure, Determinants and Efficiency of Groundwater Markets in Western Uttar Pradesh	Ext. Abstract
K. Adiseshu	Groundwater Market Dynamics in the Villages of Orissa	Ext. Abstract
Aditi Mukherji	Of Groundwater Markets, State Policy and Local Politics in West Bengal: Evidence from 15 villages across the State	Highlight

5(b). Energy-Irrigation Nexus

Experts have long averred that flat, subsidized electricity to agriculture is enemy number one for financial sustainability of India's electricity industry and environmental sustainability of its groundwater economy.

So strident was experts' and donors' opposition to electricity subsidies that it seemed only a matter of time before tube-wells were metered and farmers began to pay for electricity at a full-cost tariff. Quite to the contrary, last 24 months have witnessed further retrogression. Instead of metering tubewells, newly elected State governments have announced free power. And in other states, flat tariff and subsidies have come to stay; unless, of course, the Indian state suddenly metamorphoses so as to mobilize courage to pursue a reform most Indian farmers consider anti-farmer.

ITP has always argued that it is wise to take flat-tariff as a given and work around it in evolving strategies that will make electricity industry viable and groundwater irrigation sustainable. ITP's case is that if the best solution is infeasible, wisdom lies in concocting and honing the second-best which seems to lie in radically transforming the way we supply power to farmers.

Author(s)	Paper	
A. Kishore and Zankhana S. Shah	Banking on Supply Management: Analyzing the Feasibility of Energy Rationing for Groundwater Management	Highlight
A. Kishore and K. N. Mishra	Impact of Cost of Energy on Groundwater Use in Agriculture	Highlight
Navroz K. Dubash	The Electricity-Groundwater Conundrum: Political Solution to a Political Problem	Ext. Abstract
Sebastian Morris	Towards a Water Resources Strategy for India: Issues in Pricing, Regulation and Financing of Water Development	Ext. Abstract
Sarbani Mukherjee	Subsidized Energy and Groundwater use for Agriculture Arguments and Facts	Ext. Abstract

WHO GAINS AND WHO LOSES IN THE GAME OF GROUNDWATER MARKETS IN SCARCE REGIONS

Dalbir Singh[1]

The present study is aimed at understanding the operations of groundwater markets in fragile conditions and identifying the losers and gainers in the game of water markets in the long run. The study was carried out in selected villages in the arid and semi-arid regions of Rajasthan.

There is inverse relationship between farm size and proportion of area under irrigation. It may be due to the fact that small farmers utilize irrigation facilities through water markets. Size of holding, availability of buyers and technology used by well owners are the major factors that determine the participation of farmers in water trading. Non-availability of water and buyers, and perception of water quality deterioration were the main reasons for not participating in the selling water on the one hand. Surplus water, prevailing power policy and profit-earning motive of well owners encourage water sellers to be part of the game. Absence of sources such as water structure followed by the power fluctuations compel the farmers to purchase water. Three contracts prevail in water markets- as (i) time based contract, (ii) crop and input sharing contract and (iii) crop sharing contract. Water markets mitigate the inequalities in accessibility to groundwater resources. Individuals who do not own wells have access to groundwater irrigation through water markets. Thus, resource -poor farmers can allocate a large proportion of total cropped area to irrigated crops and make best use of their limited size of holding. No doubt, water markets play an important role in minimizing the inequalities among the resource poor and rich farmers in the short run. But, in long run there may be adverse impact. Excessive use of groundwater may increase inequity among the farming community in the long run. In water scarce regions, water markets work on the principle of profit maximization. Sellers sell water to buyers with the motive of making profits. They adopt strategies at farm level to make groundwater available for sale. They continue their efforts for water augmentation, which help to meet the increasing demand for groundwater of their own and that of buyers. Sellers are not ready to compromise with the prevailing terms and conditions of water markets that are in their favor. Buyers have to purchase water on any condition, otherwise, they are deprived from groundwater irrigation. Therefore, we can conclude that, in water scarce regions, water markets work under conditions of monoposony, where sellers act in a concerted manner. In water scarce regions, water prices remain substantially higher than that in water-endowed regions. The experience shows that in water scarce regions, buyers use groundwater more productively due to higher price. But this does not happen when payment for groundwater is made in kind as a fixed share of total produce. Sellers continue to make more water available to increase agricultural production so that may get the maximum crop share as water price.

Various institutional provisions have been made to check overexploitation of groundwater. This includes withdrawal of institutional support for digging new wells and restriction on electric connections for irrigation purposes particularly, in problematic areas. However, these measures have proved to be ineffective in regulating the extraction of groundwater. Often, such measures are taken when the situation reaches an alarming stage. In other words, when the potential zone is converted into a dark or overexploited zone, only then restrictions are supposed to be exercised.

The study indicates that the existing institutional set-up, both formal and informal, behaves in an adverse manner. Under existing property rights

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system, groundwater is considered as an open acess resource over which farmers make private investment thinking that they have absolute rights to water beneath their land. This results in unchecked extraction of groundwater. Unrestricted access makes the situation more complicated by converting a common property resource (CPR) into an open access resource (OAR). Informal institutional arrangements also added their undesirable role in groundwater depletion.

Some of the specific and important policy implications that can be derived are as follows. (a) There is an urgent need to define water rights. Groundwater should be treated as a common property resource in a real sense. Nationalization of water resources is the only solution for sustainable use of groundwater in scarce regions. (b) An integral approach at various levels should be adopted. Institutions that play an important role in encouraging and/ or discouraging the groundwater markets in particular conditions should be the focus. (c) Effective provisions should be formed and implemented to restrict over-exploitation of aquifers. Similarly, water trading should be allowed in a limited manner. (d) Information system should be transparent so as to facilitate right action before the alarming stage. (e) Programs for recharging aquifer should be taken on a large scale. Experience shows that limited efforts made for recharging aquifer have given satisfactory results The involvement of voluntary sector should be encouraged. (f) A Community based action is required for efficient use of water resources in scarce conditions through making the effective functioning of informal institutions. In this regard, the model of "pani-panchayat" of Maharashtra can be experimented with, in other scarce regions. In this model, community determines the use pattern of scarce resources. During times of water scarcity, no farmer is allowed to grow water intensive crops. In case, any farmer violates the provisions made by the panchayat, (s)he is punished as per norms. Similar efforts should be experimented with in the case of groundwater.

WATER MARKETS AND GROUNDWATER ECONOMY IN BIHARAND JHARKHAND

Ranjan Kumar Sinha and Amalendu Kumar[1]

This paper presents the intensity of groundwater markets, their nature and structure, impact and constraints in the states of Bihar and Jharkhand. Bihar faces a paradoxical situation as the syndrome of non-development lies amidst plenty of water resources whereas in Jharkhand, which is one of the richest states in the country in terms of mineral resources, has in contrast, agricultural scenario is characterized by its heavy dependence on nature and mono-cropping with paddy as the dominant crop. However, groundwater structures have played an important role in irrigation in both states where around 47 to 49 per cent of the irrigated area is being served by them. Over the years, groundwater over-exploitation has increased in many states, but the situation in these two states is an exception where the number of over-exploited blocks has decreased from 14 to 1 by 1993. In Bihar, groundwater markets have, to some extent, transformed a stagnant traditional agriculture during the 1980s with some beneficial and equity impacts.

This paper is a part of a larger study being conducted in several states by respective AERCs. Primary data were collected from a sample of 120 farm households from each state. The sample was equally distributed in two different districts: one with developed and another with less developed groundwater potential. Out of 120 sample farm households in each state, 50 per cent belonged to the owners of water extracting devices (OWED) and 50 per cent to non-owners of water extracting devices (NOWED).

The intensity of water markets has been analyzed on two variables: depth and breadth of water markets. Depth of the water markets has been analyzed with the help of command area per OWED farm. Nearly 72.00 per cent of command area is being used by OWED farms, and of 28.00 per cent is being used for buyer's fields in Bihar. Similarly, in Jharkhand, about 85.00 per cent of the command belongs to OWED farmers and 15 per cent to the buyers. It reveals that water markets in Bihar are in a developing stage, whereas those in Jharkhand are in underdeveloped stage favoring mainly OWED farmers. As regards the breadth of water market, which is an indicator of the proportion of area of farmers as well as farm lands in the beneficial umbrella of the water market, it has been analyzed with the irrigation status of per farm operated area across the OWED and NOWED farms in both the states. The density of water extraction devices (WED) has increased significantly touching the level of 95 per cent on both sets of farms in Bihar. But in Jharkhand, it has reached the 50 per cent mark of irrigation on both the categories of farms. Factors responsible for this in Jharkhand are a) natural compulsions due to having hard rock regions; b) low surplus of irrigation water to sell it to the NOWED farms and c) poorer economic profile of farmers. Thus, water markets did not seem to have acquired significant breadth in Jharkhand.

Annual pumping pattern and competitiveness of market were also analyzed. Access to groundwater is not equal in a strict sense. In Bihar, OWED farms received 65-98 per cent of irrigation for their crops against the required volume of irrigation, while NOWED farms receive 44-92 per cent on their farms. In Jharkhand, OWED farms received about 42-77 per cent of required irrigation for their crops and NOWED farms received 35-75 per cent. As regards the competitiveness of the water market, field level data did not suggest that the market is under pure competition; rather it enjoyed some degree of monopoly. The fact is that most of the WED

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owners desired to meet the entire operational and other overhead costs by way of sale of water. The reasons for this are low returns and soaring diesel prices.

The percentage of operated area covered for five studied crops is not very different between OWED and NOWED farms in both states. Thus, the benefits are equally balanced in distributive terms for both sellers as well as buyers. Yield variation is not significant. In many cases, the differences are very small. The study shows that the incidence of labour migration is reduced and absorption of rural labor has increased in area with increased groundwater irrigation.

It is interesting to note that water markets were not found free from constraints due to some structural and micro and macro economic constraints faced by both OWED and NOWED farms. Irregular power supply, unfavourable power tariff, high operational and maintenance costs, etc. were the prominent constraints faced by OWED farms, whereas exorbitant water prices, failure of STWs and lack of fair participation in marketing practices were problems faced by NOWED farms. Finally, the paper suggests some policy implications such as regular power supply and its judicious scheduling and expansion of diesel sub-distributorship at the village level to improve water markets.

STRUCTURE AND EFFICIENCY OF GROUNDWATER MARKETS IN WESTERN UTTAR PRADESH

R P Singh[1] and D R Singh[2]

Reliable irrigation is a vital ingredient in modern agriculture. Initially, surface and groundwater irrigation through traditional water extraction devices brought stability in the agriculture sector, but they could not cope fully with the demand made by modern agriculture. Therefore, policy makers and farmers started giving more emphasis to the development of groundwater irrigation through modern water extraction mechanisms (WEMs). However, ownership of private WEMs is confined mostly to large farmers. Small and marginal farmers and even large farmers with fragmented holdings are buyers of irrigation water from neighboring WEM owners. Against this backdrop, the spontaneous emergence of water markets and their imaginative management offer easy access to groundwater irrigation to resource-poor farmers with smaller and fragmented holdings. The present study is an attempt to examine the structure, determinants, and efficiency of groundwater market in Western Uttar Pradesh.

Data on groundwater markets were collected from 180 randomly selected farmers from Meerut District for agricultural year 1994-95. Farmers were classified as buyers, self-users cum buyers, self-users cum buyers cum sellers, self-users cum sellers, and self-users only based on their accessibility to different forms of groundwater markets. The determinants of buying and selling of groundwater were identified using a logit model. The efficiency of water markets was examined with the help of resource productivity analysis and by comparing the cost of groundwater extraction and its selling price.

It was found that, of the total farm holdings, buyers only constituted the largest segment (26 per cent) followed by self-users cum buyers cum sellers (23 per cent), self-users cum sellers (19 per cent), self-users (18 per cent), and self-users cum buyers (14 per cent). In other words, a large proportion (82 per cent) of farm holdings entered into one or the other form of water market transactions. With increase in farm size, there was decrease in number of buyers, while reverse was true in the case of water sellers. The average size of holding was found to be the lowest (1.30 hectares) for buyers only category. The buyers' category had proportionately higher accessibility to diverse WEMs than the self-users category mainly because of the fragmented nature of the buyer's holdings.

The estimated logit model showed that farm size, fragmentation of holdings and joint ownership were the major factors contributing to installation of electric operated WEMs. The other factors were non-availability of canal water and adoption of modern varieties of seeds. The model further established that the farmers with small sized and fragmented holdings, low education attainment, and less probability of joint ownership of a WEM were more likely to buy groundwater. Owned operational holdings, fragmented holdings, installed electric operated WEMs (horse power per hectare), and joint ownership of WEM were factors influencing water selling decision of farmers. Fragmented holdings and non-availability of canal water along with multiple uses of diesel engine/ tractor and erratic supply of electricity were important factors responsible for installation of diesel operated WEMs. Major factors which affected water buying were the farm fragmentation, non-availability of canal water in canal command area, non-availability of suitable joint owners, higher WEM density, smaller size of holdings, and accessibility to state own tubewells.

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Crop productivity and farm income varied widely across different players in the water market. The self user realized relatively higher returns than the buyers. This was because they devoted proportionally more land to high value crops and partially because of better accessibility and reliability of groundwater irrigation. Yield values of the two major crops in the area, sugarcane and wheat, showed the same trend.

Using the Cobb-Douglas production function, the coefficient of irrigation was found to be positive and significant for buyers only, suggesting that increased use of irrigation would further increase the productivity of sugarcane on buyers' field. The irrigation coefficient however, was negative and significant for self-user farms, indicating over-utilization of this resource. In the case of wheat, irrigation was found to be positively significant in buyers' farms and non-significant in other categories of farms. This suggests that there is a possibility of increasing the productivity in sugarcane and wheat by reducing excessive water use on self-user farms, which in turn will increase the availability of water on buyers' farms.

The cost of water extraction of an electric and diesel operated WEM was Rs 12.6 and Rs 44.7 per hour, respectively. The shares of fixed and operating cost respectively were 47 and 53 per cent, respectively for both types of WEMs. Interest on fixed capital constituted the highest share (35 per cent) in total cost of water extraction followed by the share of electricity cost (29 per cent) and diesel cost (37 per cent). On the other hand, average selling price of groundwater extracted by electric and diesel operated WEM respectively were Rs 6.8 and Rs 29.5 per hour. Lower selling prices than the cost of water extraction, implied that water markets were not efficient in pure market theory sense and water buyers were in better position than the WEM owners. Although, water selling does not seem to be an economically viable proposition, WEMs sell water to recover part of expenditure incurred on electricity or diesel charges and operation and maintenance costs.

Thus, both WEM owners and groundwater buyers stand benefited in one way or the other by the water market. In order to achieve better distributive social justice and to encourage efficient water markets, suitable water price policy needs to be evolved. Similarly, erratic electricity supply compels farmers to install more than optimum numbers of WEMs, thereby making them bear high fixed cost per unit of water extraction. This calls for rationalization of electric distribution system. The study also identifies policy prescriptions such as consolidation of land holdings and joint ownership of WEMs for the realization of equitable benefits from groundwater irrigation.

GROUND WATER MARKET DYNAMICS IN THE VILLAGES OF ORISSA

Dr. K. Adiseshu[1]

One of the most striking features of irrigation development in India during the last four decades is the rapid growth in groundwater use. Groundwater is cheap and easily available and can supply required quantity of water at appropriate time. Hence the strategy in revolutionizing irrigation should be the use of ground water resources on a massive scale. There is one school which believes that efficient utilization of groundwater is best achieved through a system competitive water markets without any subsidization of capital or current inputs. The development of such markets is supposed to be facilitated by legally sanctioned private property rights over, and freedom to trade in groundwater. But there are serious practical problems in implementing this approach; and the social consequences are very much a matter of contention.

In Orissa, area, under both surface and groundwater irrigation, has not considerably increased during the last 6 -7 years. This may be attributed to the erratic nature of rainfall and vagaries of monsoon. Owing to this, the quantum of percolated water from the surface flow has decreased which has led to a decrease in the ground water potential. With limited groundwater resources, farmers in the villages of Orissa irrigate their crops. As per the calculations based on Groundwater Estimation Committee norms of 1997, the state has a ground water resource of 2,101,128 HM (hectare meters) of which 1,988,856 HM (95 per cent) is the utilizable resource for irrigation. But the annual draft for irrigation use is only 236,044 HM (11.87 per cent) leaving a vast chunk of untapped potential. Therefore, there is a wide scope for developing ground water irrigation and reduce the risk to agriculture. In the expansion of groundwater irrigation, private investments play a crucial role and mostly large and medium farmers alone can afford to take up such investments. For instance, among semi-medium, medium, and large holdings, 7.6 per cent had wells without pumpsets, 2.26 per cent had wells with pumpsets and 1.62 per cent had tube wells, whereas among small and marginal farmers, only 0.43 had wells with pumpsets and 0.98 per cent had tubewells in 1995-96. Thus small and marginal farmers have relatively less access to ground water, which is a common property resource. If there is a well-developed market for groundwater, the small and marginal farmers can have better access to this resource. It may also have an expansion effect on cropped area, yields, employment, and agricultural incomes through adoption of technology and changes in crop pattern. Water markets in India have a history of more than 70 years. Although, initially, selling water was considered as immoral and many owners of water extracting machines were reluctant to participate in water markets; slowly, they overcame this moral scruple giving more weight to economic considerations over non-economic considerations. This led to the emergence of ground water markets in many parts of India.

As ground water is a common property resource, water extracting machines are mostly privately owned and over-extraction of groundwater causes externalities because of environmental degradation. Development of groundwater markets may pose issues of equity and environmental problems.

This paper presents the groundwater market dynamics: (1) crop wise number of irrigations required and the number of irrigations actually provided by farmers to important crops like maize, paddy, tomato and brinjal; (2) conditions imposed by the owners of water extracting devices on non-owner farmers; and (3) the extent of water rates demanded by owner farmers. The analysis is focused on both owner and non-owner farmers in

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the selected villages of Ganjam block in Ganjam district and Gunupur block in Rayagada district of Orissa. Untimely and inadequate rainfall has resulted in the decline of groundwater table to a considerable extent. Overexploitation of groundwater lead to further decline in the groundwater table and resulted in intrusion of sea water into land and salinity in some villages. Owners of water extracting devices charge exorbitant rates to release water per hour, depending on the distance of the cropped area from the water source and also urgency of crop conditions. Almost all the farmers in the sample villages are facing the problem of inadequate power supply. Frequent cuts in electricity supply are causing damages to the water extracting devices. As a result, farmers have to incur heavy expenditure on repairs of electric motors. Sometimes the burden of repairs has to be borne by water buyers. Farmers are unable to adopt better cultural practices and technical know-how because of inadequate irrigation facilities. The government should implement the watershed development programs in these selected blocks to improve ground water potential. Uninterrupted power supply, at least, in the crucial periods of the crop condition must be ensured.

THE ELECTRICITY GROUNDWATER CONUNDRUM: THE CASE FOR A POLITICAL SOLUTION TO A POLITICAL PROBLEM

Navroz K. Dubash[1]

The problematic interface between electricity use and groundwater access has been a subject of debate for well over a decade. This debate has taken on a renewed urgency following the recent 2004 Indian national elections, in the aftermath of which free or cheap power came roaring back on the political agenda. The electricity-groundwater conundrum has implications not only for the productivity, viability, and sustainability of India's agrarian economy, but also for the health and future viability of the larger project of electricity reforms in India. Indeed, power to farmers is perceived, in many ways correctly, as being at the heart of the electricity reform agenda. For the viability of both water and electricity sectors, this interlinked problem needs resolution.

Although the debate on the electricity-groundwater link is longstanding, it is marked by a focus on technocratic approaches to policy-making rather than an appreciation for the entrenched political nature of the problem. Fixes have tended to be economic - raise prices to farmers - and/or technical - install meters. Both are standard elements of the electricity reform prescription that the nation has struggled with, largely unsuccessfully, to implement over the last five to ten years. Failures to follow both prescriptions are ascribed to a lack of political will. And there the matter rests. Until politicians develop a backbone, it is argued, there is little that can be done.

By contrast, this paper seeks to develop a more consciously political interpretation of the electricity-water conundrum, and consequently a case for a more deliberate political solution. The "lack of political will" argument suggests that, when technocratic solutions run into a political obstacle, the political process should be bypassed, either by stealth, or by pinning hopes on a political strongman at the state level who can demonstrate the way forward for the rest. If, by contrast, there is some weight given to the democratic process through which policy change must pass, then the reasons why farmers have been so opposed to the standard reform prescription must be taken seriously, weighed, and addressed. This is not to say that the prescriptions themselves are necessarily wrong, but that a political solution is needed to provide a larger framework within which technical and economic solutions can be embedded. Efforts to solve the electricity-water problem by advocating technological and economic fixes have so far have put the cart before the horse; sustainable reform first requires a workable political bargain to which the various parties involved, particularly farmers, can agree. Technical and economic instruments are, then, needed to implement the political bargain.

This paper is organized in three parts. The first provides a brief summary of the electricity-water intersection, and the nature and history of the problem. The paper stresses the path dependent nature of the problem and the consequent destructive cycle that has developed between groundwater and electricity use. The second part develops the argument that the electricity-groundwater conundrum is, at root, a political problem. The paper discusses some of the conventional wisdom on which the standard prescriptions of tariff increases and metering agricultural supply rests, and argues that farmers may indeed have good reason to be concerned about their future under these prescriptions, concerns that are not being taken sufficiently seriously. In particular, the paper examines the real contribution of farmer subsidies to the fiscal problems of states, asks whether farmers are misguided in demanding subsidies, and whether farmer subsidies really should have the support of a few rich farmers. In the third part, the paper

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turns to the literature on proposed solutions, at both macro and micro levels, to assess them in light of the political understanding developed earlier in the paper. These solutions include proposals for a rational flat tariff, the conventional metering and tariff hike approach, and some hybrid approaches. The paper concludes with reflections on what it would take to transition to a more political solution to the highly politicized electricity-groundwater conundrum.

Towards a Water Resources Strategy for India
The Issues in Pricing, Regulation and Financing of Water Development

Sebastian Morris[1]

This paper discusses the stylised problems relating to water and irrigation in India and argues that most of the inefficiencies, misuse, and environmental damage have their roots in the mispricing of water and electricity. Since the only kind of subsidies thus far used are price based input subsidies and they end up distorting the allocative prices, from which other distortions follow. The problems of the sector can be overcome by setting the subsidization method right converting price based subsidies into direct subsidies and endowments with improved tradability. These and other actionable measures would not only solve the problems in the sector but also result in political capital for its initiators; it should also make private and public financing of water projects possible.

The issues related to pricing, water rights, subsidies and financing are deeply interlinked, and the correct pricing would have recognize the financing implications. Being a scarce commodity with major composition and coordination economies in its use water pricing cannot be discussed without a consideration of the rights (implicit or otherwise).

More than a diagnosis of the problem, we have been led by the need to find solutions to a fast deteriorating situation: rising implicit subsidies, movement away from optimal use in a major way, huge distortions, and resulting social costs in the use and misuse of water with as much as 30 percent of the irrigation water supplied being wasted. The environmental effects of such inappropriate use and waste increase by the day. Reform is not possible if the present approach to work around major policy and design continues infirmities rather than remove them in the first place. This is because the distortions have been so deep-rooted as to have fed back into the governance and institutional structure of water management. We also argue for solutions that are incentive compatible in the sense that the designs for pricing and regulation and financing (within the appropriate policy and rights framework) are internally consistent and would work without depending continually upon political commitment, administrative initiatives, and managerial energies.

By incentive compatible we mean that the policy and design meet the criteria that the actors, civil servants, proposed water companies and cooperatives, electricity companies, and farmers have the correct incentives to do what is right for efficient production, management, allocation, and consumption of the resource without administrative direction or urging or demanding the presence of persons with exceptional morals, or leadership qualities. Key elements of our recommendations are as follows:

The right to water of a state should also include the right to trade, i.e. to sell the water. This would be consistent with the fact that the bulk of water is for commercial use. A formal perhaps constitutional basis of sharing the waters of interstate rivers, rather than national level optimal use being pursued weakly through agreements, is important.

The irrigation sector at all levels is open to the private sector. It would be far more useful to institute regulation which is incentive in approach and price cap in form, though uniform caps across large regions would not be possible nor desirable

All subsidies whether for electricity or water have to be direct subsidies delivered to the farmer. An identification exercise done once that allows the endowments of a farmer to be fixed, so that he can be issued electricity and water coupons periodically. This ensures the political commitment of the farmer since now he has

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nothing to lose but a lot to gain. Without such commitment, and certainly with their hostility no reform is possible

With all subsidies going direct, there need not be restraints on commercial behaviour and orientation for the participants in the market. The productive organizations: bulk water companies, retail companies and distributors including WUAs, and farmers can all relate to the regulated bulk and retail market prices.

