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RETHINKING REHABILITATION: SOCIO-ECOLOGY OF TANKS AND WATER HARVESTING IN RAJASTHAN, NORTH-WEST INDIA

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ABSTRACT

In the arid and semi-arid Indian state of Rajasthan, tanks and ponds have been a mainstay of rural communities for centuries. There are over 4600 large minor irrigation tanks, plus numerous *johads, bandhs* and *pals* (small water harvesting structures). This paper assesses a strategy proposed for rehabilitating 1200 of the larger tanks. It argues that treating tanks only as flow irrigation systems—which lies at the center of the mainstream thinking on rehabilitating surface irrigation systems--is very likely to result in a flawed strategy when applied to tanks. Instead, reviewing the successful experience of NGOs like PRADAN and Tarun Bharat Sangh in reviving and rehabilitating clusters of small traditional water harvesting structures at a watershed level, it posits that Rajasthan's tanks belong more to the watershed development domain than to the irrigation domain and that a strategy that views tanks as multi-use socio-ecological constructs, and which recognizes varied stakeholder groups is more likely to enhance the social value of tanks.

KEYWORDS: watershed, watershed management, multiple uses, natural resource management, tank rehabilitation, collective action

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1. INTRODUCTION

As the potential for creating new irrigation capacity approaches closure, many developing countries and international donor agencies are turning to ways of enhancing the productivity and performance of existing irrigation infrastructure through rehabilitation. In the face of growing water scarcity, there is also new-found interest in applying the notion of rehabilitation to small traditional water harvesting and irrigation systems which have existed for many decades or even centuries in countries like India. In the strict sense, 'rehabilitation' has traditionally meant technical interventions aimed at restoring a system to its original design potential for performance (FAO, 1997).[3]

However, critical assumptions made in the original design are often erroneous, and in any case, over a long period after the commissioning of a new system, conditions in the irrigation system change a good deal and warrant a different design appropriate to modern conditions. As a result, a broader conception of rehabilitation often questions the original design and results in its modification to suit contemporary conditions. There is also growing recognition of the

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[1] Research Leader, International Water Management Institute, Colombo.
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[3] According to Renault (1998:5) Rehabilitation..'consists of reengineering a deficient infrastructure to return it to the original design.' But modernization implies 'fundamental changes in the rules governing water resources management. Modernization may include interventions to the physical infrastructure as well as to its management'.. According to an FAO conference (cited in Kalu 1998:169), 'Modernization is a process of upgrading (as opposed to mere rehabilitation) of irrigation schemes combined with institutional reforms, if required, with the objective to improve resource utilization (labor, water economic, environment) and water delivery service to farms.'

importance of effective institutional change as a precondition to the success of a rehabilitation program. In the debate on farmer participation in irrigation management, an issue of interest now is whether institutional intervention preceding technical rehabilitation — rather than vice versa — might not enhance the overall chances for improved performance. The original narrow notion of rehabilitation continues to have a powerful sway over irrigation establishments as well as donor agencies. As a consequence, a good deal of what goes on under 'rehabilitation' continues to be 'technical intervention aimed to restore the system to its original design potential for performance'.

This conventional, narrow notion of rehabilitation is at the heart of a strategy proposed in the arid and semi-arid state of Rajasthan in north-western India for improving the performance of large irrigation tanks (GOR, 1997a and b), as well as a new strategy being evolved by the Government of India on a country-wide approach to tank rehabilitation (GOR Planning Commission, 1999). In assessing such a strategy, this paper adduces evidence and insights gained in the course of field research on tank communities of eastern Rajasthan carried out during 1998. Findings suggest that while the conventional notion of rehabilitation is destined to fail when applied to Rajasthan's tanks, even the broader, modern notions of rehabilitation would need considerable refinement, especially if rehabilitation should improve their overall performance. A major challenge lies in defining 'tank performance' in an appropriate way in the context of Rajasthan. Tank rehabilitation needs to be planned in the river basin context especially in basins that are approaching closure.[4] A strategy that has greater chance of success is likely to be one that views tanks as complex socio-ecological systems with multiple

[4] When water diversions in a river basin approach net inflow of water into it so that there is no scope for new water development, the river basin is said to be approaching 'closure'.

stakeholder groups in watersheds rather than the present one which treats them as pure flow irrigation systems.