Current subsidies in irrigation are converted to endowments in units of water and provided to the farmer in the form of coupons with which (as also with cash) he can buy and even sell subject to certain constraints. Prices are, thus allowed to perform their function of ensuring allocative and use efficiency. Since water supplies may be limited (because of natural factors, and because of limited existing capacity to produce and store) bulk water rates are regulated, with only small opportunity for water companies (bulk and distribution) to gain from (high) retail water market prices. Regulated prices could be LRMC, in which case the difference between commercial viability prices and the LRMC prices is made up through annuities in an appropriate PFI deal.

The benefit of the difference between regulated retail prices at which water is supplied to the farmer and retail water market price in the command area is to the account of the farmer. Since the farmer is able to internalize this benefit with reference to the price, there are strong incentives for judicious use and optimal trade and, depending upon the situation, even investments in water saving technologies. Some benefits will accrue to the water distribution entity so that it has the incentive to save water in distribution, recover losses, and make investments for repairs, rehabilitation, and augmentation.

Tradability across an entire command is a desirable objective, which can come through experience. Cross-command tradability should also slowly emerge subject to certain safeguards against the monopolization of access rights to water.

Water distribution companies are ideally WUAs but cast as cooperatives with some allowed asymmetry in shareholding. But they ought not be limited to WUAs or even to farmers' companies. Bidding for distribution business should be open to entirely private companies too.

For entirely new projects requiring construction of new distribution assets, access rights can be sold at prefixed prices or market prices but strictly limited to farmers with operational/own holdings of land in the command area, to raise the capital to construct the distribution system. This can be done separately for each of the distribution areas, since the bid prices are likely to vary depending upon such factors as the alternative supplies available including from groundwater. Such purchase of the rights to water would lead to much flow of finance into the sector in a way that is functional and entirely incentive compatible. Banks could support participation of farmers in the equity of distribution companies.

Tank systems would also require a certain recasting with formally defined rights and prices for use of groundwater and surface irrigation. The need is to minimize the free-rider problem that is inherently a barrier in the management and judicious use of tank irrigation (a common resource in many ways). The key to reform is to lead the system to an explicit relative valuation of the direct and indirect output of the tank (canal water and groundwater) through bids restricted to farmers from within the ayacut. A prior fixation of the shares of each farmer in the tank business that includes already existing use of wells is the key. Tradability among members of such rights water would ensure its judicious use, and the expansion in supplies would follow from the large profits that the farmer would make in avoiding leakages and siltation.

SUBSIDIZED ENERGY AND GROUNDWATER USE FOR AGRICULTURE: ARGUMENTS AND FACTS

Sarbani Mukherjee[1]

Over the years, groundwater has emerged as an indispensable resource for irrigation, especially in those regions where surface water is scarce. However, intensive groundwater extraction in several regions of the country has led to critical situations such as depletion of water, increased drilling and extraction cost for farmers and premature failure of irrigation wells. These, in turn, have adversely affected the economic condition of farmers. Many of the problems are rooted in high governmental subsidies in the agricultural sector, especially power. In most states electricity is provided either free of charge or at a flat annual rate based on pump capacity. Availability of electricity at subsidized rate has facilitated farmers to increase the area under groundwater irrigation significantly. On one hand, this has made a substantial contribution to raising agricultural productivity and farm incomes; excessive extraction has led to depletion of groundwater in many parts of the country. This, in turn, has resulted in increased drilling and extraction costs for farmers and complete abandonment of some wells. Life of irrigation wells and their groundwater yield are gradually declining due to overdraft of the resource. Subsidy for lifting groundwater eating into the finances of state electricity utilities. Rise in demand for electricity coupled with low realization has raised subsidy to agriculture to unmanageable proportions. Moreover, the quality of supply to farmers has worsened over the years. Operational inefficiencies and high distribution losses due to pilferage have led to financial insolvency of power utilities across India. With little or no funding available to rehabilitate the power generation and distribution system, unscheduled power failures and voltage fluctuations have become increasingly frequent. Farmers' dissatisfaction has grown and so has their unwillingness to pay even highly subsidized charges. As users refrain from paying, cost recovery diminishes for the power utilities thereby worsening the funds problem. In other words, although farmers are using more power, this is not getting translated into more revenue to the utilities. Further, because of political reasons, farmers pay the lowest charge amongst all consumer categories. Subsidized energy for groundwater has encouraged inefficient patterns of energy and water use by farmers. It is, therefore, necessary to regulate groundwater extraction not merely to ensure its sustained availability but also to optimize economic benefits from energy use.

It is argued that subsidization of electricity for pumping groundwater reduces the marginal cost of extraction to near zero and thereby encourages farmers to use the resource inefficiently. In other words, subsidized energy for groundwater irrigation encourages over-pumping, as lower electricity rates decrease the cost of pumping and increase the depth to which it is profitable for farmers to pump water. However, it is difficult to assert with certainty that reduction in electricity subsidy would make significant changes in the groundwater use. This is because, apart from electricity tariff, consumption of groundwater for agriculture is also dependent upon factors like pump capacity, irrigation intensity, proportion of groundwater irrigated area to total irrigated area, energy efficiency of pump sets, etc. Besides, electricity subsidy does not necessarily mean overexploitation, unless market forces exist for the product of groundwater irrigation. Groundwater has a 'derived demand'. In other words, the demand for groundwater is actually derived from the demand for 'groundwater products', which are the different crops. Therefore, ultimately it is the "derived demand', which is the influence of subsidy and not just demand. Overexploitation also results from lack of well-defined property rights. In India, rights to groundwater are vested

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with the landowner as groundwater is attached to the land. There is no limitation on the volume of groundwater that can be extracted by a landowner. Since, landownership is a prerequisite to ownership of groundwater, it is difficult to assign 'open access' nature to groundwater resource. Although landowners own groundwater, this right is limited by the huge investment required for tapping it. Farmers often tap the resource with myopic behavior, not recognizing that each one's extraction is a function of the neighboring well's extraction at a time and over time. This, in turn, leads to cumulative interference of wells and reduction in life of wells and in the gross area irrigated by wells.

Efficiency of groundwater use cannot be improved simply by manipulating electricity-pricing policies through reduction in subsidy. Subsidy for agricultural consumption of electricity is a complex issue. Often, losses in electricity supply to the agricultural sector reported by State Electricity Boards are inflated. As supply is unmetered, losses arising from theft of power are also ascribed to agriculture. Subsidy accrues to relatively better-off farmers. Many of the farmers possess diesel pumps as backup. This is indicative of the fact that capacity to pay is not a real issue. Besides, supply of power to agriculture has far-reaching social and economic implications. Hence, one needs to look into this issue more pragmatically.

In this backdrop, it becomes necessary to explore the areas of inter-linkages between energy and groundwater irrigation so as to adopt effective measures for energy-groundwater co-management. In addition, it is also vital to examine whether subsidy meets the social objectives or not. This paper examines the impact of subsidized energy on groundwater use for agriculture. It also attempts to develop an analytical framework for assessing whether electricity subsidy meets the social objectives or not. This is addressed by examining the distribution of the benefits of subsidy across different categories of farmers. Finally, the paper highlights some alternative policy options to increase groundwater use efficiency in agriculture.

6. Understanding Culture Fisheries Revolution in India

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14:30 – 16:00; 16:30 – 18:30

Session Chair: Deep Joshi

During recent decades, India, Sri Lanka and Bangladesh have experienced a veritable revolution in culture fishery in small and large common property tanks. This has powerful livelihood, food security and nutritional impacts in rural areas. At the same time, the rise of culture fishery has simultaneously strengthened complementarities as well as competition between irrigation and fishery in inland water bodies.

Fishery science, which is leading this charge, is thickly into this massive change. However, social science has overlooked the massive socio-economic change this can bring about and the institutional drivers of this productivity revolution.

ITP digs into this phenomenon to explore if it yields generalizable lessons about institutional drivers of productivity growth.

Author(s)	Paper	
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Amalendu Jyotishi	The Tawa Reservoir Fisheries Management: Experiences and Options	Ext. Abstract
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R. Indu and S. Ghosh	Inland Fishery in a Traditionally Vegetarian State: A Gujarat Story	Ext. Abstract
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THE TAWA RESERVOIR FISHERIES MANAGEMENT: EXPERIENCES AND OPTIONS

Amalendu Jyotishi[1] and R. Parthasarathy[2]

In developing economies, open water inland fisheries not only plays an important role in the nutrition for the poor, but also provides livelihood for many people. Reservoir fisheries are classic examples of common pool resources, which have the characteristics of rivalry in consumption on the one hand, and non-excludability of resource extraction on the other. Therefore, it requires an analytical framework to describe the management of them towards an equitable, efficient and sustainable end. A system, which delivers or ensures these, becomes a reliable response to the institutional requirements in Common Pool Resources (CPR) type of resources in general and in reservoir fisheries in particular. In the case of reservoir fisheries, we identify various types of institutional regimes. Each regime has its advantages and disadvantages in terms of allocation of rights, appropriation of the fish resource, and distribution of income. In India, these institutions can be broadly classified as, state, private and cooperative managed. Each regime has diversified activities relating to stocking, production, collection, transportation, marketing and distribution of products, income and profit. These factors are driven by opportunities and uncertainties.

Institutions in reservoir fisheries are of varying nature in different states of India. The system of leasing rights and fishing rights also vary from state to state. Even within a state, leasing and fishing rights vary between reservoirs. In most of the states, the department of fisheries or state fisheries development corporations obtain fishery management rights from the reservoir authorities by paying a nominal amount or royalty (and in cases without any payment at all). Fishery departments or corporations either manage the system themselves or lease-out the reservoir on a royalty basis for a definite period ranging from a few months to a few years.

Madhya Pradesh with thirty-two medium and five large dams has more than thirty-two and ten percent area of medium and large dams in India respectively. In the last three decades, there were four different regimes, which encompassed the Madhya Pradesh fisheries management at different points of time. Before 1979, it was the state fisheries department that managed fisheries. In 1979, the MPFDC (Madhya Pradesh Fisheries Development Corporation) was formed which became the nodal agency for fisheries management in reservoirs. In the early part of 1990s, MPFDC started leasing out fishing rights to private contractors. Madhya Pradesh Matsya Mahasangh (Fish Federation) replaced MPFDC in the year 1999 and this fish federation is now responsible for management of fishery activities except for the Tawa reservoir.

An attempt is made here to understand functionaries and regime change in the case of the Tawa reservoir. The analysis contrasts productivity (efficiency criterion), wages and employment (equity criteria), and stocking production and technology use (resource sustainability criteria) across different regimes. Further, the paper details the management practices under the Tawa Matsya Sangh (TMS) and emphasizes that management practices should be integrated with the understanding of resource base.

The Tawa reservoir was constructed on the river Tawa, a tributary of the River Narmada. The construction of Tawa Dam began in 1956 and was completed in 1974 and fish production started in the reservoir in the year 1975, initiated by the state government. The authority was transferred to (MFDC), which continued till 1994. In 1994, the reservoir was auctioned to a private contractor from Bhopal. During this period, the local communities were not allowed to catch fish from the reservoir even for self-consumption. Denial of

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access to the resource led the local communities to demanding exclusive fishing rights over the Tawa reservoir and gave birth to the Tawa Matsya Sangh (TMS). Initially the TMS got exclusive fishing rights for five years commencing in 1996. The rights were further extended in 2001.

An analysis of different regimes during this period shows that private or cooperative regimes performed better than the MPFDC regime. It is therefore essential to understand the factors that would have led to these outcomes. Though the existing micro level scenario would be different for the reservoir, the poor performance during the MPFDC regime can be attributed to inconsistent level of stocking, irregularity in marketing and lower wage and lower number of fishing days. This led fisher folks to pass on the catch to illegal marketing networks. Therefore, the reported level of production may be an underestimate of actual production. All these factors point towards the inefficient management system of the regime.

Efficient and sustainable production accompanied by more equitable distribution of income is what is required for a desirable institutional arrangement. On income and employment generation front too, private and cooperative regimes performed better than MPFDC regime. Private regime, though yielded a very high per capita income, also enhanced the cost of production owing to change in the quality of net. But, contractors did employ outsider fishing-communities. Therefore, income was not accrued to the local people. On these aspects cooperatives seem to be a better alternative.

MPFDC managed the resource for a long period, whereas other management regimes did it only for a brief period. As a result, strict comparison of management regimes is difficult. In Tawa, the dam-displaced people, who traditionally did not belong to the fishing communities, got the fishing rights after a sustained struggle. Therefore, the implications of such cooperatives in terms of fishing rights are different from the usual cooperative regime. The TMS, which started with 31 primary cooperatives and three affiliated cooperatives, now consists of 34 primary cooperatives and 6 affiliated cooperatives spread across the Kesla and Sohagpur blocks of Hosangabad district. There are about 1300 primary members of the cooperative, of which 477 members actively participate in fishing activities. Twenty-nine out of thirty-four primary cooperatives are dominated by Gonds and Korkus communities (both scheduled tribes). Of the remaining, the five cooperatives consist of heterogeneous communities, including the scheduled castes, other backward castes and scheduled tribes. The six affiliated societies largely consist of traditional fishing communities of Dhimar and Kahar. The local people who do not belong to traditional fishing communities get a larger stake over the resource and hence a share on the revenue. Besides, by taking initiative in rearing fingerlings, large number of people from the Tawa region got additional employment and income. Fingerlings being one of the major inputs in reservoir fisheries, production of it within the system also has implication for sustainability of the institution and resource base. Over the years, TMS has developed capacity among the local communities to harvest fingerlings that has significantly reduced the dependency on external sources. This shows the internal institutional capability to manage and sustain fish production of the reservoir. However, declining production in recent years is a matter of concern.

The Tawa case points out that natural resources in effect, offer a vector of management options. In the macro environment context where the state is increasingly withdrawing from day-to-day management and maintenance of local infrastructure, the contextual importance of this historical analysis is obvious. What makes Tawa a case by itself is the management of the reservoir by different management regimes in a relatively short period. As expected, the government system appears weak while the private option manifests the much-debated issues of sustainability and equity. Cooperatives seem to be the best bet. It should be noted that the strength of the cooperative is not only from within the reservoir activities, but also largely owing to establishments or claims of aboriginal rights. Therefore, to claim the success of cooperative purely on merits of use and management of the resource alone would be misleading. What the study does signal is the need for an arbitrator who could take into account not only production-trade-marketing related functions but also a scientific analysis of resource base planning.

WHOSE FISH IS IT ANYWAY? MAHARASHTRA' S STRUGGLE TO KEEP ALIVE ITS FISHERIES

Sachin Mardikar[1]

Maharashtra produces 15 to 20 percent of the annual fish production of the country. With six marine districts, marine fish landing is nearly 5 lakh tons. The state has a coastline of 720-km along with 112,000 square km area of the continental shelf available for coastal fishing. It also has a vibrant tradition of inland fisheries in over 13,000 tanks which include minor, medium, and major irrigation tanks. The total water spread area of these tanks is around 311,000 ha. There is also a brackish water area of nearly 80,000 ha along the coast, out of which about 10,000 ha of area is suitable for brackish water aquaculture. The fishermen population in Maharashtra is 4.24 lakh and constitutes 0.4% of the total population. The average per capita consumption of fish is around 3 to 5 kg in urban area and less than 1 kg in rural area.

The ownership of tanks in Maharashtra is dispersed and is one of the major factors in promotion of inland fisheries in the state. Culture fishery in Maharashtra is centuries old, dominated by migrants from the north. They have adapted to the region's culture and are an integral part of every village with a water body. They have played a major role in construction and maintenance of tanks which primarily provided support irrigation to paddy. They were granted fishing rights by the erstwhile landlords. They have organized themselves into cooperatives but still it is an exclusive club. Elsewhere in the state the governments attempt at popularizing culture fishing in large reservoirs has not met with success as these water bodies are located in perennially drought prone areas.

Leasing Policy

Before June 1995, tanks below 200 hectares and above 200 hectares under irrigation department were given to primary fisheries cooperative societies on annual lease. However, these societies did not make enough stockings of optimum fish seeds in the tanks because of financial difficulties. The state government's response to this was construction of 27 new circular hatcheries and introduction of a renewed policy of leasing through public tender system for tanks more than 200 hectares. The expectation was that it would introduce healthy competition, increase revenue from leasing and result in higher production by stocking optimum fingerlings in tanks. This led to the increase in revenue for the government.

However, fishermen co-operatives strongly opposed the policy and therefore in October 2001 the policy was modified and societies in whose jurisdiction tanks were situated were granted lease at an upset price fixed at 3 percent of total income based on the price of fish at Rs.25/kg.

As per the prevailing policy (2002), the expected value of fish from a tank was based on the sale value of fish at Rs. 20/- per Kg (the ruling market price then was Rs. 50/- Kg). And lease rent for a tank was kept at 1 per cent of the expected value of production calculated above.

The state has all the while encouraged fisherman cooperatives for inland fishing and reservoir development. There exists a three- tier cooperative system in the state. However, the cooperative movement in this sector has remained financially and organizationally weak. Members come from one of the most marginalized segments of society. Subsidies have done little to improve their productivity and financial strength. The leasing policy itself underwent drastic changes from total reservation for cooperatives at subsidized rates to maximization of revenue through public auction.

Private Trade: A Caged Tiger?

As against organizations, institutions are not static. The study of some of the fishermen's cooperatives, which in essence is an attempt to formalize traditional institutions, offers interesting insights. Prohibited from sub letting or leasing out tanks to third parties; in reality most of the tanks

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report existence of some kind of private partnership often with the full knowledge of the officials from FFDA. At the state level, there is fierce competition in the eastern part (dominated by inland fisheries) that has created a new investor class. Private trade continues unabated and is quite adaptive to the changes being brought about through several legislations. However, there is little regulation and check on the functioning of private players. Production due to private efforts is not recorded any where, but increasing bid amounts quoted by private players could be a good indicator of the likely productive value of the tanks.

The Natives - Does anyone Care about Them?

Forming a committee to manage common property resources is no guarantee of success (Stalker 2001). Decentralization and local empowerment is not a guarantee for environmental stewardship. In fact, the opposite may result. Jodha quantifies the extent to which the rural poor benefit from CPRs.

Most of the fishermen are poor, have no assets (except for a chosen few, namely office bearers) and are marginalized in the village. The FFDA officials concur that an average fisherman in Maharashtra engaged in inland fisheries is not aware of any of the policies and schemes that have been made for his protection. Part of the blame lies in the fact that he has no access to information about the key aspects such as markets and an alien technology (fish seeds were imported from Bengal and the local varieties have practically ceased to exist).

A good amount of time of the officials is spent in handling court cases filed by aggrieved parties. Ironically, the average fishermen now needs to know the nuances of contract laws and interpreting government resolutions when all along he was simply casting the net and earning his livelihood.

The Response of the Fishermen's Community

We spoke to a number of members from the fishermen's cooperatives on why they do not seem to be investing money (own or obtained through credit) into fisheries. Most cited their own financial condition as the biggest obstacle. There was a marked preference for partnership rather than taking loans from the moneylenders. When we asked the members of the cooperatives about this arrangement, almost all of them were apprehensive of taking credit from formal banking sources saying, "Who will bear the risk of repayment? This gives rise to a more generic observation as whether the members per se are better off as a "rent seeker" than as a producer?

If there are competing claims for livelihood opportunities, the trade-off is not just likely to be between production of fish versus rent but also with the likely return (social and economic) that the alternative activity is likely to bring to the community. The Suradevi tank is unique in many ways. The property rights on the tank are with 23 families and their descendants. Although the 35 acre tank offers tremendous scope for fishing, cultivation of *Singhada* takes precedence over fishing. Although fishing offers good money, its ability to provide employment to a larger community remains restricted. In the case of production of *Singhada*, the community members felt that almost every one had a chance to make anywhere between Rs. 5-15,000 during the three months of winter.

The technology in many cases is alien to the native practices. Driven by the urge to geometrically multiply the states fisheries production, the officials simply imported fish seeds from west Bengal and encouraged the farmers to take up culture fishing in a big way. There was little support (except for a training program for youths, where some stipend was paid) to the local fishermen in training and upgrading their skills. The learning curve has been slow. As evidence from some case studies show, even now the fishermen community is hired for their ability to catch fish and nurture them.

During the field visits and interactions with the officials of the fisheries department, it became obvious that a new class of intermediate service providers has emerged. These are people with background in fisheries and technically qualified professionals, who are often hired by influential private contractors to provide technical know-how for culture fishing. The local fishermen are increasingly turning to be labor provider. This shift from operating in a knowledge market to a

labor market has had a negative impact on the fishermen. For they do not share the profits arising out of better prices in the market and have to contend with wages

The government kept changing the institutional environment through promoting multiple agencies, tinkering with lease rental charges, or announcing rehabilitation packages for the ailing Maharashtra State Fisheries Development Corporation. Yet, the state has witnessed a silent revolution in inland fisheries through redefining of institutional arrangements. The traditional community arrangements have given way to more market friendly practices that are based on ease, speed, and sharing of risk and profits in an equitable manner.

This is the best, the marginalized fishing community can leverage on the only strength it has, that is its ownership rights over tanks.

Inland Fishery in a Traditionally Vegetarian State: A Gujarat Story

Rajnarayan Indu[1] and Santanu Ghosh[2]

Though traditionally a vegetarian state, Gujarat has recorded a threefold increase in inland culture fisheries production over the last three decades. The major drivers of growth, as stated by the government fishery department, have been interventions of the FFDA's training in fish culture technology and improved fish management practices. But there has been very little understanding of the role played by institutions as a driving force to the inland culture fishery revolution in the state. This study looked into the leasing policies of the government, existing institutional arrangements, and the historical perspective of the change which has occurred over the years.

The major growth of inland fisheries in Gujarat has been seen in the village ponds and irrigation tanks. These water bodies have multiple uses for human and animal populations of the village. This system is governed not only by a well-defined set of institutional arrangements concerning who may or may not use the resource but also by rules concerning the conduct of accepted users, both formal and informal. Conflicts arise within this system since these rules are not explicitly stated.

Institutional arrangements can be both formal (contracts, agreements) and informal (norms, customs and conventions, etc). While formal institutional arrangements can be changed through legislation, political power, influence, and so on, informal institutional arrangements (like culture of a society, village culture) develop over long periods of time and are thus not very amenable to change in a short time span. This study is an example of how institutional arrangements adapt to reduce conflicts, reduce transaction costs, and induce growth over a period of time. We selected Bharuch district which had 23.80 percent share of inland culture fishery in Gujarat in 2002-03.

Probably the best weapon for the government to influence growth in inland fishery is the leasing policy. The government made small changes in the leasing policy over the years; in fact a lease policy for village ponds and tanks was finalized in 1976 and subsequently amended in1982, 1990, 1992, 1995, 1996, 1997, and 2003. The focus of the government in the initial years was to develop fisheries as a viable livelihood option for the tribals displaced by the construction of dams, generate livelihood opportunities for the poor in villages, and bring as many village ponds under fishing as possible. Over the years, the government set-up co-operatives and doled out large amount of subsidies to make them sustainable. However, the co-operatives found it difficult to control poaching including by their own members; and the gross revenues could not even meet the bank loans. Many of the co-operatives became defunct while the ones which survived, metamorphosed and adapted themselves to the changing policy environment. Most of these co-operatives have become the domain of family-run businesses who were traditionally fishermen, or a few influential people within the co-operative, who used the monopoly rights conferred on the co-operatives by the government to the full, yet showing poor performance in their books.

However, the government, with the help of the FFDA's, has done its job. It has reduced the huge transaction costs related to learning and finding out the relevant costs and prices related to starting the fishing business, thus paving the way for budding entrepreneurs to enter the fray. But the costs related to negotiating and concluding contracts, and then of monitoring and enforcing them, were still high. This was because the village panchayats had the right to lease out fishing ponds and the irrigation department for the irrigation tanks. Because of the fear of losing the

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lease with change in the village panchayat, the beneficiaries had to dole out huge amounts to the sarpanch and the talati to extend their lease periods.

Many private contractors, noticing the huge profits which could be made in fisheries, entered the business and developed their own informal arrangements which made them move towards a low transaction cost-high payoff scenario. Usually these fishing contractors came from the lower rung of the society. The contractor was sometimes a village toughie or a local bootlegger. Successful fishing contractors had painstakingly cultivated the image of a toughie, or a ruffian capable of enforcing his rights even at times by using violence. But this is not always the way they enforce their rights. Many of these budding entrepreneurs actually share a part of their income with the villagers in their times of need. Many of the contractors got the lease of the ponds only after they had helped in the renovation of the tank with their own resources, which eventually helped the whole village. It helped them not only to build their image in the village as a good samaritan but also helped them retain the lease for a longer period. In fact it will be difficult for the fishing contractors to justify their huge profits generated from fishing without distributing a part of it to the village community. These are the more important issues that are working as 'real deal' in the world of inland fisheries in Gujarat.

To bring in more transparency to the system of allocation of fishing rights, the government brought in the open auction system in July 2003. This change in leasing policy has helped in reducing the transaction cost associated with negotiating and concluding contracts and brought extra income to the village panchayat, which was otherwise being diverted to the sarpanch and talati. The increase in leasing period from 3 years to 10 years also reduced the transaction cost of getting loans from banks. The immediate effect of this new policy is seen in the astronomical rise in leasing amounts as much as 10 times the upset price received before.

Bharuch district has a very large saline-affected area. It has both coastal and inland salinity. Inland salinity is caused in many areas, because the floors and sides of canals are not cemented and natural geographical drainage is poor. Also some of the inland salinity is man-made due to over-irrigation. Fishing is turning out to be a lucrative income proposal in comparison to low return crops grown on saline land or keeping the land fallow. Therefore, fisheries can be promoted in these saline areas, which would give a high return to landowners or even to non land holders, who can be given saline land on lease for culture fishery. Income from fisheries would have a multiplier effect through other allied activities connected with culture fishery.

Fish Or Fowl? Dialectics of Multiple Economies, Property Rights and Institutional Regimes in Kolleru Region, Andhra Pradesh

JANAKI TURAGA[1]

This paper analyses the inland culture fishery intervention in the Kolleru region in Andhra Pradesh. The intervention has clearly demonstrated that private entrepreneurship, rather than government interventions per se, has revolutionized culture fishery-technologically and economically, besides bringing about socio-economic changes in the region. The intervention is analysed over six phases: genesis, manager entrepreneurs, fish entrepreneurs and growth phase, expansion phase in and around the Kolleru lake, spread effect phase, and present phase of sustainability issue. Each phase is marked by specific entrepreneurship and technological innovations.

Culture fishery in the Kolleru region operates in multiple paradigms- of property rights—individual, community and state; of shareholder and stakeholder; of economies, livelihood and commerce; of resource use-livelihood and commerce/ individual/collective, judicious use and exploitation; of institutional systems and arrangements; of fishery as an occupation and business; of cottage industry capture fishery and modern industry of culture fishery. Each of these paradigms operates in conjunction with others and a complex mosaic of competing interests over resource use has emerged.

Culture fishery in the Kolleru region (which includes the Kolleru lake and the areas surrounding it in Krishna and West Godavari districts), is practiced in the Kolleru lake itself, in private agricultural lands around the Kolleru lake, in addition to government land in and around the Kolleru lake, legally through the fisheries cooperative societies(FCSs) and illegally by private 'shareholders. Each of these geographical units of culture fishery operation brings with it specific issues of property rights, institutional regimes, and economies.

The culture fishery intervention was initiated through the FCSs in the Kolleru Lake. The FCSs were not able to sustain the profitability of culture fishery and consequently accumulated huge loans to the banks. In order to recover the loans, private entrepreneurs were given the fish tanks on lease. The commercial success of private manager entrepreneurship paved the way for the decline of self management of the FCS and the emergence of private entrepreneurs. Whether, the FCS were the right institutional mechanism for culture fishery is a question for which there are no answers. But what is unquestionable is the critical role it played in acting as agent of change through which culture technology was transferred from the lab to the field on a collective basis. The department of fisheries could reach out to the larger collectivity of fishermen through the institutional arrangement of cooperative societies. The actual functioning of the societies is dependent on myriad factors and in Kolleru, one of the chief reasons was that fishermen were not able to transition from the mindset of capture fishery to culture fishery, which made it difficult for them to handle the 'high risks' associated with culture fishery, the chief among them being market facilities which were located in Calcutta. This gave rise to the formation of informal institutional arrangements with local private entrepreneurs, who managed the fish tanks, took the high transaction costs and risks, and gave an agreed upon profit amount to the fish farmers. This institutional arrangement continues on a vastly higher scale to this day, with huge areas of the lake being brought under illegal fish tanks. The formation of FCSs enabled members of the cooperative societies to become 'entrepreneurs' who privately leased out the FCS to 'manager entrepreneurs'.

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Since the government formed FCS for below poverty line fishermen, the remaining fishermen felt deprived and the Kula Panchayat (caste panchayat of the Vaddi fishermen community), built tanks around the Kolleru lake and leased them out to fish entrepreneurs. Whether the fish tanks were built on common property resource or on government land is a matter that is to be decided by the Revenue department. At present the very legality of the FCSs is under question with the declaration of the Kolleru lake from 0'-+5' MSL contour as a wild life sanctuary, and the enforcement of G.O. Ms. 120 of 1999. The Department of Fisheries is now caught in difficult position where its legal FCS are now 'illegal' according to the Department of Forests, and would need to relocate from the sanctuary area. Therefore, while the formal institutional arrangements are now under question, the informal institutional arrangements continue to thrive. This gives rise to the generalization that the initial institutional space created by the government facilitates the emergence of private entrepreneurship.

The success of the inland fisheries in the Kolleru region has demonstrated the sheer might and potential of 'collective entrepreneurship of the stakeholders', which made it possible for technological innovations, establishing marketing linkages, and providing infrastructure without any assistance from the government. The model developed by the Kolleru culture fishery entrepreneurs is based on three planks-technology of culture fishery, management of fish tanks, and marketing of the produce. The Kolleru culture fishery model is now widely replicated across the country with varying degrees of success.

The key driver of the growth of inland fishery was private entrepreneurship. The growth of private entrepreneurship was possible as the returns from agriculture were very low with high transaction costs, while culture fishery with high transaction costs also gave high returns. At present, fish farmers have moved on to fresh water prawn aquaculture, which has higher transaction costs and is riskier. The upward spiral of entrepreneurship, with each new enterprise having more transaction costs than the other, from agriculture to inland fishery to aquaculture, characterizes the entrepreneurship of the region. Having charted a new growth sector through a process of 'community or collective entrepreneurship of stakeholders over years, the intervention faces critical issues of sustainability, both economic and ecological, primarily because of the emergence over years of a large heterogenous/amorphous group of shareholders in the water resource ecosystem. Conflicts over water emerged in the summer of 2003 in the spread effect area near Eluru, with agriculturists and fish entrepreneurs fighting over the limited water in irrigation canals. The agriculturists perceived the fish entrepreneurs as water guzzlers, who deprived the farmer of their rightful share of water. Thus, the future of culture fisheries is fraught with conflicts within Kolleru and in the spread effect areas. The emergence and strengthening of the new and old multiple property rights regimes with corresponding multiple economies have resulted in the lake area being reduced, its hydrological processes interfered with, and the regional ecosystem tampered with. The very survival of the lake and consequently the culture fisheries is now at stake.

Opportunism with Guile? Aquaculture Revolution in Haryana

Harsh Vivek[1]

Haryana has been ruling the roost in aquaculture revolution with manifold increase in inland fish production and per annum per hectare fish productivity. With a per hectare per annum fish productivity of around 4500 kg, Haryana today stands next only to Punjab in inland aquaculture productivity. This exploratory study investigates the current status of inland fishing in Haryana and the factors that have been the driving forces behind the stellar performance of aquaculture in this state.

Much of the development in aquaculture in Haryana has been attributed to the advancements made in the fields of technology, rearing practices, and the interventions made by the government through its departments and fishing development agencies like FFDA. However, as this study reveals, behind the success of fishing as a preferred livelihood option lies strong institutional environment at the macro-level and especially institutional arrangements at the micro-level. These institutional arrangements have spurted from the entrepreneurial acumen of fish-farmers, who have devised newer and innovative ways of reducing the uncertainty and costs involved in the business and safeguarded their long-term extended payoffs. Several case studies of fish-farmers in villages of Rohtak and Faridabad highlight the fact that opportunism has been at the very core of several institutional arrangements at the grass-roots level, however, such opportunism and the motive of profits also trigger investments in fishing, improvements and creation of assets, and experiments in devising better and more efficient practices.

In villages in Rohtak, several experiments have been tried by entrepreneurial fish-farmers to take advantage of the opportunities in fishing by carefully managing the stakeholders, especially the village panchayat and FFDA officials. Even if the fish-farmer has to make certain payments to the panchayat and the FFDA to circumvent certain rules and regulations, he does it because he is ready to take risks for reaping higher returns in the future. A few such instances are cited below:

- In Maina village in Rohtak, a fish-farmer operating on two perennial common property ponds, upon sensing opportunity for maximizing his pay-offs paid a consideration to the panchayat to get the two seasonal ponds (informally) leased much below the minimum reserved price set by the FFDA. The seasonal ponds were being run and managed by the village panchayat and were a good example of "tragedy of commons". However, with private entrepreneurship, even these seasonal ponds are registering good fish production adding to the pay-offs of the fish-farmer. There is a clear incentive diffusion in such an institutional arrangement between the entrepreneurial fish-farmer and the panchayat members, which makes it natural and lasting and also ensures compliance.

- In Mandnaka village in Faridabad, a fish-farmer, driven by his own sheer motive of profits, was successful in getting the reserved price reduced for two common property ponds during auctions. By doing so, he was able to pay the lease rent for the entire 10-year period, and in turn was able to save for himself the 25 percent increment in lease-rent every three years if lease-rent was paid annually. By bearing a cost of Rs. 2000 as bargaining and contract-making cost, he was able to assure for himself a pay-off of around Rs.45000 extended over a 10-year period.

- On similar lines, a farmer in Dubalo village in Faridabad, unable to secure a loan for excavation of pond in his own farmland, did not hesitate to pay a small consideration to the FFDA to vouch for his creditworthiness. The FFDA did not argue this farmer's case with bank officials out of any altruism, but to make some easy money in the

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transaction. It was again a case of sheer motive of profit that got the transaction through, but, as an end-result, fish production got a boost by the setting-up of a private fishpond in this farmer's land.

There is an inherent instrumentality of the exchange partners in the institutional arrangements between the different stakeholders in the transaction. In other words, the institutional arrangement's primary concern is with the transacting parties and not other players in the institutional environment. For instance, in the above cases, both the fish-farmer and the FFDA stand to gain from the transaction, and the inherent "opportunism" on part of both the players gets the deal through despite the risk of repercussions in the future.

• Unlike villages in Faridabad, common property ponds in most villages in Rohtak get perennial water supply from irrigation canals. However, farmers have to be statutorily charged commercial water rates at Rs. 100 per 2500 cusecs. But, it is not uncommon to find arrangements (albeit illegal and unethical) between fish-farmers and officials in the irrigation departments to charge the bulk (rather than commercial) water rate at Rs. 40 per 2500 cusecs, which is also the rate applicable for irrigation. It was reported by a fish-farmer that upon consideration of 20 percent of the water-bill, the lower rates would be charged. The fish-farmer agreed and his effective water rate became Rs.48 (Rs.40 + 0.2 x 40), thereby effecting a saving of Rs.52 per 2500 cusecs.

There is a clear benefit for the fish-farmer to get the water rates reduced, and even the irrigation official stands to gain personally by striking this deal, even though the society may stand to lose. This commonisation of costs and privatization of profits is at the core of many such institutional arrangements, which have emerged out of the unbridled pursuits of profits and maximization of long-term pay-offs by entrepreneurial fish-farmers.

Owing to the open-auction system, the fish-farmer, in most cases, is an outsider in the village, and many in the village have a feeling that he impinges upon the common rights of the village community over common assets of the village for his personal profits. Such feelings are especially high when the fish-farmer wins the contract after defeating a bidder from the village whose common property was put on auction. A fish-farmer, who has won the lease of a pond in Bhagwatepur village in Rohtak after defeating a bidder from the native village, reported such an instance. He does not belong to Bhagwatepur village; rather he is a native of Kasar village in Jhajjar district of Haryana. He has to significantly bear costs in maintaining goodwill in the village so that he can carry on with his business without the risk of breach of contractual agreements that the panchayat has done with him on behalf of the village community.

What is striking is the absence of cooperative societies in fisheries primarily because Haryana as a state has never had a strong history of cooperatives. Fishing here has been developed as an allied activity of agriculture, and just as agriculture is an all-out private activity (done on privately-owned or leased farms and not collectively on community farms), the same is true for fisheries. Here the preferred mode is to undertake fishing as an entrepreneurial activity - whether on private or leased ponds - and there is no initiative on the part of fish-farmers to form cooperatives and practice fishing collectively. This has implications for transaction costs, and the fish-farmers, given the high costs of collective decision-making, do not prefer to form cooperatives for fishing. The FFDA too does not feel any such need, as it is able to meet its mandate of development of fisheries through the existing system of open-auction to fish-farmers.

It comes out clearly from the study that private entrepreneurship has been the driving force behind the growth and development of inland fishing in Haryana. Despite the institutional environment being deliberately created by the government through regulations and legislations, most of the institutional arrangements at the micro-level have emerged on their own without any deliberate attempt on the part of the government or the village authorities, but out of the sheer innovative acumen of the enterprising fish-farmer. It does not come as a surprise that there exists an institutional similarity in fisheries across different villages in Haryana. With the

development of social capital, informal institutional arrangements no longer remain confined to just one village; rather many fish-farmers in different villages, faced with similar issues of transaction costs and risks of transaction failures, resort to similar institutional arrangements.

The entire gamut of institutional arrangements point to the fact that private entrepreneurship, in its quest for profits and long-term pay-offs, has devised innovative means of reducing transaction costs in the activity, installed effective institutional arrangements that check perverse incentive diffusion, induce investments in the enterprise, and take the activity to higher levels of production and productivity. Many would argue that the institutional arrangements discussed in the report do not pass the test of ethics. However, this being an exploratory study just explores what exists on the ground, and discusses it in the context of transaction costs and pay-offs. Commenting upon the ethics or morality of any such institutional arrangement is beyond the scope of this study.

PONDS AND TANK MANAGEMENT BY FISHERY COOPERATIVES: ANALYSIS FOR CHHATTISGARH

Dinesh K Marothia[1]

In the state of Chhattisgarh, fisheries cooperative societies (FCSs) have been assigned usufruct rights to use common ponds and tanks for culture fisheries, subject to certain socio-economic and administrative conditions. This study provides an overview of the governance structure of culture fisheries in ponds and tanks in the state and to discuss outcomes of an in-depth analysis of five fish cooperative societies (FCSs), which cover different categories of ponds and tanks administered under different property rights regimes. Out of five FCSs, four are located Boriya Khurd, Barbanda, Serikhedi, and Kura villages of Dharsiwa block of Raipur district and one is located in Raipur city. All the four FCSs functioning in the rural areas have usufruct rights over village water bodies whereas the FCS located in Raipur town is basically engaged in leasing in urban water bodies. The State Department of Water Resources Development has the ownership over the Boriya Khurd Irrigation Tank (BKIT) and Serikhedi Irrigation Tank (SIT), while the fishing rights under the three tier panchayat institutions have been assigned to Boriya Khrud and Serikhedi primary fisheries cooperative societies respectively. Both tanks are canal fed and the minimum water level required for fish culture is available throughout the year. However, there is restriction on adding manure and fertilizer as feed input for the fish culture. Also these tanks are multipurpose in nature, since water is provided for irrigation of kharif paddy and one irrigation of rabi crops. The Serikhedi FCS leased in a village common pond constructed by an ex-zamidar and the village panchayat has ownership over this pond. The Kura FCS leased in 29 common pool village ponds. Out of these ponds, 8 perennial and 7 seasonal ponds have been effectively used for fish culture. For nursery hatching, two seasonal tanks have been used. Remaining 12 tanks have not been used for fish production owing to inadequate water availability. The Kura FCS has been given usufruct rights for fish culture in these common water bodies. The Barbanda FCS has leased in five tanks for fish culture. Three tanks were constructed by the soil and water conservation (SWC) wing of the State Department of Agriculture and handed over to the village panchayat for management. The three tanks and two other tanks constructed by ex-zamidars have been leased out by the panchayat to the Barbanda FCS. Tanks constructed by SWC get water from canals and are perennial. The other two village tanks are also perennial in nature. The Matwa *talab* is rainfed and the Dev *talab* is canalfed. All five tanks have multiple uses.

The Mahamaipara FCS is a basically an urban fish cooperative society and has leased in two tanks which were constructed almost 300 years ago by the Gond kings for meeting water requirement of the local people. These tanks are located in the heart of Raipur city. The Raipur Municipal Corporation has ownership of these tanks. Both tanks are multi-purpose and multi-functional in nature and water quality is regularly monitored by Chhattisgarh Pollution Control Board.

An institutional framework was applied to analyze the strength and weakness of cooperative governance structures . The institutional framework has assessed physical and technical attribute of tanks and ponds, characteristics of fishermen community in relation to other stakeholders using common water bodies, external and internal institutional arrangements, impact and outcome (in terms of fish catch, input use pattern, disposable pattern and distributive gains).

The key findings of the questionnaire survey are summarized here. In terms of objectives, social structure of members, membership criteria, management system, and external institutional

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support, all the five FCSs have more or less similar pattern. Differences can be seen with respect to membership fees, working capital, assets, lease period and rents, and differences basically associated with ownership, size, and water spread area of the ponds and tanks leased in by a particular FCS. Decision making mechanisms are more or less similar with all societies working under the cooperative governance structure. Members of FCSs derive benefits jointly from the resource as all operations of fish culture are collectively managed by members of the FCSs at a specific time period. Fishermen contribute to each others welfare through reciprocity which eventually leads to collective action. The decision making arrangements deal with operational rules, collective choices and external arrangement and their relationship with FCSs, state department of fisheries, and panchayat. Owing to well defined institutional rules and their effective implementation by FCSs, free riding behavior is not seen among fishermen. Effective interrelationship of pond and tank attributes, fishermen community characteristics, decision making arrangement, and pattern of interaction provided economic and equitable outcome for fisheries cooperative in terms of fish production, income and employment, rational disposable pattern and equitable distribution of benefits, and effective enforcement of working rules by FCSs.

It may be inferred from the analysis of FCSs that further research on understanding of institutional hierarchy in terms of property rights, entitlement systems and mechanism for adjusting common pool water resource allocation is needed for promoting freshwater aquaculture in the state. Further research is also needed in Chhattisgarh, eastern India and north eastern states to understand nature of property rights structures, institutional arrangements and governance pattern of ponds and tanks and possibilities to transfer ownership of some of these multipurpose common pool resources, on experimental basis for five years, to fisheries cooperatives or contractors or other agencies. An *ex ante* analysis of such transactions in governance structures may be studied for formulating sustainable institutions to promote and enhance productivity of common pool water bodies.

7. Tank Rehabilitation Experience of Two Decades

R. Sakthivadivel

[iwmi-tata@cgiar.org]

24th February 2005

16:30 – 18:30

Session Chair: Madar Samad

IWMI-Tata researchers have been recording strange things happening to tanks and their relationship with their users. In Eastern India, where millions of tanksfar more than in Southern India--dot the landscape, their condition and socio-ecological role has been neglected by researchers and policy makers alike. ITP has just begun a study of tanks in eastern India. But in the meanwhile, in Haryana, ITP researchers have come across farmers converting otherwise productive agricultural fields into small tanks for culture fishery. In parts of Gujarat where tanks were never known to be a major irrigation tradition, tank-like structures have come up in thousands during the past decade to recharge aquifers. In eastern Rajasthan, Rajendra Singh's johad movement has pitch-forked small tanks to the centre-stage of semi-arid livelihood systems. And in South India, researchers find users of irrigation tanks converting them into percolation tanks by sealing their sluices.

Against this changing dynamic, we have large donor and government-supported tank rehabilitation programs that are designed to restore decrepit tanks to their centuries-old role: of flow-irrigating paddy fields. ITP's two year-long researchwhich intensively studied 40 rehabilitated tanksfound that one reason why rehabilitation is not working is that the socio-ecological context of tanks today is different. However, it also concluded that the approach adopted to rehabilitate tanks offers scope for improvement. The session concludes ITP's tank-research in southern India by offering a superior protocol for rehabilitation programs.

Author(s)	Paper	
P. Gomathynayagam	Two Decades of Tank Rehabilitation in India: Evaluating Sustainability of Rehabilitation	Ext. Abstract
J. D. Sophia and B. Anuradha	Two Decades of Tank Rehabilitation in India: Livelihood Options and Gender Related Issues	Ext. Abstract
A. B. S. Raj and D. Sundaresan	Declining Trend in Tank Irrigated Area: Is there a Way to Arrest?	Ext. Abstract
K. Sivasubramaniam, R. Sakthivadivel and A. Vaidyanathan	Farm Level Land and Water Productivity in Tank Irrigation	Paper only
R. Sakthivadivel	Two Decades of Tank Rehabilitation in India: Investment, Institutional and Policy Issues	Ext. Abstract

TWO DECADES OF TANK REHABILITATION IN INDIA: EVALUATING SUSTAINABILITY OF REHABILITATION

Dr. P. Gomathinayagam[1]

India's water resources potential and its agricultural economy hinge around monsoon rains and its spatial and temporal variations. To attenuate temporal variability of rainfall, India had followed from time immemorial, a policy of conserving rainwater for subsequent use through innumerable tanks and small storage structures like ponds, built, owned and managed by the local people through community organizations. Tank systems provided insulation from recurring droughts and floods and vagaries of monsoon, and provided the livelihood security to the poor. The tank is recognized as having at least four different functions in irrigated agriculture - water conservation, soil conservation, flood control and protection of ecology of surrounding area. Behind these existing indigenous systems of irrigation, there are thousands of years of tradition. This system gradually collapsed from invasions and changes introduced by the British in the administration.

After Independence, the canal irrigation was developed in a massive way including in tank irrigated areas. Most of the public investment in irrigation has gone to major and medium canal irrigation and development of groundwater. While the area under irrigation increased substantially after the beginning of the five year plans at the rate of more than one million hectares per year, the percentage of irrigated area under tank to total irrigated area showed a steady decline. Realizing the importance of tanks, south Indian states have started rehabilitating the tanks in the mid 1980s under state funds and with external assistance.

The European Economic Community [now European Union], NABARD and World Bank provided financial assistance for tank rehabilitation in the southern states with their own models. Besides this, the governments of Tamilnadu and Karnataka carried out repairs to tanks from their own funds either directly or with support from NGOs. There are NGOs who had rehabilitated tanks through contribution from tank users and other donor agencies without getting any funds from the government. However, many administrators and policymakers consider that tanks are in a vicious cycle of "poor maintenance - decline in condition - rehabilitation - poor maintenance". On the other hand, there are others who argue that tank rehabilitation is a must around which livelihood options of the rural poor are to be built in view of the multiple uses of tank water.

Under the IWMI-Tata Water Policy Programme an explorative study was made in the states of Tamilnadu, Karnataka and Pondicherry to make an evaluation of rehabilitation implemented by different agencies and to find out what components of rehabilitation are cost effective, sustainable, and have a bigger impact on the rural poor. Purposive sampling technique was used to select 40 rehabilitated tanks under different models from the rehabilitated tanks. The study relied on both secondary data obtained from official and village records and information from field visits. The field study made use of participatory rural appraisal techniques, focus group discussions, and structured and unstructured interviews. A methodology of scoring the factors that contribute to the sustainability was developed and used. This paper looks at the sustainability of rehabilitation and the factors that contribute to the sustainability from the findings of this study.

Findings of the study

The investments often depended on the objective of tank rehabilitation. The EEC project had the objective to increase food production and rural income by achieving higher cropping intensity

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through improved water management and reduced losses. The focus is clearly conserving storage and improving command area water use. Physical works like reconstruction of weirs, sluices, and lining of water distribution channels took the lion's share in investment.

NABARD funded projects were conceived on the EEC model with modernization of structures, constitution of tank water user's association and farmers' involvement from the planning stage. Farmers' contribution to rehabilitation cost was not stipulated, but formation of tank user group was stipulated. The implementation is through contractors.

The Tank Rehabilitation Project-Pondicherry (TRPP), with aid from the European Union (EEC) had the objective of preserving agricultural incomes from irrigated crop production, diminishing reliance on underground water resources, and halting the process of salinization of the aquifers. Here also, implementation of the project was through contractors.

World Bank, under WRCP in Tamil Nadu, increased the allocation to bund strengthening. Though earth was removed from tank bed for strengthening, it was not uniform desilting that left pockets of depressions. Institutional strengthening was not considered. In this project also farmers were not required to contribute a share to rehabilitation cost.