The research reported here was carried out as part of an assignment to review the proposal developed by the Government of Rajasthan for rehabilitation of some 1200 of the largest minor irrigation tanks for the Swedish International Development Agency. The sections on non-government organizations like PRADAN and Tarun Bharat Sangh draw heavily on Tushaar Shah's work for the Swiss Development Agency on the evaluation of PAWDI (Participatory Watershed Development Initiative) project implemented by the Government of Rajasthan and a group of Rajasthan NGOs. The survey methods included participatory appraisal techniques, focus group discussions and unstructured interviews with opinion leaders. The present study included interviews with community members in some 25 areas served by large and small tanks in five districts (Bhilwara, Ajmer, Jaipur, Alwar, Bundi and Tonk), some managed by the Irrigation Department (ID) and some managed by *Panchayats* (Village Councils). In some areas revenue assessment and collection is done by the ID and in others it is done by the revenue administration. The authors also interacted with prominent NGOs—notably, PRADAN and Tarun Bharat Sangh (TBS) in Alwar and a TBS associate NGO in Chaksu tehsil (Jaipur district). The authors also scrutinized available documents and relevant literature, and interviewed a broad cross-section of officials from the ID, researchers and development practitioners. These interviews were useful to triangulate perceptions and conclusions gathered from fieldwork. The effectiveness of this approach proved variable. Information available about the current state and productivity of tanks is patchy and little research and analysis of tank systems has been undertaken by independent researchers so far. As a result, some of the key arguments of the paper still remain in the nature of hypotheses rather than conclusions but the central argument of the paper—that 'conventional' engineering rehabilitation would not improve performance of tanks—remains a robust conclusion.

2. PROBLEM AND PROPOSED SOLUTION

Rajasthan, including the Thar desert, forms one of the most arid regions of India. The state receives an average of around 550 mm of rainfall, and has a per capita water availability of around 700 cu m, far below the all India average of over 1200 cu m (GOR 1996:17). The bulk of the rain falls in the span of a few hours in torrential showers. Small check dams called *johads* or *paals*, with water spread areas of a few acres, and larger minor irrigation (MI) tanks—with command areas of 1000 ha or more-- are the mainstay of rural communities especially in the eastern and southern parts of the state. Rajasthan has 4600 such minor irrigation tanks with an estimated potential command area of 630,000 ha. Typically, these have earthen dams with a *pucca* (cement-lined) overflow structure and one or more sluices. From each of the sluices emerges a canal, generally unlined, but often provided with *pucca* outlets irrigating *chak*s (command areas) of various sizes. A large number of these tanks (2272 according to GOR 1997a) were built before India attained Independence in 1948, some built by the *rajahs* and *jagirdaars* are over 100 years old. Others are new and were constructed by the Irrigation Department (ID) of the Government of Rajasthan (GOR) mainly under famine relief schemes. A major concern of the ID is that all these tanks—old as well as new—have fallen into disrepair. The tank beds have silted up, particularly near the dam, reducing the storage capacity far below potential. Siltation near the sluice gates often blocks gates partially and/or raises the sill level, enlarging the dead storage. Many water distribution systems are considered to be inefficient. Sluice gates in many systems are in a state of disrepair. In many, water leaks out continuously.

Poorly maintained cross-drainage works result in wastage of water and damage to structures. Most tanks have only *kuchcha* (unlined earthen) canals, few have portions of main canal/s lined. After years of siltation, the carrying capacity of canals has also been reduced. In many old canals, there are no outlets, and farmers have made breaches, which weakened the canal walls, to divert the flow to their fields, On-Farm Development (OFD) work is of poor quality or non-existent. Farmers themselves do some maintenance work. In most systems, before the irrigation season commences, farmers co-operate in small groups to clean the canal portions closest to their fields, removing weeds, grass and other foreign matter so that water can flow smoothly. However, nowhere did we find them desilting the canals or strengthening the canal walls or deepening the canal beds. Seepage rates during conveyance are high. Water takes a long time to reach the tail end fields and the number of days the system has to operate to complete one round of irrigation has been increasing. In many systems, tail-end farmers face difficulty in receiving water at all, particularly in years of low rainfall when tanks have filled only partially and the need for irrigation is acute. At such times, the problems of equitable distribution of water between head reaches and tail farmers worsen. In an average year tail-enders hardly manage to irrigate once while head-reach farmers are able to irrigate three times. This situation is of concern for the ID.

The strategy devised by the Government of Rajasthan (GOR, 1997 a and b; GOR, 1998) to restore the tanks to their design potential entails: [a] major renovation of the physical structures — bund, sluice gates, canals — by the ID in 1198 of the largest tanks; [b] organization of command area farmers into Water User Associations (WUAs); [c] turn over of the O and M of the distribution system below the minors (but *not* the head-works and the main canals) to the WUAs, along with the responsibility for determining and collecting irrigation fees, and developing and enforcing norms for water distribution; and [d] strengthening and modernizing the Minor Irrigation Division (which is responsible for tanks) including the provision of vehicles, computers, and communication systems. The most important benefit of implementing the strategy, it is claimed, would allow to increase the additional command area by 64,000 ha, partly as a result of expansion in storage and improved distribution systems, and partly as the Project is expected to close the gap between the designed intensity of irrigation (59%) and the actual intensity of irrigation (estimated 51%). This would enhance net annual agricultural production in the command area by an estimated value of US $30 millions against an investment US$ 10.3 millions, 95% of which is assigned to engineering works including repairs on head-works, canals, farm channels, and other OFD works.

In a recent article (Raju and Shah, 2000) the authors discuss the organizational and 'process' aspects of the proposed strategy and suggest a preferable alternative strategy. In this paper, we analyze some of the basic notions underlying the present strategy of rehabilitation. There are several grounds for concern regarding the proposed strategy:

1. First, it is expensive: the cost/ha of new irrigation potential of US $1600 is high compared with the average cost of US $1280 incurred in constructing new small scale systems during the 1992-96 period, and several times higher than costs incurred by NGO programs with people's participation in construction.
2. Second, the sequencing of the interventions is problematic: it is proposed that Irrigation Management Transfer (IMT) to Water User Associations (WUAs) will begin only after the technical rehabilitation is completed by the ID, whereas experience world-wide suggests that farmers lose interest in taking over the management of systems once rehabilitation is completed, especially if it does not involve their participation.
3. Third, the proposal indicates that only the distribution system at the minor level and below is to be turned over to farmers' WUAs, while the head-works and the main canal will still be controlled and managed by the ID. This would unduly limit the role of the WUAs and fails to address the problem of dependency of farmers on the ID.

4. Fourth, the understanding of the role of tanks is very limited: we believe the proposed strategy takes a too narrow view of the role of tanks purely as flow irrigation systems, whereas in reality Rajasthan's tanks play a complex set of multiple roles for diverse groups of stakeholders. Entrusting their management to WUAs of command area farmers may exclude important stakeholder groups and ignore several critical roles tanks play in their local socio-ecologies.
5. Finally, the strategy fails to consider the bigger picture: many river basins in Eastern Rajasthan are approaching closure, which means that, it is not possible for one tank community to increase its water supply without decreasing it for another community. We therefore believe that a rehabilitation strategy that addresses an entire river basin or a macro watershed may produce better results than one that focuses on individual tanks.

The next sections focus on the last two points that, in our view, are central to the development of a strategy aimed at real improvements in water productivity in Rajasthan's tanks.