During this period two NGOs demonstrated a different mode of rehabilitation. The IYD, an NGO in Karnataka, helped villagers get fund from CAPART only after they started contributing their share of 25%. PALMYRA, an NGO working in Pondicherry and Tamilnadu, worked in the same way. If farmers were prepared to pay 30 percent of the cost for any rehabilitation component, that work was carried out. The works provided livelihood options to the poor in the both cases.

The World Bank funded Karnataka tank rehabilitation project encompassed all these learnings. Tanks are viewed as multiple use structures; the investment pattern has changed accordingly and cost per ha has increased. The tank users group with all villagers as members shared the rehabilitation cost to the tune of 25%. This project brought back the tank as a common property of the village.

From this study, we found that the sustainability of rehabilitation depends mainly on the institutional sustainability and the sustainability of physical works. If livelihood options for the poor are made a component in the rehabilitation project (as made by JSYS and NGOs), people show keen interest in the upkeep and management of the tank system. As the sustainability of rehabilitation depends on the availability of water to the tank, most farmers want cleaning of feeder channels to be taken up first. The next choice is desilting of the tank. After making suitable provisions of augmenting supply and increasing storage capacity, the focus should be on providing livelihood to all including landless during off-season and during the dry periods.

TWO DECADES OF TANK REHABILITATION IN INDIA: LIVELIHOOD OPTIONS AND GENDER RELATED ISSUES

J. D. Sophia[1] and B. Anuradha[2]

Though tanks are the oldest sources of irrigation in India, many have fallen into disuse and are dysfunctional. There is a continuous decline in the tank irrigated area and a neglect of the maintenance and upkeep of the tank system. Realizing the importance of tanks, the south Indian states have started rehabilitating the tanks in mid 1980s. More than 5000 tanks out of 80,000 tanks in the States of Tamil Nadu, Karnataka, and Pondicherry have been under rehabilitation with different level of success and failures. Rehabilitation work has been carried out by the States and NGOs with funding from EEC, NABARD, and World Bank. These projects initially had the objective of increasing the agricultural productivity of tank water and later on, focus was shifted to poverty alleviation.

A research study under the IWMI-TataWater Policy Program was undertaken to assess the physical, institutional, and livelihood sustainability of the tanks rehabilitated over the past decades. Purposive sampling technique was used to select 40 rehabilitated tanks under different models from the rehabilitated tanks in three states. The study relied on both secondary data obtained from official records and information from the field visits.

The field study made use of participatory rural appraisal techniques, focus group discussions, and structured and unstructured interviews. Detailed field investigation was carried out to look at the extent to which tank rehabilitation has helped the marginal farmers and landless poor to improve their livelihood options and gender related issues in tank rehabilitation.

Among the households in these 40 villages, 51 percent are landless and 35 percent are marginal who operate lands less than one hectare. Thus the majority households are predominantly marginal farmers and landless. Statistically, rainfed tanks receive full storage only in two years out of ten. They get half filled in three years and less than one-third filled in three years. They go dry in the remaining two years. With this precarious condition, marginal farmers have to work in other's fields to earn their livelihood in the years of less rainfall and deficit inflow to the tanks. In the years of poor storage, farmers have to switch over to rainfed dry crops. These crops are less labour intensive. Most of the landowners use their household members and do not employ outsiders. Under this situation, the option before landless and other marginal farmers is to migrate to nearby urban areas to earn a living. All able bodied male and female members go out like this. But the old and children remain in the villages. Generally, those who remain earn their livelihood through cattle grazing, poultry rearing, collecting fuel wood, etc. This opportunity is not always available to all. If lands are kept fallow in succession, fodder and water may not be available, resulting in distress sale of cattle. Because of the tanks not getting filled regularly, maintenance works of the tank systems is poor resulting in reduction of tank flow. The entire economic activities of the community are thus decided by whether the tank gets filled or not.

The tank rehabilitation projects in the beginning focused mainly to benefit the farmers and were implemented by contractors. Even in this type of rehabilitation, the poor and landless received some benefits during rehabilitation with increased number of workdays as spin-off effect. In the tanks where rehabilitation works were implemented by the local community with stakeholders' participation, the local landless and the poor were employed to work in the project and earned wages. This provided the livelihood during progress of works.

Most of people said that rehabilitation components that will bring water to the tank like

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feeder channel cleaning and tank desilting are the most beneficial. Increase in water availability increased the intensity of agriculture, brought changes in cropping pattern and increased agriculture production. More water availability led to more biomass production, which provided opportunities for livestock rearing especially, the small ruminants. This resulted in more milk production and regular income to households.

In most of the study areas, the poor are allowed to cut juliflora [wild tree] grown on tank bunds for fuelwood purposes and also earn an income by selling them. Increase in the groundwater table through recharge is another important impact of tank rehabilitation. In some tanks, wells in and around 10-15 villages get recharged due to tank rehabilitation that not only supplement tank irrigation but provided drinking water also to these villages.

During the last decade there has been an increased awareness on micro-finance through self help groups (SHGs). These SHGs have not only brought out the poor women from the debt trap but also have gradually grown into a social capital, empowering women and building confidence among them. SHGs are not only involved in savings but are engaged in income generating activities. Tank rehabilitation projects in future should ensure more active role for women stakeholders through SHGs. In the past, women were strategically excluded by stipulating landholding criteria. But the Pondicherry project provides a dual membership for each household that empowers women as stakeholders. This is a better proposition as many men migrate out for work while women stay back at the village . In Karnataka, the JSYS project includes all villagers especially, the vulnerable groups, in the rehabilitation process.

To conclude, in tank rehabilitation, augmentation of tank water and increasing tank storage have a marked impact on the livelihood options of the landless and marginal farmers. Involvement of SHGs in rehabilitation and providing funds for income generating activity has had a marked effect on the livelihood of marginal farmers, landless and women. Moreover when all the villagers are made members of the Tank Users Group (TUG), all are benefited in one way or the other and such tanks are likely to be more sustainable.

DECLINING TREND IN TANK IRRIGATED AREA: IS THERE A WAY TO ARREST?

A.B.S. Raj[1] & D. Sundaresan[2]

Three-fourth of average annual water availability from rainfall in India is concentrated during the monsoon months of June to September. This necessitates creation of facilities to hold the rainwater for use at a later date. A reliable estimate of the number of tanks and ponds existing in different states is not known; the reported number varies anywhere between 200,000 and 350,000. The shape and size of each tank seems to have been determined by the terrain. Over flow of one-tank moves into another tank in the downstream and so on up to sea or drain. Building and maintaining such an extensive system and sharing the waters need extraordinary social and managerial skills. In the past, tanks were common property resources and the center of socioeconomic activities of villages.

After Independence, canal irrigation was developed in a massive way including in tank irrigated areas. Water resources development has been carried out through successive five-year plans since 1951. Millions of rupees were invested in major, medium, and minor irrigation systems with extensive canal network. The government, even under planning, did not give due attention or resources to keep the tanks in good repair. Area under irrigation increased substantially after the five year plans at the rate of more than one million hectares per year. In percentage terms tank irrigated areas showed a steady decline. There are many reasons attributed for the decline in tank irrigated areas: [a] construction of large canal systems has led to the displacement of traditional tank systems; [b] groundwater exploitation got a lift in the form of heavily subsided electric and diesel pumping and availability of institutional finance. This resulted in financially better off farmers to go in for well irrigation in the tank command. [c] Decline in the traditional local institutional arrangements for the maintenance and management of tank systems.

Some of these observations were based on isolated studies and some based on official statistics. The official statistics on tanks is perplexing and each government organization has its own data on tanks.

While South Indian tanks are known for their antiquity and were created essentially as a source of supplementary irrigation during monsoon season, innumerable small water holding structures called ponds have been in existence in many north Indian states and even constructed after independence for multiple uses including irrigated agriculture. For example, Marothia quotes that more than 10,000 ponds have been constructed in Madhya Pradesh (now Chattisgarh) for rearing fish under the Fish Farmers Development Program(FFDA) with World Bank assistance during the 1970s and 80s (Marothia, 1992). Although these ponds are primarily meant for inland fresh water aquaculture, water from them is used for irrigated agriculture, livestock, and domestic consumption. The multiple uses of these ponds makes management of fish rearing difficult, mainly because of the common property rights regime. The institutional setup also varies from place to place depending upon how effectively the common property rights are converted into a private property regime.

Under the IWMI-Tata Water Policy Program, a study was undertaken to investigate the reasons for continuous decline in tank irrigated area over the last five decades and to identify possible ameliorative measures to arrest such decline and stabilize tank irrigated area. Rapid appraisal studies were undertaken in nearly 100 tanks in the states of Tamil Nadu, Karnataka, Andhra Pradesh, and Pondicherry while in-depth studies were conducted in four tanks located in the Palar basin of Tamil Nadu. The study indicates that the

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main reason for decline in irrigated areas is decreasing flow to tanks which is because of the decreasing trend in rainfall pattern, encroachment of supply channels and tank bed, unplanned catchment development, sand mining of supply channels, and absence of institutional arrangement to maintain and manage the tanks. The decreased inflow coupled with focus on groundwater development, improvement in technology with regard to locating well sites, improvement in drilling and abstraction devices and techniques, easy institutional credit, and availability of free and/or cheap electricity supply has spurred the ground water development in the recent decades and well irrigated areas have replaced tank irrigated areas. In the context of present scarcity of water supply to tanks, wells have assumed a greater role in providing the additional water needed for crops and make the tank irrigation more productive and profitable to farmers. Conjunctive use of rain water, tank water, and well water has become a necessity for the survival of tank irrigation and is being extensively practiced in some tanks taken up for studies. All these factors have contributed to replacement of tank irrigated areas with well irrigation.

Presently, tank rehabilitation is considered as panacea to arrest the decline and revive tank irrigated areas. The paper argues that selection of physical components of tank rehabilitation should be based on the hydrological endowment of a tank and conjunctive use rather than the conventional methods of identifying the tank as the sole source of water supply to irrigated agriculture. Based on hydrological endowment, a classification procedure for identifying appropriate physical rehabilitation components is presented. By implementing such a procedure, it is possible to improve the production and profitability of tank irrigation and thereby arrest the declining trend in the tank irrigated area; this strategy seems to work in a number of tanks.

Two Decades of Tank Rehabilitation in India: Investment, Institutional, and Policy Issues

R.Sakthivadivel[1]

Over the last two decades, more than 5000 tanks out of 80,000 tanks in Tamil Nadu, Karnataka, and Pondicherry have been under rehabilitation with different levels of success and failures. These rehabilitation works have been carried out by the states and NGOs with funding from agencies such as EEC, NABARD and World Bank. In this process, the agency which funds the project imposes its policies which has a bearing on the models used for rehabilitation. No systematic analysis and evaluation of performance have been hitherto undertaken.

A study under IWMI-Tata Water Policy Program (ITP) was initiated to evaluate the impact of rehabilitation on their sustainability and options provided for the livelihoods of the rural poor. A total of 40 sample tanks from among the 5000 rehabilitated tanks were selected and a detailed analysis was carried out. Based on this study, the guidelines for change in the investment pattern and institutional and policy related changes for future rehabilitation projects are presented.

The present investment strategy is heavily loaded toward physical rehabilitation and very little towards institutional development, and maintenance and management.

It is recommended that the rehabilitation budget be allocated in the ratio of 10, 75 and 15 percent to institutional development, physical works, and maintenance, respectively. The institutional component should be implemented through a well-trained NGO and continue to provide assistance for at least five years from the start of the rehabilitation work. Adequate funds must be provided for linking tank user groups to market and knowledge centers for improving gross tank product of rehabilitated projects through capacity building and training. The physical component should be implemented by the tank user group (TUG), which should be made responsible for decision-making regarding components to be rehabilitated, implementation, maintenance and management.

The maintenance and management component will be provided as a corpus fund, the interest of which can be withdrawn only if a matching amount is mobilized by farmers in terms of labor or cash or both. The budget provided for physical rehabilitation will have two levels: a base level which can be drawn without any matching contribution from tank user groups and a supplementary level for which tank user groups contribution is a must. A higher level of contribution from the tank user group will fetch more government grant for physical rehabilitation of tank work. The base level budget should be used to remove encroachment, provide requisite dead storage through desilting and to provide livelihood options for the landless and marginal farmers. The present time allocation for various activities of tank rehabilitation is not adequate and the thrust is only on completion of physical works. The tank user groups are given training during the fag end of the project. But they have to be trained in the beginning and continued training throughout the rehabilitation period should be provided.

Each tank is unique in terms of its physical, hydrological, institutional, socio-economic and cultural parameters. As a result, tank rehabilitation components and requirement for its effective functioning differ from tank to tank. Adopting uniform norms and following a blueprint approach leads to wastage of money and dead investment. For example, there is no point in rehabilitating and increasing the width of a surplus weir which has not surplused over the last 10 years. Local people who have been using the tank for years together are the best judges to say what is to be rehabilitated and how that can be done to get the maximum benefit out of it. They need to

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be consulted and they must be allowed to make decisions and their decisions must be implemented through them with their contribution to rehabilitation cost sharing. Components to be rehabilitated and budget for different components and timing of completion must be flexible to meet the requirement of tank users. Rehabilitation components aiding augmentation of tank water and improved storage of water to cater to the needs of the summer season and to recharge the groundwater should be given preference over others.

Providing livelihood to all including landless during off season and during the dry periods should form part of rehabilitation. Some options are:

- Allow the landless / self help groups to plant fruit bearing trees / herb cultivation / flower cultivation / vegetable cultivation in the tank puramboke and foreshore. The planter should tend the plants and the revenue from usufructs will be shared at 20 percent to the tank user groups and 80 percent to the planter.
- Allow the removal of soil for brick making by leasing earmarked areas in the tank bed. Tank user groups can charge nominal fee for each cartload.
- Allow fish rearing to group of landless or fishermen in the village.
- Allow the self help groups to grow and cut fodder grasses from the tank bund.
- Dig a community well to be owned and operated by the tank user groups to encourage conjunctive use.

In view of multiple uses of tank and its appurtenant structures, all village community including landless must be made members of the tank user groups. Involvement of two members from a household (1 man + 1 woman) in tank user groups as practiced in Pondicherry State is recommended as many men migrate out for work while women stay in the village to take care of the family, livestock and agriculture. Through training given by self help groups; these women should be made effective to participate in tank user group's activities.

There are too many agencies having control over different components of tank system. One way to circumvent this is to lease the tank water spread area and the tank to the tank user groups on a long term basis and vest with it the responsibility of upkeep. On the government side, a plethora of agencies interfering with tank management should be dispensed with and one agency must be made in charge of the tank system.

A regulatory body for small water holding structures including tanks is to be established at district level to provide needed assistance to maintain and manage these structures and to monitor and safeguard these structures from encroachment, pollution and their misuse. A good database comprising all the past studies made by various organizations on tanks and ponds is to be created and made available to all who need them. Similarly, an authentic database on tanks, ponds, and *ooranies*, percolation ponds on the lines of erstwhile tank memoirs has to be created under a special drive.

8. System of Rice Intensification (SRI)

Assessing the Prospects

Jayesh Talati and Shekhar Sinha

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24th and 25th February 2005

16:30 – 18:30; 8:30 – 10:00

Session Chair: Norman Uphoff

Developed first in Madagascar, the System of Rice Intensification (SRI) has a lot going for it; claims are that it reduces water use in rice cultivation by 25-50% and raises rice yields commonly by 25-100 percent but according to some scientists by 3-4 fold!!! PRADAN, an ITP partner, has got some hundred poor farmers in Purulia, West Bengal to experiment with SRI, and feels strongly encouraged by results over two successive years. If these claims are true, SRI can act as a broad-spectrum medicine against many ills that bewitch Indian agriculture, including poverty, low productivity, water scarcity.

But claims about SRI's benefits are questioned by many, including scientists from IRRI, world's leader in rice research.

These claims and counter claims obfuscate the discussion on SRI. Can it really revolutionize rice cultivation in South Asia? IWMI-Tata partners bring new evidence from field studies; and **Norman Uphoff**, SRI's best-known protagonist, leads the ITP discussion on the promise of the magical technology from Madagascar. Several senior Indian scientists share their research results and experiences with SRI.

Author(s)	Paper	
Shekhar Kumar Sinha and Jayesh Talati	Impact of SRI on Rice Yields: Results of a New Sample Study in Purulia District, India	Highlight
T. M. Thiyagarajan and S. Jothimani	Optimum Water, Grain Yield and N-use Efficiency of Rice under SRI: Synthesis of Results from Tamil Nadu	Highlight
T. M. Thiyagarajan *et al.*	SRI for Enhanced Water and Rice Productivity in Tamil Nadu	Ext. Abstract
A. R. Pathak, N. P. Bhuva and Atul M. Mehta	Performance of Rice Genotypes under Different Establishment Methods	Ext. Abstract
C. Shambu Prasad and P. K. Basu	Understanding Scientific Controversies: The case of SRI	Highlight
P. Punna Rao and A. Satyanarayana	Producing More Rice With Less Water: Farmers, Researchers and Extensionists' Experiences with SRI in Andhra Pradesh	Ext. Abstract
Regassa E. Namara, Parakrama Weligamage and Randolph Barker	Prospects for adopting System of Rice Intensification in Sri Lanka: A Socioeconomic Assessment	Ext. Abstract

System of Rice Intensification for Enhanced Water and Rice Productivity in Tamil Nadu, India.

T.M. Thiyagarajan[1], K. Senthilkumar[2], R. Priyadarshini[1], K. Ezhilrani[1], S. Jothimani[1], P.M.M. David[1], J. Sundarsingh[1], A. Muthusankaranarayanan[1], Huib Hengsdijk[3], Prem S. Bindraban[3]

Rice cultivation in Tamil Nadu consumes 70 per cent of water available for agriculture and hence economizing water use in rice production has become important. The System of Rice Intensification (SRI) offers much scope in that direction.

Five experiments were conducted in a sequence to (i) understand the principles of SRI, (ii) study the effects of SRI components, (iii) develop a SRI package for farmer practice, iv) test the effect of the developed SRI package in large plots, and (v) evaluate the SRI package in farmers' fields. To suit the handling of younger seedlings, the method of nursery bed preparation was altered. Additionally, two experiments were conducted to better understand pest interaction and the effect of polymer coated urea.

Results of experiment 1 showed that grain yields were low using plant density of 16 m-2 or less. This suggests wide spacing is not suitable but a plant density of 32 m-2 could result in yields equal to conventional (50m-2) spacing.

Four SRI components were considered in experiment 2: seedling age, irrigation, weed management and green manure application. This showed a significant yield increase because of the use of a weeder and non-significant effects for differences in seedling age, irrigation and nutrient management. Grain yields with alternately submerged-non-submerged irrigation were similar to yields realised with conventional irrigation while on average 53 per cent less irrigation water was used.

Results of experiment 3 showed no interaction between the factors but confirmed the statistically significant yield increase owing to weeder use. Direct seeding also resulted in significantly higher yields. Continuation of alternately submerged-non-submerged irrigation up to maturity significantly reduced the yield indicating that water was limiting production during the grain filling period. The highest water productivity (kg m-3) was obtained for 24 day old seedlings and alternately submerged-non-submerged irrigation in experiment 2 (0.732) and experiment 3 (0.871). In these treatments water productivity increased by 84 and 96 per cent respectively, compared to conventional flooded irrigation.

Confirmation of results on water saving with SRI cultivation methods prompted submission of a policy note to the government of Tamil Nadu suggesting the possibility of reduced water use for rice cultivation. The state government sanctioned Rs.25,00,000 to conduct adaptive research trials (experiment 5) in two major rice-growing areas of the State, one of which was the Tamiraparani basin in southern Tamil Nadu.

The results of the on-farm evaluation showed that grain yields recorded under SRI and conventional cultivation ranged from 4214 to 10655 kg ha-1 (STDEV : 1379) and from 3887 to 8730 (STDEV : 1108) kg ha-1, respectively. The mean grain yields for SRI and conventional cultivation were 7227 and 5657 kg ha-1 respectively, showing an overall yield advantage of 1570 kg ha-1 for SRI-derived practices. Nearly 31 farmers recorded grain yields of more than 8 t ha-1 under SRI. The maximum yield advantage recorded for SRI was 4036 kg ha-1 (70%).

The Tamil Nadu Agricultural University has recommended SRI as a techonolgy to increase rice productivity and save irrigation water. The results of SRI evaluation through experiment 5 drew the attention of extension officers of the state department of agriculture. They laid out demonstration trials in all the rice areas of the state during the 2004 rice season which helped in spreading SRI methods to farmers. Farmer to

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farmer spread is also taking place.

Research on SRI has continued to generate more information for refining it. Experiment 6 and experiment 7 concerned studies on pest and N management in relation to SRI. The pest studies experiment 6 were carried out as farmers wanted to know the impact of wider spacing and less standing water in the field on crop protection aspects. The experiment 7 with polymer-coated urea (PCU) was carried out because of its higher N use efficiency and hence wanted to assess its effect in combination with SRI.

A combination of management options using younger seedlings, square planting of single seedlings with wider spacing, using a rotary weeder in between hills to incorporate the weeds and disturb the soil, and limited irrigation could promote the growth of rice crop and increase its productivity. Irrigation water use would go down by 30 to 50 per cent Nutrient use efficiency also increases. The technology is now being disseminated to farmers of Tamil Nadu.

PERFORMANCE OF RICE GENOTYPES UNDER DIFFERENT ESTABLISHMENT METHODS

A. R. Pathak[1], N. P. Bhuva[2] and A. M. Mehta[3]

India is the second largest rice producing country next to China in the world, but ranks first in area. Water is an important natural resource which is becoming scarcer because of population pressure and inefficiency of the developed water infrastructures. This warrants an urgent need to study the water use efficiency in agriculture, especially in rice being a water hungry crop. In the context, concerted efforts are being made all over the world to increase water productivity besides increasing labour productivity and profitability of lowland rice cultivation.

Generally, farmers follow a traditional method of rice cultivation where they transplant 25-30 days age old seedlings in puddled fields and the fields are kept flooded throughout the crop period. The System of Rice Intensification (SRI) is an alternative to the existing practices where fields are kept wet and not flooded with water. This system seems to be promising to overcome the shortage of water in irrigated rice. SRI appears to be a viable alternate for rice cultivation that saves expensive inputs, improves soil health and optimizes water use efficiency. The practices of SRI are helpful in improving soil quality and soil biodiversity. It appears to be an environment friendly approach of rice cultivation.

SRI was developed in Madagascar in the early 1980s by a French priest. SRI involves use of certain management practices which together provide better growing conditions for rice plants, particularly in the root zone. Four "novel" practices worth a mention are key practices in SRI: (i) seedlings are transplanted early in unpuddled conditions, (ii) seedlings are transplanted singly, (iii) seedlings are widely spaced, and (iv) moist but unflooded soil conditions are maintained till panicle initiation stage.

The ultimate effect of SRI techniques is reflected in considerably higher grain yield. The concept of SRI is still evolving and therefore needs to be evaluated further and refined to suit local environments. Keeping the foregoing discussion in view, an experiment on the evaluation of different crop establishment methods including SRI was laid out at Main Rice Research Station, Anand Agricultural University, Nawagam, during Kharif 2004 with the following objectives:

(i) Identify the sustainability of different crop establishment methods for increasing the yield in transplanted rice

(ii) Identify the cultivars for the SRI method of rice cultivation.

The experiment was arranged in split-plot design replicated thrice with main plot treatments as three varieties viz; KRH-2, Krishnahansa and GR-11, and sub-plot treatments as five cultivation methods viz; S1 Standard practices of transplanting, S2 Systems of rice intensification method (SRI), S3 Integrated crop management (ICM), S4 Direct seeding with drum seeder, and S5 Farmers practice of random transplanting.

The results revealed significant differences in grain and straw yield. The variety KRH-2 was found significantly superior as it produced the highest grain (6575 kg./ha.) and straw (5959 kg./ha.) yield than the rest of the varieties. Further, significant differences in grain and straw yield were also observed because of different sowing methods. The standard practice of transplanting produced significantly higher grain yield of 5840 kg/ha which was found at par with SRI (5813 kg/ha.) and ICM method (5721 kg/ha.). In the case of straw yield, the standard method of transplanting produced 5754 kg/ha which was found to be at par with that in SRI. Although significant grain yield (kg/ha) differences were not observed amongst establishment methods S1, S2 and S3, a net saving

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of 46% of irrigation water was realized in SRI. On the basis of a one-year study, although standard transplanting practice produced significantly higher grain and straw yield, it was statistically found on par with SRI and ICM practices. It further appears that SRI method of cultivation uses 46% less water compared to traditional/normal method of cultivation. However, this needs further study.