3. DECREPIT, YET MARVELOUS

MULTIPLE FUNCTIONS, FREE OF COST

Even in their present decrepit state, Rajasthan's tanks are a socio-ecological and economic marvel. At a low opportunity cost, they perform many useful functions, six of which seem particularly notable. First, they help capture, conserve and store what little rainfall the region receives and in the process reduce soil erosion by cutting the pace and momentum of run-off waters. Second, they provide low-cost flow irrigation. Third, they help recharge groundwater aquifers, which provide a stable and reliable source of irrigation and domestic water supply. Fourth, they reduce the intensity of flash floods and droughts. In years of high rainfall, such as 1996 when the monsoons caused devastating flash floods in Alwar, Bharatpur and other districts of northeastern Rajasthan, tanks significantly reduce the threat and damage of flash floods. In contrast, in years of low rainfall, tanks and aquifer storage directly fed by tanks provides some protective irrigation. Fifth, tanks concentrate silt and minerals contained in rain water run-off in tank beds and in the command area and fertilize the soil. Sixth, and most importantly, unlike large reservoirs and tanks in South India which take land in the submergence areas away from other uses, tank-beds in Rajasthan are used both for water-storage as well as for cultivation. As a rule, farmers grow winter –and, sometimes, summer-- crops in tank beds after they are emptied; as a result, tanks are efficient in land-use.

TANK-BED CULTIVATION

Use of tank beds for farming, locally known as *petta* cultivation, is an integral and distinctive feature of the tanks of Rajasthan, as also of other smaller water harvesting and storage structures such as anicuts, *johads, paals, and bandhs*. Indeed, in smaller water harvesting structures, the submergence area is the primary beneficiary. *Petta* cultivation is an extensive practice. The legality of *petta* cultivation is controversial, and especially for old tanks, the ownership of the submerged lands itself is ambiguous. Commonly, no records exist about the ownership of these lands. Originally, it must have been the *jagirdaar*'s land, but over several decades private use rights were established and defended by farmers. These farmers have become de facto owners of *petta* lands, and this practice has continued in newly built tanks too.[5]

Over the years, an interesting practice—fancifully called 'inundation irrigation'—has become the vogue in many tanks in Eastern Rajasthan. This involves emptying the entire tank in one go. In the Ramnagar tank on the Boondi-Bijolia road, for instance, the tank storage is

[5] In newer tanks, such as Govind Sagar in Ajmer, the Irrigation Department acquired the private fields falling in the submergence area (and the cost of this acquisition, even at government rates, was nearly half of the total project cost in Govind Sagar). The practice in such cases is to give erstwhile owners the right to cultivate for three years after acquisition; thereafter, the cultivation rights on acquired submergence land are either auctioned or departmentally allocated, usually to the original land owners. Moreover, since acquisition is not compulsory, many farmers with land in submergence areas refuse to sell their land to the government and retain their ownership rights.

emptied in just one long spell of irrigation on 15th September. While the exact dates may differ, in many tanks areas in Rajasthan, inundation irrigation is formally accepted as an operating practice with consent of farmers as well as the ID. This surfeit of involuntary irrigation creates a 1.5-2 feet thick sheet of water that covers a large area downstream of the bund, including all the fields in the design command and beyond. Fields deprived of gravity flow are sometimes irrigated using diesel pumps installed on canals during this inundation period. Both the lifters as well as the gravity-flow irrigators wet their land to the limit, since the next irrigation is not guaranteed unless a substantial late shower fills up the tank again. Inundation irrigation serves to help recharge the aquifers; it also helps top soils retain enough moisture to allow rabi crop to grow. Over the years, the practice of inundation irrigation has produced important changes in districts like Alwar, which has a total of 115 tanks[6], most following variants of this practice. Farmers in the *petta* lands and command areas have, through some process of negotiation, agreed on the date on which the sluice gates will be opened up for inundation irrigation. The date is critical: it must leave *petta* land farmers enough time to soak their lands; and it must leave enough time for the downstream farmers to dry their lands and get ready for rabi cropping. Inundation irrigation has also affected infrastructure maintenance. Since under this practice canals are not used, they have fallen into disuse and disrepair. By default, then, many of the Alwar and Bharatpur tanks have begun to function like out-sized *paals* (bunds). Both in *petta* as well as command areas, a crop of mustard is raised using soil moisture with little supplementary well-irrigation. The Irrigation Department is concerned about the state of disrepair of the tank and canal structures. But in some ways, farmer improvisations have resulted in what might be

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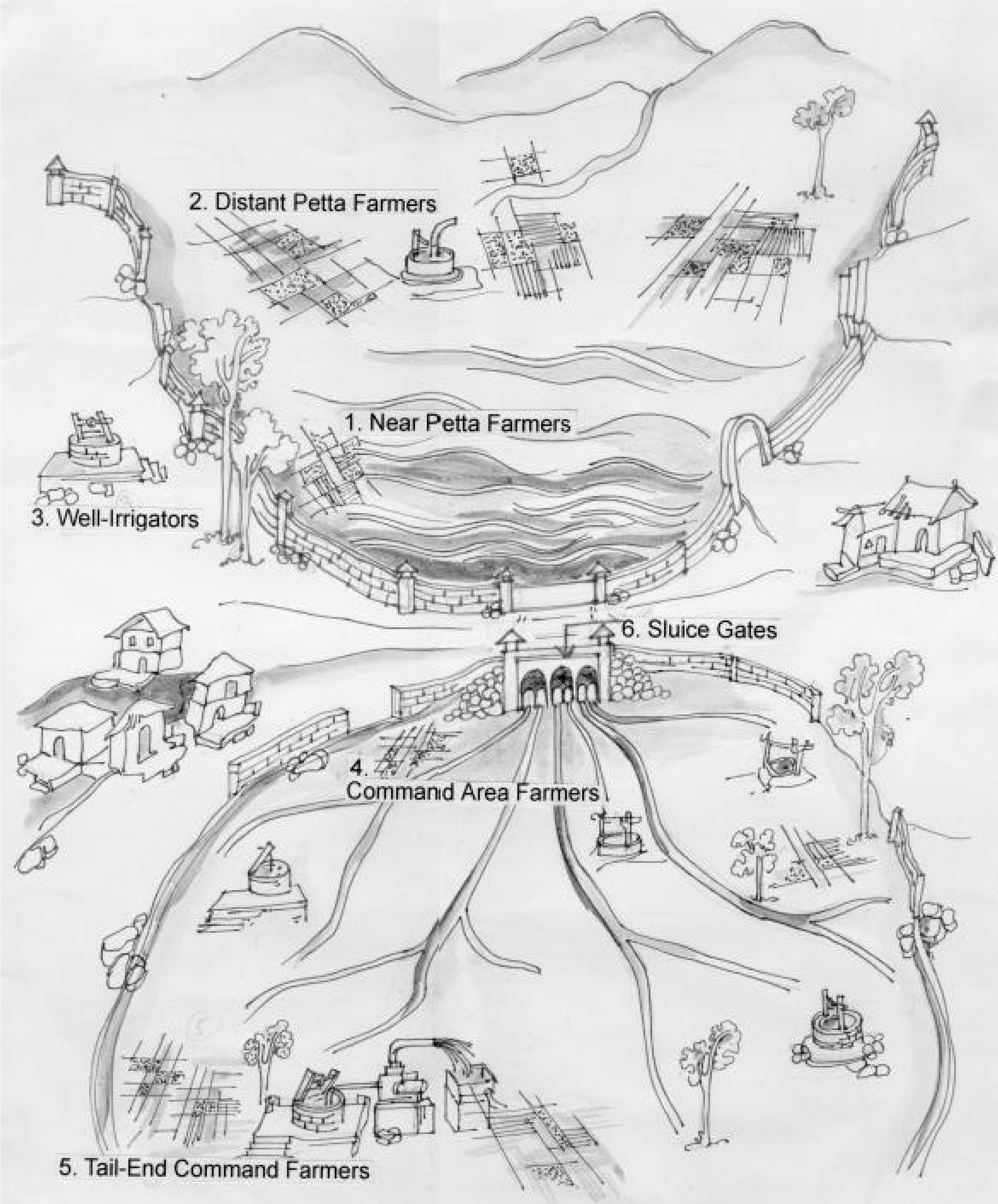
[6] including the famous Jai Samand, a big tank with over 900 mcft capacity designed to provide 4 waterings to a command of 3500 ha

considered the best of a bad situation. In any case, with the profusion of new water harvesting structures in the catchment areas, most tanks in a district like Alwar do not impound enough water to provide intensive irrigation even to their small official design commands. It is argued that the total area reached by the inundation irrigation is probably larger than that reached with conventional irrigation even after rehabilitation.