PRODUCING MORE RICE WITH LESS WATER: FARMERS, RESEARCHERS AND EXTENSIONISTS' EXPERIENCES AND IMPRESSIONS WITH SYSTEM OF RICE INTENSIFICATION (SRI) IN ANDHRA PRADESH

P.Punna Rao[1] and A.Satyanarayana[2]

Scarcity of water in agricultural production is becoming a major problem in India. In many areas, rainfall is becoming unreliable, with extremes of drought or floods occurring at unexpected times. Water saving, therefore, is a high priority for rice production in the years ahead because irrigated rice production is the leading consumer of water in the agricultural sector. Finding ways to reduce the demand for water to grow irrigated rice should benefit both producers and consumers.

The System of Rice Intensification (SRI) is a methodology for increasing the productivity of irrigated rice by changing the management of plant, soil, water and nutrients. This methodology which is based on agro-ecological principles with good scientific foundations is of interest because of its potential to achieve higher yields at lower costs of production along with saving of water. SRI is a set of principles (use of young seedlings, careful transplanting, planting at wider spacing of 25 X 25cm, weed management, water management- keeping field only wet, not flooded and organic manures) for enhancing plant growth performance.

SRI was introduced in Andhra Pradesh during kharif 2003 which was given wide publicity with a slogan "Produce More Paddy with Less Inputs" to exploit its potential to double rice productivity with less inputs particularly water. Farmers were informed before the season about the skills needed by organizing on-farm demonstrations (0.4 ha each) across all 22 rural districts. With a view to understand the performance of SRI in the context of farmers' realities, a systematic study was undertaken i) to find out the experiences of SRI farmers with respect to advantages over the conventional system and difficulties encountered ii) to obtain impressions of neighboring farmers, researchers and extensionists and iii) to suggest strategies for popularization of SRI. The study was carried out by contacting 291 respondents (SRI farmers (67), neighboring farmers (71), researchers (77) and extensionsists (76). The key findings of our study are reported below.

SRI farmers reported that their rice plants were healthier with extensive root growth and resistant to pests and diseases and no longer needed chemical pesticides. Farmers observed that Sheath blight and BPH incidence were low under SRI environment. Only a seed rate of 5 Kg/ha was followed as against 50 Kg/ha in the conventional method. Because of alternate wetting and drying of the Rice fields, nearly half of the water was saved, making it possible to double the area under irrigation in the state using the same quantity of water. An average yield advantage of over 2t/ha was reported. With reduced seed rate, water saving and reduced pest load leading to reduced expenditure with high yields, SRI farmers realized higher benefits.

However SRI farmers faced the difficulties in operating rotary weeder and complained that it did not work well. Transplanting young seedlings and water management were also the problem areas reported by them.

Neighboring farmers, researchers and extensionists were impressed by less seed rate, less water, more root volume, more tillers, more grain / panicle, less pest incidence and high yield in SRI. They also felt that farmers needed special education on transplanting young seedlings, weeder operation and water management.

The study helped in identifying areas where owner farmers, practicing farmers and laborers needed skill upgradation like, on raised bed nursery, transplanting young seedlings, weeder operation and water management. Strategies like awareness building using electronic media, field demonstrations, skill upgradation on identified

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areas and bringing out publications on SRI, particularly the manuals in local language were, suggested for SRI promotion.

Farmers not only learnt the SRI management practices, but also adopted and realized high yields with reduced seed, water and chemicals. Improvements in SRI that are continually being made including better implements and techniques, in addition to farmers innovations needs to be encouraged and considered to further improve upon.

The experiences of SRI farmers and impressions of other stake holders show the vast potential of SRI in the region.

PROSPECTS FOR ADOPTING SYSTEM OF RICE INTENSIFICATION IN SRI LANKA: A SOCIOECONOMIC ASSESSMENT

Regassa E. Namara, Parakrama Weligamage and Randolph Barker[1]

These days the demand for water resources is becoming intense as a result of population pressure, competitions among different uses and users, and the inefficiencies of the developed water infrastructures. As agriculture currently consumes the bulk of the available water resources, the efficiency and productivity of water use in this sector may contribute to the relaxation of the demand for water. The System of Rice Intensification (SRI) first developed in Madagascar and now being tested in many countries, is an example of an on-farm water productivity enhancing approach. The system is based largely on organic farming principles and additional requirements for the timing of transplanting and spacing of seedlings, and irrigation scheduling.

SRI recently generated interest and discussions among researchers, development practitioners and policymakers in Sri Lanka. This has often resulted in polarized views. Some proponents claim that SRI will revolutionize the method of rice production, while others see it as a fad. Studies in Africa, Asia and Latin America provide mixed results. But most of these studies are anecdotal in nature or are limited to experimental and demonstration activities. Only one other study that we are aware of (conducted in Madagascar) applies an appropriate methodology that would assess the farmers' experience. This study contributes to filling this research gap based on Sri Lankan farmers' experience. The study specifically assesses the adoption pattern, economics and the poverty outreach of the SRI, and draws research, extension and policy implications.

The data for the study were obtained from focus group interviews and structured questionnaire surveys conducted in Ratnapura and Kurunegala districts of Sri Lanka. The sample farmers were selected using a two stage stratified random sampling design. The total sample size was 120 farmers, 60 from each of the two study locations, and from each location 30 each, from SRI and non-SRI farmers. The resulting data were analyzed using descriptive statistics, econometrics of qualitative dependent variables, enterprise budgeting, and indicator based poverty assessment tools.

There was a wide variation in the way that farmers practiced the SRI, with the majority of the adopters using the methodology on only a portion of their farms. However, as found in other studies, many farmers disadopted after a season or two largely because of heavy labor requirements (about 3 times more than that for conventional rice cultivation), owing mainly to transplanting, weeding, bund construction and cleaning, and organic fertilizer collection and transportation. Among nonusers, 87.5 percent reported having heard about the SRI, mostly from other farmers, and, of these, only 25.4 percent confirmed that they intend to practice SRI. Consistent with the practicing farmers' observations, the non-adopters reported that the major obstacle to the adoption of SRI was the high labor demand and the tedious nature of the associated management practices, such as transplanting and manual weeding.

The determinants of adoption of SRI were identified using logistic regression analysis. Labor availability, years of schooling, access to training programs, farm or field location, and the poverty status of the household were the main determinants. Households with a large family size and greater labor availability were more likely to adopt SRI, which reflects SRI's higher demand for labor. There was no significant difference in the SRI adoption probability between farmers situated at the head of the irrigation canal and rain-fed farmers. On the other hand, farmers at the middle and tail of irrigation systems are less likely to adopt SRI than rain-fed and head farmers. For rain-fed farmers, the opportunity to minimize cash costs from weather risks was an incentive for

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the adoption of SRI. In a parallel analysis of determinants of disadoption of SRI, average realized yield during the first season(s) of adoption and poverty group membership were statistically significant variables. One of the controversies surrounding SRI is whether it is suitable for adoption by poorer households. The analysis showed that the rich and poor farmers were equally likely to practice SRI, though for different reasons. The rich are more educated and more inclined to experiment with new methods; the poor have more urgent need to raise the productivity of their limited land and their relatively more abundant labor. Their net benefit per hectare was somewhat less than for richer farmers. Once they adopted SRI, the poor were more likely to continue using it.

SRI farmers in Sri Lanka reported a yield increase of 44 percent, which is lower than that reported by many other countries. Returns to crop budgets were higher even when charging a relatively high rate for labor. The cost of production per hectare was not lowered with the SRI methods. However, given that production significantly increased, the cost of production per unit of paddy output was considerably lower. Consequently, the estimated average profits for SRI was almost double that of the conventional practice. But not all farmers registered positive profit figures. Some had net losses. The incidence of losses among the SRI farmers was substantially lower than that for conventional rice cultivators. The reduction in inorganic fertilizer and other agrochemical use under SRI are environmental benefits, which only a few farmers appreciate, or are concerned with. But these societal benefits could justify public efforts to support the spread of SRI.

Thus we conclude that the SRI, like its closely related practices, such as organic farming, ecological farming, and low-input sustainable agriculture, is a niche production method. Without widespread adoption, there is little, if any, water saving at a system or basin level. The main avenues for making SRI more viable for rice farmers in Sri Lanka are: (1) improving the efficiency of or mechanizing the transplanting and weeding operations; (2) research into an alternative source or method of soil fertility management; and (3) improving the reliability of irrigation supply. Whether or not to pursue these avenues and promote SRI remains an open question. However, this study will provide policymakers with a realistic appraisal of the potentials and limitations of SRI in Sri Lanka. Hopefully, it will stimulate further systematic research efforts to assess the potential benefits and limitations of SRI adoption in diverse climatic and socioeconomic environments.

9. India's Water Future 2025/2050

Shilp Verma and Sanjiv Phansalkar

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25th February 2005

10:30 – 13:00; 14:00 – 15:30

Session Chair: Frank Rijsberman

India has hotly debated a US $ 120 billion dollar mega river-linking project that will help make India water-secure in 2050. Just what will India look like in 2050? How much water will it use, where and for what?

In a 3-year research program beginning 2005, IWMI aims to promote a balanced, analytical national discourse on India's water future 2050, and approaches to shaping it, including through the proposed mega project. As a precursor, IWMI-Tata Program presents a clutch of studies towards a refined, textured and nuanced understanding of India's water challenge.

Frank Rijsberman, IWMI's Director General, brings in a global perspective on how best can nations brace up to face water scarcity.

Author(s)	Paper	
Shilp Verma and S.J. Phansalkar	India Inc. 2050: Potential Deviations from 'Business-As-Usual'	Comment
Tushaar Shah	Nature of India's Water Economy	Presentation Only
A. D. Mohile	National Water Policies of India: Need for Interventions and Reforms	Ext. Abstract
A. Mahmood and A. Kundu	India's Demography in 2050: Size, Structure and Habitat	Ext. Abstract
S.J. Phansalkar, P. Deshpande and Vivek Kher	Expanding Rings of Dryness around Indian Cities: Shall Crisis alone Drive the Policy?	Ext. Abstract
S.J. Phansalkar and S. Verma	Water Intensity of Rural Livelihoods in 2050	Highlight
M. Gayathri Devi and C. Scott	Wastewater Use in Urban and Peri-urban Agriculture: Generating Livelihoods and New Management Challenges	Ext. Abstract
U. Amarasinghe, B. R. Sharma, N. Aloysius, C. Scott, V. Smakhtin, C. de Fraiture, A. K. Sinha and A. K. Shukla	Spatial Variation in Water Supply and Demand across River Basins of India: PODIUM Results for 2025 and 2050	Ext. Abstract
Frank Rijsberman	Water Future Projections: Global Experiences, Key Issues and Concerns	Presentation Only

National Water Policies of India: The need for Interventions and Reforms

A.D. Mohile[1]

The paper aims at analyzing on one hand the Indian water situation, present and future, and, on the other, the present policies and programs of the union government. This comparison, leads to some suggestions for interventions in the Indian water sector. These interventions covering three closely related aspects, water related laws, water-related institutions and the system of water policies.

The National Water Resource Council, in 1987, finalized the National water policy. This was further revised in 2002. This document represented the consensus in regard to the various policy issues after considering the opinions of the States. In order to arrive at such a consensus, this policy document is occasionally vague, and does not elaborate the various strategies, which would have to be used. Some important shortcomings resulting from this process are:

It does not provide for the creation of enabled and regular basin authorities, with stakeholder participation.

- There are no guidelines regarding water allocation amongst states.
- Water policies do not reflect new economic policies, and do not spell out strategies on privatization in the various activities of the water sector.
- It does not deal with water rights of the final users of water.
- Although the policy recognizes "water" as a single resource, it does not indicate actions for full integration of surface and groundwater use in assessments, allocations, planning development and management, beyond the conjunctive use in canal commands.

In regard to legal reforms, the study concludes that Constitutional reforms are not required. It recommends enactment of legislation by the Parliament to enable the Union to more effectively manage interstate river valleys. This includes the empowerment in regard to the approval of development plans, collection of information, overseeing water management, creating empowered basin authorities, approving and converting interested agreements into enforceable instruments, dam safety certification, and decisions about surplus water availability. It also recommends the establishment of a new and just regime of water rights, in which it would become clear that water is a "negative community", and that the water rights are usufruct, are revisable, and need to be delegated from the state to users.

In regard to institutional reforms, it recommends a legal support for the National Water Resources Council and reforming the Ministry of Water Resources and the Central Water Commission to enable consolidation of various water related concerns and disciplines; as also the reforming of the National Committees related to water. It recommends a reformed institutional mechanism to settle water-related discords, by integrating the processes of mediation, arbitration and adjudication To facilitate this process and to build expertise, a permanent or standing water disputes tribunal, has been suggested .It indicates that the various discipline-wise National Committees be broad based, towards professional autonomy.

In regard to water assessments, it recommends that the precipitation be considered as the main water resource, (rather than considering the river and aquifer flows as the water resource). Management of evaporation can then become an important additional strategy. Also, proper water accounts, indicating, inter-alia, the use by the 'nature', 'food' and 'people' sectors would become possible and give a more meaningful information. Both the nature sector and the agriculture sector seem to involve some water use, which does not

1 Former Chair, Central Water Commission

result in any significant goods and services. This could be reduced through evaporation management

Apart from these basic and conceptual interventions, it recommends other important interventions. These include the reconsideration of food security in the changing world trade regime, clarifying and elaborating the role of the private sector in water management, considering and adjusting water policies to the likely changes in the role of the Government, detailing the policy in regard to water shed management etc .The paper indicates that there is a need to involve the private sector in a large way, in some fields such as hydropower, distribution of domestic water, development of urban water sources, etc .In regard to irrigation, a limited role in secondary and tertiary distribution of public supplies may be beneficial.

The paper recommends the need to consider use-wise water allocation and integrating the priority for the core domestic demand with the concepts planning since irrigation may be an important option both for increasing the 'carrying capacity' of high density low rainfall area and alleviating poverty of the rural population in such area. The study indicates that if the cereal farm households have to improve their incomes, large crop diversification would be essential. In this context the provision of the National Water Policy (2002) regarding water zoning needs elaboration. Different strategies related to agriculture and irrigation needs to be prescribed for different zones, with deferring water availability and population densitie

INDIA'S DEMOGRAPHY IN 2050: SIZE, STRUCTURE AND HABITAT

Aslam Mahmood[1], Amitabh Kundu[2]

Success of a developmental planning effort in meeting certain projected requirements of people will depend, among other things, on the accuracy of population projections. Water, which until recently was taken almost as a free gift of nature to human society along with many other natural resources, is increasingly becoming scarce. Population explosion of recent times and its concentration in a few large conurbations is posing tremendous pressure on available water resources.

Like in many developing countries, size and growth of population in India was not alarming until the first quarter of the last century. Even up to the second quarter, the problem had not acquired any serious proportions. It was only during the third quarter of the last century that population and its growth started being viewed as a problem causing serious resource constraints. Population stabilization has thus emerged as a major agenda, particularly in the context of acute pressure on agricultural resources and urban facilities.

A review of projection exercises in India reveals that the figures vary extensively depending on the developmental parameters incorporated in their models. Importantly, the National Commission for Integrated Water Resources Development (1999) has taken estimates given by Visaria and Visaria (1996) as the "high variant" (1581.00 million) and those of the United Nations (1995) as the "low variant" (1345.90). These have then been used for making future estimates of food requirement for the growing population in the country.

The two projections, providing the basis for the analysis undertaken by the Commission, suffer from two major deficiencies: (a) these were made prior to 2001 and therefore did not have the benefit of the recent Census data with regard to the size and composition of population, its age structure, geographical distribution etc. and (b) the projections had not given due consideration to the impact of the HIV/AIDS on the expectancy of life and other demographic parameters.

The present paper tries to fill in this gap by making fresh population projections by incorporating the trends patterns noted in Census of India 2001. Also, it takes into consideration the impact of HIV/AIDS on the future estimates of mortality. For making these projections for

Population Projection of India : 2001-2051

Year	High Variant		Low Variant	
	Total	Urban	Total	Urban
2001	1019.72	286.40	1,019.72	286.39
2006	1101.48	302.91	1,096.21	301.45
2011	1180.38	354.12	1,167.64	350.43
2016	1270.92	413.04	1,249.64	404.88
2021	1360.91	476.32	1,330.08	459.06
2026	1440.76	561.90	1,400.54	528.93
2031	1504.24	586.65	1,455.64	540.83
2036	1569.52	635.66	1,504.96	573.14
2041	1626.96	683.32	1,549.92	602.77
2046	1685.15	733.04	1,594.09	630.06
2051	1731.92	779.37	1,621.23	650.45

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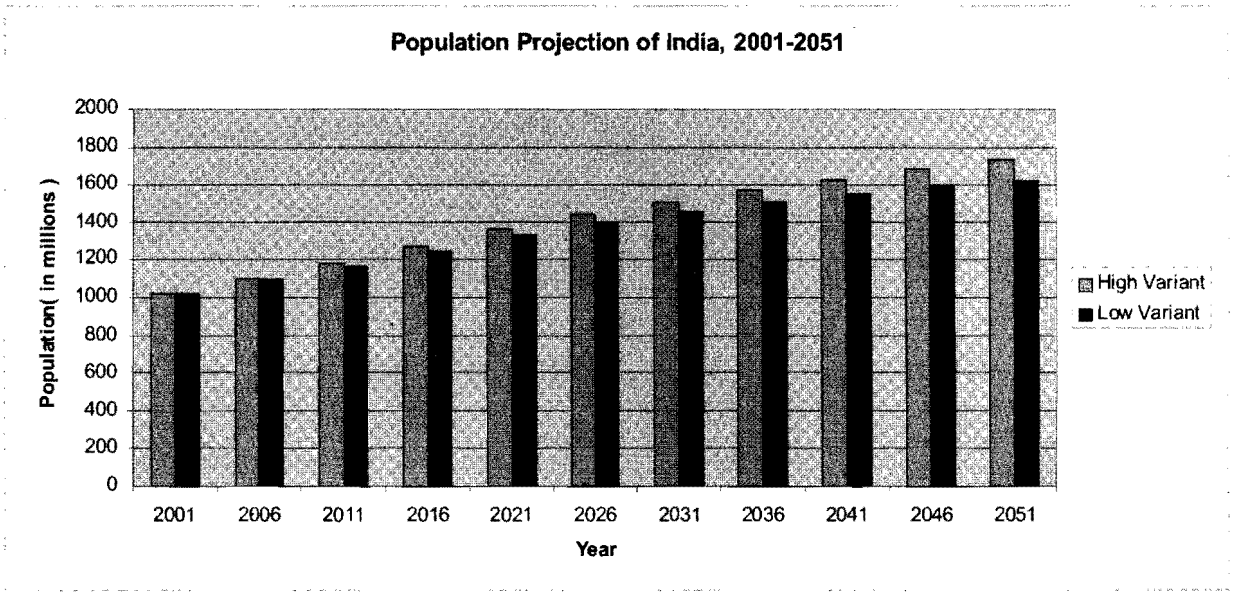
quinquennial periods - from 2001 to 2051 - Cohort Component method has been used.

Revised Population Projections for India 2001 -2051

Based on the results of a UN study on the estimated effect of HIV/AIDS on the life expectancy, the projected course of mortality in India has been modified to account for the effect of HIV/AIDS, using the UN model South Asian life table. For projecting fertility, regression line fitted to the TFR figures from 1982 onwards has been used. Average values of TFR, as given by regression estimates, have been taken as the low variant of fertility and the upper limit of the confidence interval of the regression estimate as the high variant. Using the age structure of population, as given by the Census of India 2001,and applying the projected values of fertility and mortality, the projected population estimate for India have been obtained. The population figures have then been divided into urban and rural components, by making assumptions about the future course of urbanization also. The projected total population of India along with its urban component is given in the table.

It is interesting that the projected population in the country shows a continuous increase over the next twenty five years as the population is expected to rise from the present figure of 1028.61 million to 1440.76 in 2026, as per the high variant. By the low variant, the figure is expected to go up to 1400.54 million. It may be noted that after 2026, the growth rate of population reports a significant decline. Indian population would continue to rise during the second quarter as well reaching 1731.92 million and 1621.23 million by the high and the low variants respectively in 2051. As per the high variant, the increase in population during the first quarter is expected to be in the order of 421.04 million. In the subsequent 25 year period, the increment would be only 291.16 millions, about two third of the figure of the first quarter. As per the low variant, incremental population would be 380.84 million and 220.69 millions respectively.



EXPANDING RINGS OF DRYNESS AROUND INDIAN CITIES: SHALL CRISIS ALONE DRIVE THE POLICY?

Sanjiv Phansalkar[1], Pradyumna Deshpande and Vivek Kher

Domestic and municipal water requirements account for less than 10 percent of the total fresh water requirements. And yet, most water crises emerge from a shortfall in meeting this demand. The media and civil society are also more responsive and alert on issues of drinking water scarcity. Water from irrigation dams is routinely "diverted" for meeting domestic and municipal demand. Most states are considering legal solutions for getting a measure of control on allocating groundwater in favor of drinking water use. Literally billions are spent in paying for water tankers that carry water to urban and rural populations.

All this apart, most water resource planners tend to ignore or undermine the importance of this demand since, in terms of billion cubic meters (BCM), this demand is miniscule compared to the huge demands in irrigation. however, with several projections indicating that by 2050, between 45 and 60 percent of India's population will live in cities, the need to focus attention on growing domestic water requirements is imminent. The situation is most likely to be more critical in peninsular India, which is already water-starved.

A recent ITP study in six A-class cities found that in three of them (Jaipur, Ahmedabad and Chennai), the contribution of groundwater towards meeting the domestic and municipal water requirements ranged between 72 and 99 percent. Several of these cities also have a thriving tanker water economy, supplying anywhere between 14 and 55 MLD [total volume in the six cities equals 166 MLD] with annual revenues ranging between Rs. 11 and 100 crores. This informal water economy depends entirely on groundwater extraction from peri-urban areas and, in the absence of any regulation, has led to the emergence of well-fields all over the cities' periphery.

This paper looks at the domestic water situation in four cities Nagpur, Coimbatore, Aurangabad, and Solapur in peninsular India and explores the following issues: [1] at what pace and to what extent groundwater resources of surrounding areas are being exhausted; [2] what are the drivers of this process; [3] what are the costs to the exchequer, to the consumers, and indirectly to surrounding areas; and [4] how are the people in peri-urban areas coping with the phenomenon.

The speed at which the ring of dryness expands around a city can be hypothesized as a function of the population of the city, local hydrology, availability of surface sources of water in/near cities, and the extent of development and reliability of the municipal water supply system. Data was gathered by: [1] carrying out extensive discussions with the municipal water supply authorities in the four cities; [2] conducting a survey among the private water vendors in the cities; [3] conducting a survey among the owners of the water sources from which the private water vendors pump water; and [4] discussing with the people living close to these water sources to see how water being taken to cities affects them.

Urbanization is a continuing phenomenon. The boundaries of the cities have expanded to include the surrounding rural areas, in some cases as much as up to 15 km. In all these cities this rural land was previously under regular cultivation. This is the expansion of the ring of urbanization. The problem of "unauthorized layouts" (that is, housing areas not accorded sanction by the municipal authorities and hence not provided with amenities such as water supply) increases in direct proportion to the growing urbanization. Also, the topographical constraints have been often ignored for the sake of urbanization, new housing schemes coming up on top of hills or highlands. This trend has direct negative influence over

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municipal water supply network. Here lies the opportunity for private tanker trade to prosper. Deficit rains have also contributed to the growth of private tankers. Around Solapur city, almost all the cultivators sold water from their borewells during 2000 and 2003 instead of growing crops. Private tankers now are indispensable for obtaining water to a large number of residents in the municipal area in all study cities except Nagpur. Groundwater depletion is very rapid everywhere. Although Solapur presents the only instance of groundwater exhaustion in wells and borewells, new borewells have appeared rapidly in last five years in Nagpur and Aurangabad. Boring is as lucrative as private tanker trade. Running private tankers is free of any legal formalities. Growing demand due to urbanization and lacunae in municipal water supply have created intense competition since last 5 years. In all cities, except Nagpur, the private tanker owners have increased by about 25 percent. Profits of tanker operators have multiplied several times.

We find that municipal authorities in Nagpur (Pench), Aurangabad (Jayakwadi) and Solapur (Ujani), get water from dams located in their hinterlands for urban water supply. The main reason for private trade of water is the inability of the municipal authorities to keep pace in developing supply infrastructure with the cities' growth. By design, the cities take water originally stored in these dams for farming and by default the cities take water from aquifers in surrounding areas causing lands to remain uncultivated.