In normal gravity flow systems and South Indian tanks, the primacy of command area farmers as the sole or main stakeholder group is unambiguous. In contrast, stakeholder groups in Rajasthan's tank areas have far too many conflicting interests for a straight-forward engineering rehabilitation to enthuse all of them (Figure 1). As a result, the central problem in improving farmer management of tanks in Rajasthan is the difficulty in harmonizing the interests of different stakeholder groups. Take the problem of tank bed siltation: the Department considers this the central problem in need of fixing through rehabilitation. But tank-bed farmers have a strong interest in siltation which they find beneficial. It fertilizes the soil, reduces the period over which their land near the headworks remains submerged, but expands the overall area of submergence for just long enough for it to be prepared for cropping. In some tanks, siltation gives tank-bed farmers near the bund time to take a rabi as well as a summer crop using soil moisture and groundwater irrigation.

Figure 1 : Multiple Stakeholders In Rajasthan Tanks



There are similar conflicts of perceptions with respect to the siltation problem. The technical solution preferred by the ID is de-siltation, but it is simpler and cheaper to raise the height of the bund by a foot or two to raise storage capacity by several million cubic feet. Although this is highly cost effective, the Department's technical appraisal discourages this practice because it increases the submergence area — which the department considers a cost — and increases evaporation losses. Command area farmers agree with the department but tank-bed farmers prefer raising the bund height to desilting because it expands the submergence area—to their benefit--without unduly lengthening the period for which the tank-bed *petta* land near the bund remains submerged. In tanks practicing 'inundation irrigation', of course, *petta* farmers give their unreserved support to raising the tank bund.

Petta cultivators' interests, thus, are generally in direct conflict with command area farmers. They like siltation in the tank-bed; command area farmers do not. *Petta*-cultivators want the tank emptied by end-September, while head-tail farmers in the command area want the tank to hold water so that they can receive three full irrigations during the rabi season. *Petta* farmers have no interest in the rehabilitation, particularly of the canal system; command area farmers have a strong interest in it. Existing *petta* farmers near the dam loathe the idea of desilting the tank-beds because their lands will not dry in time for a rabi crop; distant *petta* farmers[7] prefer raising the bund height to desilting the tank bund near the dam, and the command area farmers prefer desilting over raising the bunds. *Petta* farmers are probably a strong interest group in tank management; else, it is difficult to understand why the practice of `inundation irrigation' is so much in vogue. There are other stakeholders, too. Fishing communities' interests differ from those of other groups; they have no interest in canal rehabilitation; they the

[7] That is, those in the periphery of tank-bed whose lands get submerged only in years of high rainfall.

bund to be raised but abhor inundation irrigation. Generally fishing communities do not have a powerful voice, but in Panchayat (Village Council) managed tanks where fishing contracts are awarded to private contractors, the contractors are often able to influence or even dictate the water release policies.

EXTENSIFICATION

The ID's tank management strategy — dominated by management practices popular in large irrigation systems — has tended to favor intensive, orderly gravity flow irrigation in the officially designated command. In the past, when the Irrigation Department was able to manage tanks more closely than it does today, farmers in the official command received up to 12-15 thousand cubic meters of water per ha and could grow water loving crops, which is an anachronism for this water-scarce region. But this has changed as a result of pressures for extensification[8]. The GOR strategy is concerned about the pressures for extensification that have evolved in tank systems over recent decades. Curiously, despite problems of siltation of tank-beds, poor maintenance of head-works and distribution systems — all of which reduce the design command — the actual areas served by many tanks have slowly increased far beyond the originally design command areas. This has happened in a number of ways. First, through tank-bed cultivation, which even today is not accounted for in the benefit-cost calculus of the ID. Then, the ends of the canals have commonly been extended by farmers on the fringe of the designed command to serve more land by flow irrigation. Initially, their owners were viewed as

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[8] Not very long ago, for instance, small commands of many tanks in Bhilwara and Tonk districts—such as Mandal and Lamba—had substantial sugarcane cultivation; today, sugarcane has been replaced by wheat and mustard over a larger but sparsely irrigated area far beyond the official command. In a tank called *Pechi-Ki-Bavri* we visited at Sailadutta village, Hindoli Tehsil of Bundi district, we found that the effective command area had expanded nearly 100% over the last decade, and groundwater irrigation had replaced the second and third rounds of gravity irrigation from tanks. The net effect was that a third of the command, especially near the head, grew sugarcane in mid1980s; but now there is none.

unauthorized encroachers, but over the years, they became established as part of the official command. In old tanks, many fields inside the official command were initially left fallow and therefore excluded from the design command. Due to growing population pressure and commercialization, owners began irrigating these fields. Being inside the command, they had little difficulty staking claim to tank irrigation. Moreover the traditional well-irrigators inside the command were viewed as 'non-command' farmers. Some of them deliberately opted out to evade assessment for irrigation fees, but since within the command area, they are able and do use flow irrigation. Finally, there are farmers with up-lying lands within the command where gravity flow cannot reach. Many of these have dug small ponds which they fill with tank water and then lift it to irrigate their up-lying fields using long (often 1.5-2 km) flexible pipes. In some tanks we visited, farmers enforced the department norm that allows lifting water only using traditional bullock driven devices, but in many others farmers irrigate freely with diesel pumps.

THE RECHARGE FACTOR

Another major group of stakeholders in tanks are well owners in the tank-bed as well as in the command. The ID engineers and head-reach farmers bemoan the heavy seepage losses during storage and conveyance of water, the reduction of which is on of the main objectives of the proposed rehabilitation strategy.

However, except in areas with problematic geology including impermeable soils, through out our fieldwork we found that improved productivity of wells due to groundwater recharge is by far the most valuable benefit farmers associated with the tanks (see, e.g., UN, 1998; GOR, 1999).[9] In Govindgarh tank in Ajmer district, interviewed farmers asserted that the increase in land values in the aftermath of the construction of a new tank, is by no means limited to tank bund and command areas but extends to the entire domain influenced by the increase in groundwater recharge due to the tank. Even farmers without wells feel better off with tank recharge because of improved prospects of accessing purchased well irrigation. As one of them said ‘being at the mercy of water sellers is by no means worse than being at the mercy of the Sarkar [Irrigation Department]; at least, the water seller is around for you to fall to your knees before him.” An ingenious and vibrant system of conjunctive use of surface and groundwater in most tanks compensates for having only one or two flow irrigations. Although private investment in wells has increased only slowly, pump irrigation markets are extensive and vigorous particularly in the neighborhood of tank bunds. Purchased well irrigation is expensive[10], yet groundwater is the

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[9] That improved productivity of wells due to groundwater recharge is the major benefit of new and rehabilitated tanks is supported by many studies throughout India (see, e.g., Shah et al. forthcoming; Kulandaivelu and Jayachandran 1990; Reddy, Rao and Prakasam 1990; Shah 2000b).

[10] Pump irrigation sells at Rs 35-40/hour (US $ 0.9-1) from 5 hp diesel pump-sets; flexible pipes are leased out to water buyers by the well owners at Rs 20 (US$0.5)/100 feet/day. At Rs 500-750 (US$ 12-18) for a single watering per ha, purchased groundwater is indeed expensive irrigation compared to Rs 175 (US$ 4.3)/ha for 2-3 flow irrigations from tank. and yet, farmers seem to prefer it. Most likely, this is because of the greater control and reliability that pump irrigation offers compared to canal irrigation which in any case is seldom sufficient to fully irrigate any crop other than gram or *raido* (mustard). And wells, once recharged, offer control and reliability. The pump owners we met in Gobind Gadh in Ajmer were keen that the department permits pumping from the canal or the reservoir; they were willing to pay even Rs200/bigha (Rs 1000/ha) for such irrigation compared to the standard Rs 175/ha for flow irrigation (although he was sure that no one would come to collect it). But he was sure that if such permission were given, farmers would be happier and would have better control over irrigation. There are important questions of equity involved since head reach farmers can intensively use abundant and cheap flow irrigation to grow crops like *methi* (fenugreek) and wheat while tail-enders have to make do with the costlier groundwater to grow only mustard or *taramiri* (a minor oilseed).

mainstay of the farm economy in surroundings of the tanks because it offers reliability, timeliness and control that flow irrigation from tanks does not.