There is nothing inherently wrong in these developments. The town and the country are inherently intertwined and water happens to be another item of exchange between the two. We, however, need to project ahead and see what would happen thirty or forty years down the line. These four cities represent instances of well established, old cities which had significant and at times remarkably good urban infrastructure. A large number of rapidly growing urban agglomerates perhaps have no established water supply infrastructure at all. In such locales, the phenomenon of private provisioning will proceed grossly unchecked. Since drinking water is a non-negotiable human requirement, severe stress anywhere on this front has, as it should, always spurred decisive action on the part of the state for mitigating disasters. The trouble is most often this action tends to be knee-jerk and hurried. As a result, huge expenses are involved. Funnily, the stress occurs every year and each year sees knee-jerk reactions. There of course are instances where the expenses in hiring tankers for water supply are undertaken by municipal authorities purely as a patronage dispensation mechanism. In a case currently pending in the Nagpur High Court, the municipal authorities as good as admitted this and agreed to reduce the expenditure on tankers by 80 percent in a year.

This would require larger and more planned investments in water infrastructure for cities. There is a serious cause to examine if inter-basin transfers of water for meeting urban needs are not really required to be planned on much higher priority. The Narmada drinking water pipeline project in Gujarat is perhaps only the first of several similar initiatives India will need by 2050.

WASTEWATER USE IN URBAN AND PERI-URBAN AGRICULTURE: GENERATING LIVELIHOODS AND NEW MANAGEMENT CHALLENGES

M. Gayathri Devi[1] and Christopher Scott[2]

Rapid urbanization places immense pressure on the world's fragile and dwindling fresh water resources and over-burdened sanitation systems, leading to environmental degradation. In this context wastewater is a resource of increasing global importance, particularly in urban and peri-urban agriculture. According to reports, at least 20 million ha in 50 countries are irrigated with raw or partially treated wastewater. Wastewater is used in various forms for irrigation: untreated, partially treated, and diluted. Very little information is available on area irrigated with wastewater at national and global level, which is essential for policy-makers to make realistic policies. Hence, before a global assessment of the extent of wastewater use is done, a common understanding on different types of wastewater use is essential. Wim van der Hoek of IWMI proposes a typology for wastewater use that categorizes wastewater use into three types: direct use of untreated wastewater where wastewater is directly applied to land from a sewerage system; direct use of treated wastewater where treated wastewater is directed to a particular area for irrigation; indirect use of wastewater where wastewater is taken from another receiving water body like pond, lake, canal, tank, or river.

Wastewater is used in crop production which includes fodder, vegetables, cereals like maize and rice, ornamental plants, nurseries, cotton, mulberry, coconut, banana, horticultural crops like sapota, citrus, mango, timber crops like teak, flowers like jasmine, crosandra, hibiscus, chrysanthemums etc; urban forestry which includes avenue trees, trees in parks and conservation and plantation zones, industrial estates and institutional areas; and aquaculture.

The various reasons that drive farmers to use wastewater for irrigation are: it is the only source of irrigation available; it is nutrient rich and hence farmers can save on fertilizer costs; it is highly reliable and available round the year. The positive side of wastewater use for irrigation is that it generates livelihoods for farmers, agricultural labourers, transporters of produce, market brokers, and vendors of the produce. Consumers are also benefited as they get fresh and cheap produce because of low transportation costs. It saves freshwater which would otherwise be used for irrigation and it recycles nutrients. But it has negative implications for human health and environment. In most developing countries wastewater used for irrigation is inadequately treated. WHO/UNICEF estimates the median percentage of wastewater which receives effective treatment to be 35 percent in Asia, 14 percent in Latin America and the Caribbean, 90 percent in North America, and 66 percent in Europe. Agricultural use of untreated wastewater poses various kinds of health problems depending on the kind of product produced. The most common health problems associated with consumption of wastewater-irrigated produce include cholera, typhoid, faecal bacterial diseases, bacterial diarrhoea and dysentery. Studies in Faislabad and Haroonabad in Pakistan showed that agricultural workers in wastewater-irrigated fields and consumers of wastewater-irrigated produce are five fold more likely to be infected by intestinal helminths. The contamination of the produce may not be limited at field level. It could take place anywhere between the point of production and the point of consumption. More research is necessary to determine the type and degree of health risk, the paths of contamination, and the likelihood of infection. In addition to the pathogen contamination of wastewater, illegal dumping of untreated industrial effluents in the wastewater channels is a common practice. Use of such contaminated water mainly with heavy metals like lead and cadmium pose grave problems for consumers of such produce. Cadmium and lead have been shown to accumulate in fodder grass, grains and green leafy

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vegetables. Cadmium accumulates in the kidneys of humans who ingest the plants and eventually causes kidney failure. Lead can have adverse effects on the nervous and reproductive system. Protective health measures can be taken at various levels and by various actors/stakeholders. Pay Drechsel and Ben Keraita of IWMI-Ghana and Ursula Blumenthal of London School of Tropical Medicine propose appropriate health-protection measures at farmer level, market level, and consumer level.

WHO's guidelines for wastewater use in agriculture, introduced in 1989, have been taken by most governments as the legal framework dictating safe use of wastewater for agriculture, even though they were not intended for absolute and direct application in every country. The present WHO guidelines, which recommend only treated wastewater for irrigation and impose crop restrictions do not take into consideration the economic and political realities of the developing countries, the high cost of treatment, and urban poverty of these countries. But the 1989 guidelines are currently being revised based on new data from epidemiological studies, quantitative microbial risk assessments and other relevant information in accordance with the Stockholm Framework. The Stockholm Framework encourages a flexible approach for setting up guidelines, which can be adapted by each country according to their social, cultural, economic and environmental conditions. WHO and other scientists have argued that the guidelines must be accompanied by other health promoting measures such as health education, hygiene promotion, provision of adequate drinking water, and sanitation.

Past experiences with wastewater reveal that importance of wastewater in agriculture is on the peripheral edges of public awareness and unclear to policy-makers and donors; the informal nature of wastewater irrigation tends to leave it in institutional no-man's land. The challenge is to identify practical, affordable safeguards that do not threaten the substantial livelihoods dependent on wastewater or diminish the important role this resource plays in achieving household food security and supplying low cost produce to growing cities while at the same time minimize health and environmental risks. In order to enhance the positive outcomes while minimizing the risks of wastewater use, Faruqui et al provide recommendations that are feasible and measures that need to be applied: cost-effective and appropriate treatment of wastewater; until treatment is possible, other measures should be taken such as increase farmer and public awareness of safe crops and irrigation practices, improve institutional coordination, increase security of land tenure, treat infections and invest in research to find solutions in above areas, and evaluate the feasibility and cost effectiveness of the above suggestions.

SPATIAL VARIATION IN WATER SUPPLY AND DEMAND ACROSS RIVER BASINS OF INDIA

Upali A. Amarasinghe, Bharat R. Sharma, Noel Aloysius, Christopher Scott, Vladimir Smakhtin, Charlotte de Fraiture, A. K. Sinha and A. K. Shukla

India is a large country with the per capita water supply and demand varying across regions. But a comprehensive assessment of water accounting across river basins is not available at present. Such an assessment is a timely exercise in the context of the increasing focus on integrated river basin management. This report assesses the water supply and demand across river basins of India, classifies river basins according to water scarcities and crop production surpluses or deficits, and discusses issues that are important for future water supply and demand projections.

India's land area can be divided into 19 major river basins. The per capita water resource availability of these basins varies from a low of 240 m3 in the Sabarmati basin to a high of 17,000 m3 in the Brahmaputra basin, while water withdrawals vary from a low of 243 m3 in the Meghna basin to 1,670 m3 in the Indus basin. Irrigation is by far the largest water user in all the basins. The basins of the westerly flowing rivers of the Kutch and Saurashtra regions of Gujarat, and the Luni riverhome to 6 percent of the Indian populationare classified as physically water-scarce and food-dependent. The second group of basins, the Indus and Pennar river basins, with 7 percent of India's population, are classified as physically water-scarce, but these basins have a significant food surplus. The grain surplus of the Indus basin alone is able to meet 85 percent of the grain demand from basins with grain production deficits. The water scarcity problems of the third group of 11 river basinshome to 75 percent of the Indian populationare mixed, but almost all have significant deficits in crop production. The fourth and fifth groups of river basins are classified as "non-water-scarce and food-sufficient" and "non-water-scarce and food-surplus," respectively. These last two groups of basins hold 12 percent of India's population.

Several factors could influence India's future water supply and demand. These include:

spatial variation and future growth of population, urbanization and income, and associated changes in dietary preferences, on the crop consumption side; growth in crop yield, cropping intensity and groundwater use, and contribution to production from rain-fed agriculture, on the crop production side; and future growth in other factors such as domestic, industrial and environmental water demand, and internal and international trade. These factors need to be carefully assessed in future water supply and demand projections.

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10. Watershed Development:

Strategies for Sustainable Scaling Up

Amrita Sharma

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25th February 2005

8:30 – 10:00; 11:00 – 13:00; 14:00 – 15:30

Session Chair: B. N. Yugandhar

The Common Minimum Program of the new Government at the Centre has placed renewed emphasis on the importance of watershed development for livelihoods generation as well as for regenerating the nation's land and water resources.

Science for doing this is largely in place. The challenge is institutional. We find small islands of excellence amidst an ocean of mediocrity in watershed development. In giving a new lease of life to the program, needed are institutional models of scaling up without losing quality and impact.

Harnessing lessons generated by some of India's outstanding watershed management projects. **B N Yugandhar**, the pioneer of Integrated Watershed Development Program, leads the ITP discussion.

The session runs in two parts: in part I, we present field studies and macro-assessments; in part II, architects of some India's best-known watershed projects share their experience and insight.

Author(s)	Paper	
	Part I: Perspectives from Research	
K. J. Joy, S. Paranjape, A. Shah, S. Badiger and S. Lele	Scaling Up of Watershed Development Projects in India : Learnings from the First Generation Projects	Ext. Abstract
Jetske Bouma, Daan van Soest and Erwin Bulte	How Sustainable is Participatory Watershed Development in India?	Paper Only
Amita Shah	Economic Rationale, Subsidy and Cost Sharing in Watershed Projects: Imperatives for Institutions and Market Development	Highlight
G. Anand Vadivelu	Choosing 'not' to Participate Evidence from Drought Prone Area Program (DPAP) in Chitradurga, Karnataka	Highlight
Amrita Sharma	Watershed Development Programs: Scaling Up without Loosing Quality and Impact	Highlight
Part II: Leaders of Some of India's Best-known Watershed Programs		
Al Fernandez	MYRADA's Experience with Scaling Up Watershed	Presentation
Crispino Lobo	WOTR's Experience in Scaling Up Watershed	Presentation
G. Sohani and B. Kakade	BAIF's Experience in Scaling Up Watershed	Presentation
Achyut Das	Agragamee's Experience in Scaling Up Watershed	Presentation

SCALING UP OF WATERSHED DEVELOPMENT PROJECTS IN INDIA: LEARNINGS FROM THE FIRST GENERATION PROJECTS

K. J. Joy[1], Suhas Paranjape[2], Amita Shah[3], Shrinivas Badiger[4] and Sharachchandra Lele[5]

The concept of integrated and participatory watershed development and management has emerged as the cornerstone of rural development in the dry and semi-arid regions of India. The country has made massive investments in this approach and even more ambitious plans have been made for the future. As we enter this second generation of watershed-based development programs with such heightened targets and expectations, it is important to ensure that the experiences from the first generation of widely implemented watershed development are fully understood and internalized.

The paper details the important and significant learnings from the 'first' generation watershed development experience. It takes the view that the interconnectedness of the biophysical and the social aspects is intrinsic to watershed development and the final outcome of any intervention is a combined effect of both. It also highlights some of the 'gaps' in policy, practice and research especially in relation to the biophysical aspects of watershed and watershed development.

Learnings from the First Generation Projects

The results of the first round of widespread implementation appear to be rather mixed. There is certainly evidence of positive impacts in terms of improved soil and water conservation and agricultural productivity in normal rainfall years in regions that have been ignored in the traditional green-revolution-based rural development. But on the other hand, several individual studies and reviews show that there are also likely to be serious limitations, even in the 'model', heavily funded and intensively managed programs. Some of these limitations are: [1] productivity gains are often limited and temporary; [2] landless and marginal farmers often benefit only marginally or not at all, increasing inequities within the village; [3] common lands do not get adequately treated, and revegetation does not take place as expected; [4] gains from recharge of groundwater are rapidly dissipated through increased withdrawal; [5] domestic, livestock and ecosystem water needs often do not get addressed, and may even suffer as a result of increased withdrawal; [6] downstream impacts of intensive upstream water conservation (and use) are not being considered; [7] costs at which the gains are achieved seem to be (relatively) rather high; and [8] people's participation is limited to the implementation stage; and [9] no building of institutions for long-term collective management of resources.

There are two basic reasons behind these shortfalls. One, there is often no clear normative framework as to what rural development is all about. At least for some practitioners, equity or sustainability concerns really do not figure in the concept. Two, even when these concerns are present, problems arise because the interaction between the biophysical and the socio-economic processes in watershed development is not understood and addressed in an integrated manner.

Sustainability of Biophysical Changes and its Relationship with Livelihoods: A Neglected Parameter

Watershed as a biophysical entity is an ecosystem comprising of all biophysical processes within the watershed and their interactions with the larger systems, and biophysical interventions constitute modifications of these processes. However, the very same interventions are also social processes.

Forum for Watershed Research and Policy Dialogue (SOPPECOM-GIDR-CISED)
1, 2 SOPPECOM: Society for Promoting People's Participation in Ecosystem Management
3 GIDR: Gujarat Institute of Development Research
4, 5 CISED: Centre for Interdisciplinary Studies in Environment and Development

Thus, the biophysical and social interventions are not two separate processes, but aspects of a single unified process and ecosystem processes and resources are basic economic resources as well, and watershed development has brought this unity to the forefront.

It may be argued that it is important to know the social context of intervention to understand fully how the ecosystem processes generate indirect impacts on different groups over different temporal and spatial scales, so that one can go beyond the immediate reaction that local communities might offer more to the direct benefit flows.

The spatial or locational inequalities, to a great extent, are also primarily because of the biophysical characteristics of the watershed itself. For example, in case of water, one's location in the watershed (upper reaches versus the valley portion) often determines one's access people who own land in the valley portion benefit most from the augmented resource. This issue of upstream-downstream difference is not limited to these differences within the watershed alone. It crops up as an issue between adjoining watersheds, between upstream and downstream communities, right up to those differences within the entire river basin itself. Given that the relationship is fundamentally asymmetric, that is, activities of upstream land owners or water users can affect downstream communities, but not vice-versa, the question of what constitutes fair or unfair behavior by upstream communities (or equitable allocation of resources or benefits between upstream and downstream communities) crops up immediately and needs to be carefully addressed at all scales: within the micro-watershed, across watersheds and across the entire basin.

Thus, watershed development cannot be seen only as a localized activity, though very often it is seen so, as it has basin-wide impacts. They are now showing up in decreased flows into downstream tanks and reservoirs. Drinking water is increasingly being met from deeper aquifers. However, many of these phenomena have not been adequately studied because there is a lack of sufficient awareness and sensitivity to these issues and there is also a lack of adequate data. There is also lack of proper water balance studies that would allow monitoring of the status of resources within a watershed.

The Gaps

The divergence between the official hopes and beliefs about watershed development and reality on the ground may be explained by four simultaneous gaps. The first is the conceptual gap - the fact that the normative framework within which watershed development is taken up is itself a narrow one. The second is the research gap - the fact that limited and poor quality research does not generate the kind of critical feedback that is required. Even the above insights that have emerged from some exceptional studies are somewhat indicative e.g., the conditions under which downstream impacts may be significant are not at all well understood. This prevents the formulation of clear-cut policy recommendations.

The third is an outreach gap - the fact that the critical findings or warning signals from rigorous studies are not reaching the policy-makers, donors and practitioners, or not reaching the wider public so as to bring pressure on these agencies to change their policies and practices. And finally, there is the monitoring capacity gap - the inability of practitioners themselves to identify and address some of these issues in the course of implementation. Ultimately, critiques of approaches and practices need not emerge from researchers alone; they should emerge from the field as well.

11. Which Water Counts?

Hydrology, Water Use and Water Economy in Narmada River Basin

M. Dinesh Kumar

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25th February 2005

10:30 – 13:00; 14:00 – 15:30

For decades now, Madhya Pradesh, Gujarat, Rajasthan and Maharashtra, the four riparian states sharing the Narmada basin have engaged in a legal battle for the sharing of the basin's water.

Since the Narmada Tribunal's 1979 award allocating the basin's surface water to the four feuding states, numerous changes throughout the basin - such as, increase in the area cropped, expansion of groundwater draft and surface water diversions for irrigation - have raised awkward questions about the sanctity of the Tribunal's formula. Run-off production in catchment areas has declined; so have surface water flows downstream.

A clutch of ITP studies assesses the challenge of managing the basin water economy by analyzing the productivity of water use in agriculture; water use hydrology and water accounts.

David Molden and **Hugh Turral**, IWMI principal researchers lead the discussion.

Author(s)	Paper	
M Dinesh Kumar and O. P. Singh	The Blue and Green Water Use and Productivity in Agriculture: Studies from Narmada River Basin, Madhya Pradesh, India	Highlight
O. P. Singh, M. Dinesh Kumar and S. Ghosh	Changing Water Use Hydrology of Narmada River Basin: Implications for Basin Water Allocation	Highlight
M. Dinesh Kumar, S. Ghosh, O. P. Singh, Rahul Ranade and R.Ravindranath	Changes in Groundwater Ecology and Its Implication for Surface Flows: Studies from Narmada River Basin, Madhya Pradesh, India	Highlight
Jayesh Talati, M. DineshKumar and R. Ravindranath	Local and Sub-basin Level Impact of Watershed Development Projects on Availability of Water in Narmada River Basin, Madhya Pradesh	Highlight
S. Ghosh, M. Dinesh Kumar and O. P. Singh	Water Accounts of Narmada River Basin: A Preliminary Analysis	Paper Only
Afroz Ahmad	Environmental and Social Impacts associated with Sardar Sarovar (Narmada) Water Resources Project, India: A Success Story of Conflict Resolution and Implementing Sustainable Development	Paper Only
P. Gomathinayagam, D. Sundaresan and J. D. Sophia	Water Productivity Potential in Tank Irrigation: A Comparison	Paper Only

12. Issues in Improving Water Supply Rural, Peri-Urban and Urban

K. V. Raju

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25th February 2005

8:30 – 10:00; 10:30 – 13:00; 14:00 – 15:30

Session Chair: S. S. Meenakshisundaram

During the process of economic growth, pressures towards urbanization create tensions between towns and hinterland for various natural resources. Water is often at the centre of the new emerging town-hinterland dynamic.

Planned investment in water infrastructure is often the best way of diffusing these tensions. Water supply systems - rural and urban - in many parts of India are retrogressing. What are the reasons? And what is the way out? Studies on a broad range of water supply issues from Gujarat, Karnataka and elsewhere in India.

S. S. Meenakshisundaram, Secretary (retd.), Rural Development and Panchayati Raj Department of the Government of India, and currently Advisor, Village Resource Centre, leads the discussion.

Author(s)	Paper	
Veerashekharappa, K.V. Raju and S. Manasi	Financing Rural Drinking Water Supply (DWS): A Case Study of Karnataka and Gujarat	Ext. Abstract
K. Das and R. Gupta	Management by Participation: Village Institutions and DWS in Gujarat	Ext. Abstract
K.V. Raju, S. Manasi and Veerashekharappa	Perceptions and Politics: Grey Zones in Rural Water Supply	Paper Only
D Rajasekhar, R Manjula and K. H. Anantha	User Charges for Rural Drinking Water: A Study of Gram Panchayats in Karnataka	Ext. Abstract
K.V. Raju, S. Manasi and Veerashekharappa	Understanding People's Views on Rural Water Supply: A Citizens' Report Card Approach	Ext. Abstract
A. Anand and C. Chawla	Water Access for Urban Poor: Situational Analysis of Mumbai Slums	Ext. Abstract
B.K. Anand, K.V. Raju, N. Praven, N. Deepa and N. Latha	Urban Water Supplies Dependency on Groundwater: Can it Sustain?	Ext. Abstract
Latha N, Deepa N, Anand B.K. and K.V. Raju	Wastewater Re-use in Mega Cities: Emerging Trends in Bangalore	Ext. Abstract
S. Puttaswamaiah	Environmental Problems in Karnataka DWS: Causes, Impacts and Remedies	Ext. Abstract
N. Praveen, B.K. Anand, N. Deepa, N. Latha and K.V. Raju	Drinking Water Quality in Urban Areas: Why and How it is Getting Worse?	Ext. Abstract
KV Raju, K. Das and Manasi S	Emerging Trends in RWS: Comparative Analysis of Karnataka and Gujarat	Paper Only
Gagan Bihari Sahu, K.H. Ananth and D. Rajasekhar	Rural-Urban Disparity in the Provision of Water Supply and Sanitation Services in Karnataka	Ext. Abstract
Keshab Das	Managing Finance for Drinking Water: Pointers from Gujarat Villages	Ext. Abstract
K.R. Nisha	Institutional Changes in Rural Water Supply in Kerala	Ext. Abstract

FINANCING RURAL DRINKING WATER SUPPLY: A CASE STUDY OF KARNATAKA AND GUJARAT

Veerashekharappa[1], K.V.Raju[2] and S.Manasi[3]

It has been argued that "the ratio of hospital beds to population is far less important than the water taps to population ratio in achieving public health. Investment in water is not just a humanitarian measure; it brings immediate bankable savings". [Halfdan Mehler, Director-General, WHO). Thus, investment in drinking water not only reduces public and household expenditure on health but also contributes to quality of life and human development. Considering this, various efforts are being made globally to provide accessibility to potable water.

The government of India has also introduced sector reforms to increase private investment through community participation. Unfortunately owing to low-level equilibrium trap, political risk, and poor governance, the flow of private investment is minimal. The Ninth Five-Year plan approach paper recommends for involvement of public and private sectors on various models.

Given this background an attempt is made in this paper, to examine the changing pattern of investments, by institutions in enhancing the investment and utilization of funds. This paper builds upon rural water supply study undertaken in Karnataka by ISEC, Bangalore and the publications of international agencies and government documents.

Most of the developing countries provide drinking water free of cost as basic need to consumers, under the guise of social justice and welfare economy. But now it has been realized that in the long run this approach cannot be sustained for two reasons .The first is resource constraint. Second, lack of appropriate pricing policy that has led to inefficient use of water, posing threats to sustainability. To preempt this uncertainty, it was accepted in the Dublin Conference (1992) that "water has an economic value in all its competing uses and should be recognized as an economic good". Since then countries are looking at new approaches in pricing of water and judicious use of water.

This paper identifies analytically, inefficient allocation and utilization of funds for poor performance. In last five years funds allocated to create awareness programme, information technology, upgrading skills not used by various local governments. The capital expenditure has increased because of inefficient operation and maintenance of assets created at the village level/user level. This supports the argument that the philosophy of funding and management of financial resources by state may not be appropriate for solving today's water scarcity problem. Hence there is need for developing new institutional mechanisms for financing the sector.

In some states, the community has funded capital expenditure and funds have been efficiently used by service providers and beneficiaries (brought together under co-operative societies). Capital investment is one time investment, whereas the investment on operation and maintenance is a recurring one, which contributes for increase non-plan expenditure every year. For instance, in Karnataka, 64 per cent of total allocation goes for operation and maintenance. To reduce the non-plan expenditure the Government of Karnataka has transferred the responsibility of operation and maintenance to the local governance *(Gramapanchayat)*, but due to lack of funds they are unable to carry out function efficiently. The state government forced to provide grants, but the grants and revenue earned by the *Grampanchayat* is not enough for O & M. Hence the services provided are low quality and sustainability of assets is doubtful.

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Though, large amounts are being allocated for operation and maintenance, the institutions that deliver services are unable to get enough funds to meet required expenditure. If the process of implementing continues at this level, the possibility of achieving the set goals is difficult. To achieve the set goals there is need to restructure the implementing process, making the *Gramapanchayat* as a regulatory body rather than service provider. The Village Water Supply Committee (VWSC) can take on the function of regulation on behalf of the *Grampanchayat*. The *Grampanchayat* can compel households to take care of the assets around their households. The committee can outsource the recovery of user charges and delivery of service to an NGO or any dedicated organization. This arrangement helps in freeing government agencies from routine work to concentrate on activities that they can and should do, such as formulating policies, monitoring the programme, and developing parameters to assess the quality of services. Otherwise, the alternative is to make way for private participation, bringing reforms on commercial approach, and making allowances for cross subsidy to protect the genuine poor.

MANAGEMENT BY PARTICIPATION? VILLAGE INSTITUTIONS AND DRINKING WATER SUPPLY IN GUJARAT

Keshab Das[1] and Ruchi Gupta

In rural Gujarat, drinking water supply continues to be the prerogative of the state government. Efficient management by popular participation at the village level has remained the ultimate route to success of a given scheme.

In order to capture aspects of policy on ground, nature and extent of the problem of supply of and access to potable water and popular views on various mechanisms of sustainable management at the local level this study has drawn its empirical core through a case study approach. A total of 20 villages were chosen from 17 districts of the state, representing important geo-climatic/ rainfall regions, Kutch, Saurashtra, Central, South and North Gujarat regions. Based on discussions held with state officials, NGO functionaries, academics and other informed individuals, such villages were finally chosen which would, in all probability, represent diverse scenarios in interventions in rural water supply. A total of 404 households were covered finally in the survey. In addition to using structured household level questionnaires, village meetings were also held to obtain information about various aspects of water supply and its management. The study was initiated in November 2003.

Apart from piped water systems (which, essentially, draw upon scarce groundwater) each village had its share of traditional water conservation and storage arrangements. Narmada water is also awaited in many villages. In some villages large number of public-access open wells and *talavs* met the local needs. In most cases at present these sources either lie disused or have been abandoned. There seems hardly any change in the importance attached to the specific sources over the last decade. The continuing complementarity between the traditional and modern sources almost in all villages, probably, strengthens the case for reviving/ promoting the former keeping the sustainability issue centrestage. However, during the last decade the groundwater table has declined in many villages.

One of the most critical dimensions of rural water supply has been participation by the local community in managing the source and finances. This, it has been argued, would ensure stakeholder responsibility and sustainable water supply. With close to three-fifths of the sample households reporting attendance, the *Gramsabha* emerges as the key institution where issues relating to management and finances can be discussed threadbare with the involvement of the local population. Of those who attended, about 88 per cent of households reported having discussed issues relating to water supply. Nevertheless, there remain certain constraints that need to be addressed in order to render this village institution dynamic, broad-based, and inclusive. Such an observation is derived from the findings of the village cases. About one-fifth of the respondents had some idea about water charges, contribution, and responsibility to manage the sources. However, a slightly better response was obtained on their awareness about the water distribution mechanism. A low 38 per cent were in some way involved in the planning and decision making process. Lack of time, improper timing of the meetings and, importantly, women not attending reflect factors responsible for low participation and poor management at the village level. Moreover, in a few cases, households belonging to the lower caste groups were either not informed about the *Gramsabhas* or, even when attended, their views were not given any attention; these acted as disincentives for further participation.

Relatively low attendance in *Gramsabhas* notwithstanding, water related issues do get discussed in the meetings. Experience suggests that there could be wide gap between a decision taken and actual action taken. The most frequently raised concerns have been irregular and

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inadequate water supply as also laying pipelines or installing standposts for the purpose. As *Gramsabha* also discussed other water problems, the institution of *Panisamiti* did not seem to be of much importance. In fact, it was disappointing to note that in about half the sample villages, *Panisamitis* simply did not exist. Further, wherever these existed they hardly met regularly or took up issues of importance at the local level.

A specific enquiry in the study was concerned with the households' preference for and utility of the few main agencies dealing with water supply and maintenance. As was obvious, *Grampanchayat* was clearly the most approached institution whether for minor complaints, emergencies, maintenance and repairs or financial management. A generally high level of satisfaction was reported by the villagers, certainly when they dealt with the *Grampanchayat* and to some extent when the agency was GWSSB.

Apart from the efforts by the state government, certain *Grampanchayats,* in their own right, have taken important steps towards augmenting/ improving water supply in their respective villages. Also, in quite a few villages, NGOs have played an important role in providing drinking water and maintaining the sources. This has improved the groundwater level and has largely tackled the drinking water problem of the area. The predominant view was that of collective or participative management of this critical resource at the village level. The overwhelming choice of *Grampanchayat* as the most preferred body to manage the source, collect water charges and also in for maintenance and repairs underscores the significance and relevance of this local level institution. This probably is one of the most important findings of this rather limited field level exercise towards comprehending the nature of the problem of sustainable water supply in rural areas and possible way-outs.

User Charges For Rural Drinking Water: A Study Of Grama Panchayats In Karnataka

D. Rajasekhar, R. Manjula and K. H. Anantha[1]

Though the Indian government's efforts to provide adequate potable water yielded significant results, yet the goal of providing adequate drinking water to all rural dwellers has not been achieved. This despite a shift in the concept from water as a public good to a commodity that should be priced, and change in the approach from that of supply to demand-driven. People's participation in water supply programmes is emphasized to incorporate their needs and preferences into the design, mobilise resources, improve transparency and accountability, and to achieve long-run sustainability. User financing, the contribution from users to meet recurring costs in the provision of water supply services, is also emphasised to achieve efficiency (restrictions on overconsumption and wastage of water) and sustainability (contributions towards operation and maintenance). But, water is a merit good, the provision of which contributes to health and productivity benefits. Hence, user finance has trade-off between equity, effectiveness and sustainability.

This paper examines the performance of gram panchayats (GPs) in the collection of user charges in Karnataka. GPs operate and maintain mini-water supply (MWS) and Piped Water Supply (PWS) and also collect user charges from households having rivate household connections (PHCs). The engineering department constructs PWS schemes and takes care of digging borewells and maintaining them. In the context of such a functional assignment there is a need to analyse the performance of GPs in the collection of user charges for the two reasons. Firstly, If the institution mandated to construct the water supply is different from the one collecting user charges, the latter may not succeed if the former has constructed a faulty water supply source. Secondly, GPs, being elected bodies, may adopt populist stance in the collection of user charges.

Data were collected from secretaries of 5,212 GPs from all the 27 districts in the state for 2002-03 and cross checked with official documents. Data were analysed across four types (highly developed, developed, backward and highly backward) of districts, the categorization of which was based on per-capita income in a district.

Over 84 per cent of GPs had all the types of water supply sources, and the proportion of GPs providing water through only one source was insignificant. The distribution of GPs by functioning water supply sources shows a different picture. In general, the combination with PWS shows an increase at the expense of other combinations. The mix of water supply sources in a GP depended on size and type of habitations. A large proportion of GPs had come to depend on multiple sources for providing potable water. Not all these sources were characterized by excludability and, hence, were not amenable for the imposition and collection of user charges on water provided through them.

About 83 per cent of the GPs provided PHCs. The proportion of GPs not providing PHCs was highest in the developed and highly developed districts for the following reasons.Since the people in hilly districts (falling in highly developed and developed categories) traditionally depended on open wells within the house premises, the need for PHCs was felt to a lesser degree. As the households in these districts were scattered over a vast geographical area, it became expensive for them and GP to install pipes for a long distance to provide PHCs.

In 2002-03, the total demand was Rs.134.28 crores in GPs having PHCs. Of this, Rs.64.37 crore formed arrears of the previous years and Rs.69.91 crore formed current years demand. Collection was Rs.66.37 crore. Thus, the

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proportion of actual collection to the total demand was 49.43 per cent. Among different categories of the districts, the performance of highly developed districts was better. Around 45 per cent of the dues were collected in developed and backward districts. The performance of the highly backward districts was poor. Another notable feature is that past arrears in highly developed districts were lower than current demand. In contrast, the past arrears in all other regions were higher than the current demand. Less than 50 per cent collection in these regions implies that GPs did not even manage to recover the arrears.

An analysis of GP-wise performance, however, shows that the proportion of collection to total demand was more than 95 per cent in 16.32 per cent GPs in highly developed districts. In general, GP-wise performance was relatively better in backward and highly backward districts as compared to highly developed category. The proportion of GPs not collecting water user charges was less in backward and highly backward category of districts. The proportion of GPs collecting more than 95 per cent of water user charges was almost the same across these different categories of districts. The proportion of GPs collecting less than 50 per cent of the dues was higher in the backward and highly backward districts as compared to the highly developed category of districts. This implies that a larger proportion of GPs in backward districts have fixed water rates and have had good success in recovering the dues.

The key finding is that participation of the people in payment of water user charges was better in poorer districts. There was no significant association between water rates and proportion of water user charges collected.

The paper provides the factors influencing the performance of GPs in collection of user charges. Some of the key factors are insufficient staff, lack of control on the staff by elected leaders, lack of political will to implement institutional rules, incentive structure not being congenial to collection of water charges, etc. Further attempt is to be made to analyse the factors influencing performance of GPs in collection of user charges from rural households in Karnataka.

Understanding People's Views on Rural Water Supply
A Citizens Report Card Approach

K. V. Raju[1], S. Manasi[2] and Veerashekharappa[3]

Providing drinking water being the state's responsibility, efforts are made through various approaches to improvise water supply in rural areas. While the government claims to provide safe drinking water in actual terms the performance has not been satisfactory. As people are the end users, their experiences with respect to water supply service status, appraisal of the efficiency, reliability, adequacy of services and the problems encountered in the process help in providing valuable information for improving service delivery and the constraints affecting the same. In the present context, people are at the receiving end with respect to the various public services provided and competition is absent to improve performance. Public feedback and report cards help in giving a chance to the people to express their views and understanding the problem as they perceive it.

The missing links cannot be attributed only to the monopolistic nature of the service but various other factors, inclusive of initiative and attitude of the people, which have resulted in poor performance, and inefficiency of service. Problems in providing adequate water often discussed by various actors include depletion, quality, scarcity, negligence of traditional sources etc. However, the intricate details of specific issues have gone unnoticed. In this backdrop, the 'Report card' helps in providing a better picture and provide specific ideas to the respective agencies. Perceptions and opinions of the people can be subjective and sometimes incomplete due to various biases in the process of collecting information, however the number of times that a problem is pointed at will reflect on the situation and the problem, in particular.

The report card concept has emerged as a powerful mechanism to demand better accountability and responsiveness from public service providers. The efforts towards facilitating citizen feedback have been to bring about effective results in terms of action. In reality, it is observed that public institutions are sensitive to negative feedback and the citizens experiences in using citizen feed back indicates that satisfaction levels and comparisons evoke reactions but not automatically to concrete action. A systematic effort to mobilize local citizen's bodies and NGO's to put pressure for improved services, is vital to institutionalize changes in the manner public service agencies operate. Public Affairs Centre has used the report card methodology and conducted various studies.

The report card concept presented in this paper addresses the assessment of rural water supply from the perspective of the rural people. Feedback obtained from the citizens helps in ascertaining the degree of satisfaction with the quality of services provided by the public agencies.Based on field coverage in Karnataka covering representative districts from various geographical zones and issue based, case studies were conducted in 18 villages coupled with both primary and secondary data collection. Discussions were held with various actors, officials at various levels of panchayat raj institutions, members of local user committees, NGO's, staff members of donor supported implementing agencies, and people.

Primary data were collected using a questionnaire from households. The questionnaire design covered aspects of socio-economic, physical and financial aspects of source extraction and use, alternative sources, and 'Report card methodology', which aided in getting a systematic public feedback to assess performance and perceptions. Survey of households was conducted at different districts of Karnataka to understand the field situation. Based on purposive sampling method 20 households were picked up per village. Responses were collected from a total of 380

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households.Water availability and accessibility was based on geographical locations and the lpcd levels and usage was high in the Malnad regions compared to dry regions. Scarcity was prominent in both groundwater depletion was obvious as scarcity during summer was prominent throughout. People's perception on inadequacy of water depended on other socio-economic and cultural conditions. The lpcd range that the state government aimed to achieve (55 lpcd) was viewed differently by the people between the regions; 52 per cent of households expressed inadequacy. People had access to water but the water obtained was inadequate.

Poor awareness on installation of defluoridation units in quality affected villages did not serve the purpose as there was no comprehensive plan to educate people in using water although impact on health caused due to fluoride contamination was obvious. 70 per cent of households did not use treated water. Willingness to pay was high (80 per cent) but people expected good service. However, people were not aware of the actual expenditure that was incurred for O and M. Transparency in accounts was not maintained in majority of the villages. Access to accounts was also limited.

Poor participation in *Gramsabhas* shows that there was little involvement among the people in addressing problems in the village. Awareness creation programmes by various agencies did not bring about expected results. Reasons and situations varied; poor awareness creation at field level, drying up of sources, political interventions, corruption, withdrawal of the agency led to failing of the system, and power problems. Although the schemes were meant to involve people and participation at every stage, awareness among the people with regard to the implementation of the scheme and their role was very insignificant. Operations and maintenance problems were witnessed as the people complained about poor responses by the *Grampanchayat* during complaints. Women were totally unaware about the whole context, except for an insignificant few who knew that the building of the overhead tank would help in access to better water supply.

Access to Water for Urban Poor: A Situational Analysis of Slum Settlements in Mumbai

Aruna Anand[1] and Chandan Chawla[2]

Water and sanitation sector reform is taking place in many countries and promises unlimited potential to improve services to all, through public or private provision of water services. Of particular concern however, is the situation of the poor, and reforms must be designed so that they receive increased access to affordable services. While the slums represent the urban poor in cities, two main issues with regards to water supply are the legal status of slums and the pricing of water. In most South Asian cities, public agencies are struggling to provide water supply and sanitation and end up with more expenditure than income. On the other hand private providers are also not too eager to connect the poor, because they do not buy much water, cannot pay for one-time connection fees and often lack security of tenure. In light of above, it becomes extremely critical to design water pricing policy for urban poor that takes in to account their ability and willingness to pay for water services and facilitates connection to water services. Water delivery, public or private, should take into account the considerations of urban poor who constitute 23 percent of the total urban population in India.

This paper reviews the situation in the slum settlements of Mumbai with respect to accessibility, sufficiency, safety, affordability, and acceptability of water services. The findings of the paper are drawn from a detailed household study conducted by YUVA to estimate willingness to pay for water for the urban poor in Mumbai using the contingent valuation method.

Water needs vary from household to household, and can also be affected by conditions specific to region, season, and other variables. Defining clear standards on the consumption of water and price of water for poor households have always been a dilemma for urban water pricing policy.

The authors of this paper accept affordability guideline of 5%, a generally accepted international figure, as the maximum amount a family should pay for water. The findings of the study reveal that the poorest families suggested a maximum of about 4% of their meager incomes for water. Although many were compelled to spend more than this because of lack of affordable water. We use 5% as a conservative tool to identify households paying unacceptably high amounts for water and 50 lpcd as minimum quantity that meets sufficiency.

Poor families provide an estimate of about 80 lpcd as desired for personal and domestic use, highlighting the fact that the amount sufficient for health benefits as assessed by scholars and amount desired by the families can be substantially different.

Given the necessity for affordable access to the public water system to protect the urban poor's human right to water, more funds need to be earmarked for subsidizing the costs of connection.

In the current policy of underpricing water, because of losses accrued from selling water to slum and non-slum consumers at rates below the cost of production, the BMC is unable to invest sufficient resources into subsidizing connection costs for the poor residents or into expanding infrastructure into slums. To be effective, a connection subsidy would have to be carefully structured so as to not create perverse incentives, to minimize leakage of subsidy to the non-poor,to ensure administrative simplicity, and to maximize coverage and scalability. Equally important to subsidizing the cost of individual connections of the poorest households would be to systematically plan and provide more main water pipelines to slum areas. Streamlining the connection process can be done by reducing bureaucratic bottlenecks in the process that force urban poor to employ

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middlemen to facilitate their connection application. The findings of the research reveal community management to be crucial for successfully managing a scarce resource and for taking advantage of existing BMC programs.

However, there is a need for local non-governmental agencies to support communities in accessing accurate information about connection costs, application process, and other water related programs. Such an organization could also potentially be a platform from which communities could join together to purchase pipes in bulk to secure discounted rates. In addition, innovative payment plans that spread the cost over several installments need to be developed concurrently with savings and credit options for water infrastructure.

URBAN WATER SUPPLIES DEPENDENCY ON GROUNDWATER: CAN IT BE SUSTAINED?

B K Anand[1], K V Raju[2], N Praveen[3], N Deepa[4] and N Latha[5]

This paper is an attempt to understand the extent of dependency on groundwater, the reasons for shift from surface to ground water, water consumption in different sectors, understanding water markets, access to water supply, reasons for relying on groundwater. Also an attempt is being made to estimate the number of private tubewells, and investments on groundwater. An intensive study carried out in Kolar and Bangalore (South Indian cities) has revealed some of the hidden facts on the dependency on groundwater. A brief study carried out in Chennai has revealed the extent of groundwater being extracted and found that the cost involved is enormous.

Bangalore, one of the fastest growing mega cities in South India, presently is facing with serious water problems, quality and quantity wise. Absence of a perennial river and the encroachments of the lakes have further intensified the problem. Urban authorities and private agencies have failed to meet the supply-demand gap. As a result dependency on groundwater is increased.

Kolar city, often regarded as a major drought prone area in South India lacks surface resources. To counteract, groundwater is being exploited to a greater extent. The supply-demand gap continues to be large. The 1960's pipe networks, unauthorized connections, leakages ,and sand mining continue to be the major issues apart from administrative and technical issues. Increase in depth of tubewells has worsened the quality of water in the city. Wastewater intrusion from domestic and industries has led to further complications.

Chennai, one of the four metropolitan cities, is also in the water distress zone. Local bodies are not able to meet the demand for water leading to blossoming groundwater market dominated by private suppliers. The water table has gone down from 60-80 ft to 120-130 ft.

Tubewells in Bangalore city have increased from 5000 to 450,000 over the last three decades. During the last five years, more than 100,000 tubewells have been drilled in Bangalore city to meet the growing demand. It is estimated that from 3.25 lakh tubewells, 750 MLD of groundwater is extracted from different sectors. The cost spent on groundwater is 3.5 times that on the Government supply. Study of groundwater use in Ward-39 of Bangalore city revealed 710 private tubewells within a 2.1 sq km area, costing private investment of Rs. 35 million in just one ward.

In Kolar, dependency on groundwater is total and water quality analysis of 137 samples shows that 97% is non-potable. Neither, the city municipal corporation nor private suppliers are able to meet the growing demand for water in urban areas. Per capita supply is just one-third of the urban water supply norms. There are around 200 private tubewells in the city. Of the 29000 households, 9000 of them have piped connections of which one third of them is unauthorized. Demand is 7.27 MLD and supply is 4 MLD and the gap is met by groundwater. Only 6 wards have lpcd more than 40 lts, 8 wards have lpcd within 30lts-40lts, and 17 wards have lpcd less than 30 lts.

In Chennai, the water table has gone down from 60-80 feet to 120-130 feet. The increase in private agencies has rocked the groundwater market, in which a low-scale farmer has largely benefited to a large extent. It is estimated that the number of wells owned by all types of users in the city is

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around 150,000, while the actual number according to local researchers is around 600,000. An agency with 35 tubewells in 1968 is currently having 8 tubewells. Each well owner, earns anywhere around Rs 12,000-15,000/month which is not possible in five acres of irrigated land.

The surface supply to Bangalore City is from the river Cauvery, which is 100 km from the city, river water has to be pumped up to 500 m above MSL. The minimum requirement of water for the present population of 6.5 million at 200 lpcd is around 1136 MLD, supply is 864 MLD including 38 percent indicated as unaccounted. So the actual quantity of water reaching the city is 533 MLD. There are around 4.08 lakh tubewells in the Bangalore Urban district. It is estimated that around 750 MLD of groundwater is being extracted every day.

In Kolar, the inadequacy in supply is because of administration, resource and technical constraints. Kolar Municipal Corporation spends approximately Rs. 20 lakh/month on the water supply. While only 50 percent revenue is generated from all the 31 wards. Total number of connections available was 6153 in 2002-03 and unauthorized connections numbered 3000. The technical issues are pump house conditions being critical, improper water treatment during supply, and sewage disposal into tanks. The analysis clearly indicates 50% shortage in supply of water. To meet the demand, the present level of extraction has to be doubled.

It is evident that proliferation of tubewells in Bangalore, Kolar and Chennai would evidently lead to more costly consequences in terms of water extraction and cost aspects. Measures to minimize groundwater use have to be initiated immediately- such as recycling wastewater, rejuvenation of tanks in Kolar, and compulsory rainwater harvesting.

WASTEWATER REUSE IN MEGA CITIES-EMERGING TRENDS IN BANGALORE CITY

N. Latha[1], N Deepa[2], B K Anand[3] and K V Raju[4]

Six million citizens of Bangalore are feeling the heat presently owing to the lack of adequate water. The paper indicates the potential of reuse of wastewater for meeting the supply-demand gap and focuses on the quantity of wastewater generated in Bangalore, present treatment technologies and disposal methods adopted, present extent of reuse existing and the other reuse possibilities that can be adopted for Bangalore city.

Presently Bangalore Water Supply and Sewerage Board [BWSSB] supplying 864 million litres per day (MLD) of surface water to the city from the river Cauvery. Per capita of water supplied is around 110 to 115 liters including unaccounted for water (UFW) which is around 38 per cent. Hence actual per capita supply is around 75 litres which is far below the recommended limit. Although sufficient quantity of water is withdrawn, a huge share of it goes as unaccounted and this has resulted in increased dependency on ground water. There are around four lakhs borewells in the Bangalore Urban district and it is estimated that around 750 million litres of groundwater is extracted every day both from the domestic and commercial sector. This has resulted in the overexploitation and severe stress on the aquifers; hence groundwater levels are coming down to a large extent.

Around 800 MLD of wastewater is being generated in the city (considering 531 MLD of supply from BWSSB after excluding 38% UFW and 750 MLD of groundwater utilization considering 80% of the total water used), out of which, approximately 200-300 MLD is entering the secondary treatment plant's owing to the lack of adequate sewerage system. Remaining wastewater is being let into streams such as the Vrishabhavathi. A recent survey of the stream has revealed that the water is contaminated and some of the sewers at certain stretches are not capable of handling the existing and expected future flows. Further some of the sewers are in critical condition and require immediate replacement.

Waste water generated in the city is drained through three principal valleys of Vrishabavathi, Koramangala and Challaghatta and Hebbal and other minor valleys of Tavarakere, Hebbal Minor Valley I and Hebbal Minor Valley II). Presently, the Bangalore Metropolitan Area is currently served by three major sewage treatment plants, with a combined capacity of 403 MLD and two tertiary treatment plants with a combined capacity of 70 MLD.

Wastewater reuse is minimal in the city. Around 25 MLD of wastewater is being treated in two tertiary treatment plants i.e. one in Vrishabhavathy valley (60 MLD) and the other is in Yelahanka (10 MLD). Though the capacity of TTP in Vrishabhavathy valley is 60 MLD, only 25 MLD of wastewater is being treated here just to keep the plant operating. Treated water from this plant is not reused fully as only small quantity is being taken up by a private industry. But it is proposed to supply this treated wastewater to the Karnataka Power Corporation, which is coming up in near Bidadi. In the case of Yelahanka TTP, 1 MLD of treated wastewater is being supplied to Bharathi Electronics Limited, around 2 lakhs per day is supplied to the Indian Air force, Wheel and Axil industry, ITC Limited etc, for non-potable industrial purposes. Apart from this, around 5 to 6 MLD of water is to be suppliied to the International Airport, which is coming up near Devanahalli. In addition to these two TTP, there are other private treatment plant of 1 MLD

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capacity in Golf Club and one in Karnataka Golf Association, Airport road. One more is under construction in Lal Bagh and Cubbon park. These treatment plants draw raw sewage at a cost of RS 0.50 per KL from the BWSSB sewerage lines and after treatment it is reused.

Because of the increasing gap between supply and demand and non availability of perennial Rivers, providing water would be a gigantic task in the coming years . There are also limitations on drawing Cauvery water beyond 600 cusecs .The concerned authorities should look for various alternatives such as rainwater harvesting, recycling of wastewater, reducing unaccounted water,etc.

Since the cost of ground water and recycled wastewater is almost same, people prefer fresh water (the cost of a private water tanker is Rs. 150 to 200 per 6000L and the cost of wastewater at the rate of Rs. 19 per 1000L comes to Rs. 114 for 6000L + transportation charges since TTPs are located at the outskirts of the city). This attitude of the people is mainly because of ignorance or lack of awareness about depleting natural resources. Industries having surface water connection, supply will be for 24 hours. So they do not think of using treated wastewater. Hence there is no demand for reclaimed water at present.

By reusing wastewater the city not only meets the supply and demand gap but also reduces pressure on ground water draft. Since conventional treatment plants are costly effective and requires energy and manpower, decentralized waste water treatment systems plants can be a good alternative in slums, industries and apartments. Authorities should think of dual water supply which is in practice in many countries so that the burden on fresh water can be reduced.

DRINKING WATER SUPPLY: ENVIRONMENTAL PROBLEMS, CAUSES, IMPACTS AND REMEDIES EXPERIENCES FROM KARNATAKA

S. Puttaswamaiah[1]

Drinking water, in adequate quantity and quality, is a basic requirement for life and a determinant of standard of living. Significant efforts are being made for covering more habitations with adequate safe drinking water. However, in addition to government efforts, supply and demand side factors determine water supply level available to people. Supply side, factors include water availability in adequate quantity and quality, sustainability of water resources, kinds of institutions, operation and maintenance of water supply schemes. On the demand side, factors such as population pressure, use and discharge of water by industries, inefficient land use, wastewater and fertilizer flow into water bodies and soils, inappropriate water pricing mechanisms or market, etc., contribute to water quality deterioration and depletion problems. These factors increase with pollution, degradation and depletion of resources such as water and land, limiting water supply provision and raising delivery cost. This paper examines the nature of environmental problems, causes, and impacts in drinking water supply of Karnataka .

Pressures exerted by supply and demand side factors on water resource have caused several environmental problems in drinking water supply: inadequate quantity of drinking water supply, a problem of scarcity and governance; scarcity in summer months, a problem of natural factors, seasonality, governance and management; depletion of sources, a problem of resource management ,deteriorating quality, a direct environmental problem.

Inadequacy of safe drinking water supply is the forerunner of several environmental problems, as a minimum quantity of water is essential for life, maintenance of personal hygiene and environment. In rural Karnataka, over 35 per cent of the rural habitations are yet to be covered with adequate supply. This problem is more acute in drought prone areasof 55 LPCD. The problem has been accentuated by non-functioning water supply schemes. In urban areas for which information is available only about 23 per cent of the urban local bodies of them provide adequate quantity of drinking water supply. Towns in more than 10 districts suffer from inadequate quantity of drinking water supply.

Bangalore, the capital city, too is experiencing inadequate supply of water, which is also on declining trend. Water scarcity during summer months constitutes another major problem and irregularity and reduction in the per capita availability of water. Supply level in rural drinking water schemes declines goes down by 50 to 75 per cent of the scheme during summer months.

Depletion of drinking water sources accentuates adds to further environmental problems, via water shortage and quality deterioration of quality of water. The groundwater table has been drastically declining putting more than 78 per cent of people at risk for drinking water. In the districts such as Bangalore, Chitradurga, Kolar and Tumkur the problems are acute.

In Karnataka, ground water in more than 37 per cent of rural habitations and surface water at certain pockets in some rivers is contaminated. Habitations in Bagalkot, Bangalore Urban, Bijapur, Chamarajnagar, Chitradurga, Haveri, Mandya, Tumkur, Bellary, Davanagere, Kodagu, Kolar, Raichur and Koppal districts face serious ground water quality problems. Groundwater contamination is caused by excess fluoride, excess brackishness, excess nitrate and excess iron. The drinking water quality problem is observed in urban areas also due to contamination of ground and surface water at source and pollution during transmission and distribution.

Environmental problems in drinking water supply are caused by both supply and demand side factors. While environmental problems associated with drinking water supply are many, the root causes can be fewer.

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Problem in drinking water supply are caused by both supply and demand side factors. Two major supply factors are depletion and deterioration in the quantity and quality of water. The major environmental factors causing inadequate supply of drinking water supply are non-availability of perennial water sources, high dependency on ground water, etc. Ground water availability is experiencing wide fluctuations and cyclical decline. Another cause is reduced the availability of surface water during summer, which results in inadequate drinking water supply. The general neglect in conserving rainwater has resulted in waste of rainfall by way of run-off and evaporation. Finally, manmade factors like discharging untreated waste, sewage flow, etc, to water bodies causes depletion and deterioration of water resources. In addition, lack of operation and maintenance, leakage, and unaccounted for water also reduces the supply level.

Various factors, such as natural, man-made (or demand driven) and institutional (like lack of monitoring system), are responsible for deterioration in drinking water quality. Quality of ground and surface water is affected by [1] factors like natural factors such as geological and geographical characteristics leading to inorganic contamination resulting in with excess fluoride, iron, nitrate, etc., [2]man made factors like over extraction of ground water, discharging pollutants to surface and groundwater bodies, inadequate and improperly designed drainage and sewerage systems etc., etc. and [3] institutional factors such as lack of integrated drinking water quality monitoring system. Many of these institutions lack either adequate equipment for testing of chemical and bacteriological contamination of water, trained staff, etc. or there isare serious coordination problem among all these facilities. Further, local organizations have not given adequate importance for operation and maintenance activities of drinking water supply schemes in rural and urban areas because of paucity of resources,financial and manpower. In spite of the presence of many institutions there is inadequate information or database.

Environmental problems in drinking water supply impact significantly on health status and other resources like water and land. Consumption of water less than required quantity results in 'water washed diseases'. Irregular water supply causes pollution in distributional pipes contaminates owing to rusting and back syphonage of waterleading to contamination of water and health problems. Inadequate water supply increases the hardship on women and children.

Unsustainable drinking water sources decreases water availability. The decline in the ground water table causes geo-chemical changes leading into widespread chemical contamination of water (e.g. excess of Fluoride, Brackishness, Iron, Nitrate) which has its adverse effects on health of population.

Poor quality water has serious implications on health and environment. Common major diseases arising from unsafe drinking water are gastroenteritis, cholera, typhoid and others. Gastroenteritis is the major disease with nearly 24000 incidences and claiming about 200 lives during 2001. It should be noted that viral hepatitis is increasing rapidly in the state from 1714 cases in 1997 to 5438 cases in 2001.

Considering the present status the the following points might be considered to resolve the problems and augment the services. Partially covered habitations, in rural and urban areas, should brought under full coverage of water supply, giving high priority to drought prone areas. Drinking water quality affected habitations should given priority by providing safe drinking water through alternative sources or by treating water. Importance needs to be given to operation and maintenance activities. Urban local bodies can consider privatization of operation and maintenance of water supply schemes, but by protecting poor and vulnerable groups. In villages, village water supply and sanitation committees can be established to supervise operation and maintenance activities. A single water quality-testing agency should be promoted for rural and urban areas. An integrated institutional system for groundwater conservation and recharging measures needs to be promoted to conserve the major source of drinking water. Institutional initiatives need to be promoted for rainwater harvesting .

DRINKING WATER QUALITY IN URBAN AREAS: WHY AND HOW IT IS GETTING WORSE?

N Praveen[1], B K Anand[2], N Deepa[3], N Latha[4] and K V Raju[5]

Water is depreciating in quality and in the quantity. Deterioration in water quality is rapid in almost all the places, the reasons being rapid growth in population, overdraft of groundwater and the effluents of the industries- thus contaminating both surface and groundwater resource. The paper is an attempt to understand the quality issues in urban areas of South India, and the implications of deterioration in quality. The selected cities are Kolar and Bangalore, fast growing cities mainly depending on groundwater.

Kolar city is one of the major drought prone areas in South India is currently under tremendous risk as the water supplied is inadequate and not potable .Moreover there is total dependency on groundwater. Because of overexploitation the water table has gone down to a large extent, and the quality of water is under stress. Inadequacy in resource and quality has led to a large gap in the supply and demand. The traditional pipeline networks, tubewells- some of them being re-bored year after year have led to further deterioration in the quality. Because of intrusion of nitrate affected sewage and wastewater to a surface tank, from which most of the water is supplied to Kolar city. The people are relying on the alternative sources.

Bangalore is also facing the same problems in supply levels and in the quality aspects. Most of the extraction is in the peripheral areas of the city. Presently BWSSB [Bangalore Water Supply and Sewerage Board] supplies 864 Million liters (MLD) of Surface water per day to the city from the river Cauvery. Per capita supply is around 110 to 115 liters including 38 per cent unaccounted. Hence the actual per capita supply is around 75 litres which is far below the recommended limit. Although sufficient quantity of water is drawn, a huge share of it goes as unaccounted and this has resulted in increased dependency on groundwater. There are around four lakh tubewells in Bangalore city and it is estimated that around 750 million litres of groundwater is extracted every day. A series of new wells are reported to have been dug to supplement once-in-two-day city water supply. This has resulted in the overexploitation of groundwater degradation in water quality. The quality of water is also declining because of the pollutants from industries and domestic sewage outlets. The Vrishabhavati River, once used to be the major source of water resource, is entirely contaminated from household, commercial, and industrial wastes.

In Kolar city the dependency on groundwater has led in drilling more and more tubewells. Currently for a population of 113,299 ,the number of tubewells owned by city municipal council is 119, out of which only 90 tubewells are in working condition. All the surface water resources have dried up and the municipality has installed tubewells in tanks. The city lacks adequate and good quality water. The physico-chemical analysis of 137 samples reveals that 97% of the water is not potable. Total hardness, calcium, nitrate, iron ,etc are the major contaminants. Contamination levels are very high and alarming mainly because of the deeper depths of the tubewells and wastewater intrusion from households and industries. The most affected parameter is sodium, which is found in 17 wards (55% of the total wards). Bicarbonate exceeds permissible limits in 12 wards (39% of the total wards).Excessive chlorine, total hardness and calcium are found in 9 wards (30% of the total wards). From the survey of 985 households,

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there is around 40% gap in the supply of and demand for water supply. Groundwater is extracted commercially through private suppliers. As a result of this over-exploitation the quality of water has worsened.

Bangalore city is still dependent on groundwater resources for the domestic requirements in developing areas, revenue pockets and old village areas. A survey in Bangalore city of 163 households showed that 77 per cent relied both on surface and groundwater, 13 per cent of them purely depend on the ground water and 8.6 per cent are used only piped water supply and less than 1 per cent drew water from open well. Though the quality of surface water is good and not contaminated ,it cannot be directly supplied for potable purposes without treatment. The Cauvery water is treated at different stages before supply. According to the DMG and RDED studies, groundwater quality is getting worsening. The concentrations of pH (0.66% and 11.5%), TDS (3.44% and1.3%)total hardness (2.4% and 5.5%), nitrate (35 %), iron (38.16% and 15 %) and biological contaminants like coliforms (30.71% and 74%) are high compared to permissible limits.

The Vrishabavathi river originates near the Southwestern end of Bangalore city. While the original river has dried up, at present, it is carrying industrial effluents and sewage water from about hundred small-scale industries. It receives improperly treated and untreated effluents and domestic wastewater from the treatment plants of BWSSB containing various organic materials, toxic elements and disease causing pathogens. The water quality of the stream was tested by collecting six samples at regular intervals along with the stream and water was found with high content of BOD and COD. The main source of high BOD and COD content in the water samples may be attributed to the flow of industrial effluents and the domestic sewage. People in this part of the city are mostly relying on corporation water as they find bad odour from groundwater. There are also cases of water borne diseases in the vicinity.

RURAL-URBAN DISPARITY IN THE PROVISION OF WATER SUPPLY AND SANITATION SERVICES IN KARNATAKA

Gagan Bihari Sahu, K. H. Anantha and D. Rajasekhar[1]

Drinking water supply, sanitation and health are public services, the demand for which exceeds the supply. This, therefore, leads to a situation where rationing is inevitable. Since water and sanitation have direct bearing on the health of the people, provision of safe drinking water and sanitation to the rural and urban poor is a fundamental duty of any government. Since the situation in terms of provision/providers and the perception of beneficiaries vary across the regions and population groups, the access to safe drinking water and sanitation facilities may not be uniform in different regions.

The present analysis is confined to the demand side assessment consisting of the extent of coverage, source proximity and availability of water from potable sources. It is evident from the analysis that the coverage of households under potable drinking water sources was 92.1 per cent in urban areas, for the state as a whole, in 2001 as compared to 81.4 per cent in 1991. A similar trend can also be observed in the case of rural areas. For instance, the coverage increased from 67.3 per cent in 1991 to 80.5 per cent in 2001. This indicates that there was an additional coverage of potable water supply in rural and urban areas to the extent of 13 per cent and 10 per cent of the total number of households respectively.

The analysis on status on coverage suggests that in spite of various steps undertaken for the provision of drinking water facility, tube well with hand pumps (TWHP) was still the major source of drinking water in rural areas. Nevertheless, there was an improvement in the coverage of households under potable drinking water facilities in both rural and urban areas of the state. The intervention by donor agencies has lead to better provision of water supply and sanitation services in these areas. Disparity is defined in terms of the differential rate between the two sections/regions (viz., rural and urban with respect to access to potable drinking water). The major findings are:

- The disparity is more in 'Malnad' region because of more hilly areas in these districts. This indicates that the reach of water supply is less where topographic condition is not congenial.

- The rural-urban disparity in access to potable drinking water is less in backward and highly backward districts. This can be attributed to interventions by international donor agencies in facilitating the provision of water services in rural areas.Further, the topographical features are more conducive and the large size of the villages together with concentrated spatial location of houses make drinking water supply sources viable.

- Though the coverage of potable drinking water has increased in rural areas, still urban areas are well ahead of providing this basic infrastructure. Low coverage in the provision of potable drinking water, especially in rural area, can be due to people in this area not able to afford these services. However, a large number of studies (in India and elsewhere) have found that poor people do pay for water provided the quality of services is good.

The proximity of sources is an important characteristic, which affects the consumption of drinking water. In other words, the frequency of use of a source within the premises of the dwelling units is usually higher than that of a source located away from it. In the case of urban areas, out of total number of households about 47.4 per cent of households had access to the same within the dwelling unit and/or within the premises during the same reference period. Nevertheless, the coverage of rural households under potable drinking water facility increased to 80.5 per cent by 2001. But only 18.5 per cent of

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total number of rural households had access to this facility within the premises. The proportion of households accessing drinking water within the premises in urban areas was more than three times that of rural areas in 2001. This indicates that the time spent for meeting the drinking water requirements by rural people was more than their counterparts in the urban areas. Importantly, the percentage of household's access to potable drinking water within the dwelling unit and/or premises shows positive association with the level of development, irrespective of whether it is rural and urban areas.

As per the 2001 census, only 17.4 per cent of the rural households had been covered by toilet facility as against 6.8 per cent in 1991. Similarly, about 75.2 per cent of the households had access to toilet facility in urban areas as against 62.5 per cent during 1991. This coverage widely varied across districts. It is also noticed that though there was a high coverage in urban areas, still a majority of the households did not have this facility.

It is clear from the analysis that there is high disparity between urban and rural areas in Karnataka and there is a bias towards urban areas. Though there is an increasing trend in the access to toilet facility both in rural and urban areas of backward and highly backward districts, still the gap is substantial. In this context, it is important to note that although many programmes [such as Centrally Sponsored Rural Sanitation Programme (CRSP)] have been implemented to improve the sanitation facility, the achievement in rural areas has been far from being satisfactory. This is partly due to the fact that rural households are not quite used to toilet facility. Probably, this contributes to a low rate of access to toilet facility in rural areas as against their urban counterparts. The use of toilet facility is more in urban areas mainly due to the impact of hygiene awareness and education, and more so due to considerations of lack of privacy and dignity of the woman and lack of space for open defecation.

The distribution of households having latrines of different types shows that the percentage of households having access to water closet was higher in urban areas in all the districts. These sources were managed and maintained by the local authorities for which in some cases nominal minimum user charge was levied to the households. The analysis of the availability of toilet facilities in both urban and rural areas clearly brings out that the rural areas had poor access to it as against the urban areas. More than 82.6 per cent of the rural households did not have any latrine facility. Among those who had latrine facility, a high percentage depended on pit latrines, which were unhygienic. The provision of latrine facilities requires more individual effort rather than any government intervention. A higher proportion of urban households using latrines may perhaps be attributed to individual efforts rather than those made by the government.

Finally, the analysis reveals that the provision of water supply and sanitation is highly skewed in favour of urban areas. The coverage and distribution pattern is more urban biased. This has a bearing on two important issues: First, lack of clean drinking water and inadequate sanitation facilities are detrimental to the health of the society and it adversely affects the productivity and efficiency levels. Second, the operation and maintenance of these basic amenities, especially water supply sources, needs to be looked carefully, as this is vital for sustainability. For better operation and maintenance, corrective measures such as proper pricing mechanism should be taken up. On the whole, the target of ensuring adequate water supply to all the people in rural areas seems to be still distant, and efforts should be made in this direction. Almost all local bodies that supply drinking water are financially weak. To reduce the financial burden, privatisation [including Build, Operate and Transfer (BOT)] and maintenance contract should be taken up but this should not be at the cost of compromising on the equity aspects of provisioning, else poor people would be 'crowded out' of this basic necessity. Since water schemes are not being equitably distributed to all areas, the proposed water schemes should be restructured in the light of these findings and implemented. To prevent open air defecation, especially in rural areas, it is necessary that toilet with water supplies must be constructed. This is very much essential as sanitation programmes have failed in most of the villages due to lack of proper water supply to the toilets.

MANAGING FINANCE FOR DRINKING WATER: POINTERS FROM GUJARAT VILLAGES

Keshab Das[1]

Very unlike most other basic infrastructure, drinking water by being an essential good for both survival and health could not be excluded from its provision on the mere ground of affordability. In fact, drinking water supply has been primarily and largely in the domain of the state. So much so that paying for drinking water is still considered needless, or, insisting on it a politically unsustainable proposition. Apart from the popular notion that the government should pay for and provide drinking water, as often hyped by politicians with vested interests, affordability is a genuinely serious issue, what with pervasive rural poverty. Hence, water has, conventionally, been subsidized towards achieving food security, providing wider access to clean potable water, improving the income and health of the rural poor. Nevertheless, the definite emergence of scarcity of clean potable water as a serious challenge, now being acknowledged even globally, has compelled societies to consider it as an economic good whose sparing use would only point to its not being free.

While the main purpose of alternative financing has been to reduce the burden on the state exchequer, in terms of long-term sustainability of the schemes, strong involvement of the local community in both mobilizing and managing finance has been recognized as a crucial necessity. The introduction of the Sector Reform Project (SRP) or, now what is broad-based as the Swajaldhara scheme, largely aims at energizing and banking upon village level management of finances for drinking water. It needs to be noted here that currently the financing and its management concerning rural water supply in Gujarat villages do not follow any particular pattern. In fact, both the supply- and demand-driven approaches of the government co-exist with other private and local initiatives.

This paper is based on extensive field research (including discussions at the village levels and household surveys) in 20 villages of 17 districts in the state of Gujarat. It deals with variety of mechanisms, as being practiced, of fixing/ revising of water charges and the dynamics of mobilizing and managing finance both for the capital and maintenance purposes. There emerges no pattern of any kind at all. A close study of revenue and expenditure data concerning water supply, distribution and maintenance has revealed that most villages face severe financial constraints in meeting the various regular expenses. Whereas incidence of widespread default in payment of water charge (not to mention the rate) had been the real cause of concern, panchayats or the state bodies see this as a delicate matter that could become a politically charged issue. This is despite the fact that households/ panchayats are actually not meeting even part of the power bills. There have been complains from villagers over lack of information about the quantum and mode of payment. Irrespective of the supply- or demand-driven approach, villages differ substantially in the manner they collect and spend whatever water charges. Non-revision and part-collection of charges have been a worrying factor in face of rising demand from the growing population and also need to pay for both augmenting the sources and maintaining them for the future. An important aspect of enhancing rural drinking water supply by promoting water harvesting systems needs to be effected in a major way as that would, inter alia, help reduce the level of water charges. Much work awaits understanding the wide variety of practices on ground as that defy stylised accounting systems often suggested under controlled scenarios. It is important to examine why certain manner of mobilising and managing finance is effective or difficult to change. More now than before, explorations of mechanisms of participatory and professionally handled financial management at the village level

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are essential that would tackle the vital equity question unambiguously. Discussions also include sources other than the piped water schemes, such as, revival and/ or installing of water harvesting structures both at the household and community levels. Clues for policy in this crucial aspect of rural water supply can be found in the paper.

INSTITUTIONAL ARRANGEMENTS IN RURAL WATER SUPPLY IN KERALA: CONSTRAINTS AND POSSIBILITIES

K R Nisha[1]

Water plays an important role in the quality of life and welfare of society. India is currently facing crisis on the water front in the form of falling water tables, waterlogging and salinity, inadequate access to safe drinking water and sanitation, etc. Among the states, Kerala has been placed as a 'water safe' economy. In spite of heavy annual rainfall, high 'well density' and numerous rivers and ponds, the state of Kerala is facing shortage of safe drinking water. Though blessed with abundance rainfall of about 3000 millimeters , there is significant variation and shortage of safe drinking water in many places of the state. The 'scarcity in the midst of plenty' is because of several reasons such as high runoff due to high slope, terrain condition, loss of forest cover and soil and ecological imbalances. The climate of the state is typically tropical with seasonally excessive rainfall and hot summer. It is observed that the ground water table is declining every year.

A number of institutional arrangements have come up for water conservation and management, ranging from public owned water authority to community participated schemes. The purpose of this paper is to examine the constraints of major institutional arrangements in water supply and to look at new initiatives in water management.

Drinking water system in Kerala can be broadly classified into three categories :river based urban and rural water supply schemes, groundwater based rural water supply schemes, and family-managed drinking water supply schemes. The first two systems are owned and operated by the government and the third involves individual families creating their own drinking water resources by constructing wells in their house compounds and managing it themselves. Until 1998, the state owned Kerala Water Authority (KWA) was the only nodal agency for the design, construction, operation, and maintenance of water supply and sewerage schemes in the state. Experience of the last two decades has revealed that the efforts of the state owned agency alone would not be sufficient to meet the drinking water needs of the state especially in the rural areas. Environmental constraints have also increased the momentum of failure of the state regulated water supply system. Since the government provided water supply services are always underpriced, they require subsidy (partially or fully) from the government towards operation and maintenance. The increasing difference between the expenditure and revenue has led to financial chaos and has created a negative impact on the accountability of public services. This in turn has led to a vicious circle of unreliable services, low willingness to pay, and further decline in the capacity to provide services in the state. The problem of financing water service is one of the major contributing factors for institutional change.

Some new initiatives have been experimented with in providing water supply with a reduced role for the government. Privatization of water supply service has emerged as a policy suggestion. However, the market- based profit dominated approach to an essential service, such as drinking water, is not considered politically and socially viable. As a result, community based initiatives including local self-governments and NGOs, have emerged. Alternative forms of water supply schemes in the state are: *Jalanidhi* (World Bank assisted), sector reforms (Rajiv Gandhi National Drinking Water Mission), Dutch Assisted Schemes (SUEF), and various small private initiatives and panchayat owned schemes.

Government is the dominant player among water management institutions in the state. The role of state, as provider of public services, often does not succeed because of various technological and administrative constraints. The state led water supply schemes have mainly concentration in urban areas alone and were not able to meet the

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water demand among the rural areas. Poor financial performance with high revenue loss played an important role in the failure of government owned water supply schemes. In community managed schemes, the beneficiary groups are responsible for planning and implementation. This may lead to more efficient valuation of water resources and 'economic pricing' in drinking water. Success of community based projects depends on various factors. One of the major limitations of the community management in rural water supply is, 'economic' consideration rather than sustainability consideration. Also the withdrawal of state from the provision of drinking water has some welfare implications. Locally managed community schemes are more flexible and work more efficiently. Management through gram panchayats is found to be more stable and less conflicting. The community based approach is still in infant stage and hence needs more research to understand its policy implications.

13. Showcasing IWMI's New Global Public Goods

David Molden, Hugh Turral and Upali Amarasinghe

26th February 2005

12:30 – 13:30

Session Chair: Frank Rijsberman

Have our water investment and management decisions paid off? How have they impacted poverty, food security, and the environment? What are our options for the future? IWMI's Comprehensive Assessment takes stock of these questions; David Molden presents interim results.

The RS-GIS Unit of IWMI currently holds over one Tetra-byte of data which has recently been catalogued, streamlined and released to the public through the Data Storehouse Pathway (DSP). How can researchers and academics in India use this important resource to enhance their research? What does this offer to policy makers in the government and in grassroots organizations?

This session will focus on highlighting some of the new global public goods produced by IWMI. This will include IWMI's recent work in Comprehensive Assessment, RS-GIS, Modeling and Databases.

David Molden	Global Learnings from Comprehensive Assessment of Water Use in Agriculture	Presentation Only
Hugh Turral	Presenting IWMI's Global Irrigated Area Mapping and Data Storehouse	Presentation Only
Upali Amarasinghe	Demonstrating the Uses of IWMI's PODIUM*Sim* Model	Presentation Only