Indeed, there might be value in thinking of irrigation tanks primarily as percolation tanks designed to maximize groundwater recharge over as large an area around the tank as possible. In areas with confined aquifers with rock stratum at 40-50 feet below ground, there is a strong relationship between the level of tank storage and water level in the wells.[11]

CATCHMENT ENCROACHMENT

The present tank rehabilitation strategy does not address the declining water input into many tank systems. A major factor behind this has been the profusion of water harvesting and storage structures up-stream of the tanks. Most of these were not there when the tanks were originally planned and designed. This may be partly because the population density was lower, and so was the demand for water up-stream, and partly because there has now been a major campaign to increase water harvesting, in the name of 'watershed management'. However, as population and water demand have increased in the catchment, a variety of new structures have come up under individual or group initiatives with support from government programs as well as NGOs. As a consequence the free catchment available to the tanks has declined and so has their input of rain water runoff. The ID has not approved this development, and the Rajasthan Irrigation Act empowers the state to prohibit such structures above a certain size in the catchment of existing tanks (GOR, nd), but no move has been made so far to check the growth of

[11] In many tanks, farmers described the relationship with high level of accuracy; in one of the tanks we visited in Tonk, for example, farmers told us that when the water level in the tank moves between 5 and 12 feet either way, the water level in their wells moves directly with it and on a one-to-one basis.

such structures.[12] From the technical viewpoint, the department's concern about unchecked growth is clearly understandable. NGOs like Tarun Bharat Sangh argue that each tank captures the precipitation that falls over a catchment of 30-50 sq km and assigns it to a small command belonging to 300-400 families. Decades ago when the tanks were built, the bulk of their catchment area was uninhabited and water demand in the catchment area was probably negligible. However, that is no longer the case today; and residents of the catchment areas assert their right to capture some of their own rainfall for their use rather than forgo it in order to fill up tanks downstream built under different conditions decades ago. Some of the new social organizations around water — such as the *Swadhyaya* movement in water-scarce Gujarat — are promoting a new 'water ethic' amongst people: "rain falling on your roof stays in your house; rain falling in your field, stays in your field; rain falling in your village, stays in your village" (Shah, 2000).

This sets into motion an interesting dialogue between the western notions of rights based on riparian notion and/or prior appropriation principles and the notion of rights on rainfall precipitation based on the *Swadhyaya* ethic that is gaining popularity throughout western India. It is early to predict which viewpoint will prevail. However, it is clear that notions of riparian rights and prior appropriation make sense in countries like the US, New Zealand and Canada where users compete for 'diverted' flows of water; population density is high around and towards the end of the rivers but the catchment areas are sparsely populated, and rainfall precipitation received over several months, combined with low temperatures and low wind-speeds, cause very low losses through evapotranspiration. In semi-arid regions of South-Asia, by

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[12] It did intervene once apparently when Tarun Bharat Sangh, an NGO built a series of *pals* and *johads* in Alwar district; but the NGO mobilized massive public support, took the issue to the court and even had it raised in the Legislative Assembly of the state. Finally, the ID had to drop the issue.

contrast, population density tends to be high downstream as well as in the catchment areas, monsoon rainfall is received over a short period and has to be conserved and stored over November-May in conditions of high temperatures and wind-speeds that cause very high evapotranspiration losses. As water scarcity grows in Western India, the competition is no longer for captured or flowing water, but for rainfall precipitation itself.[13]

As rain water captured, conserved and stored in a macro-watershed approaches the total precipitation, competition between water harvesting structures is to be expected. In many macro-watersheds—such as the Ruparel river basin in the Alwar district of Rajasthan—where the entire basin has been saturated with a variety of small and large, private, group, and community owned water harvesting and storage structures, increased water input and storage in a large tank must reduce the availability of water in water harvesting structures downstream, and construction of new structures upstream directly affects the water supply in tanks downstream. In such situations, rehabilitating an isolated tank will only transfer benefits from one community to another. If order is to be brought in this chaotic race to capture water, new and more complex rules, that encompass the watersheds and entire river basins, are needed. Many have already begun to question the ID's assertion that the catchment of older and bigger tanks should be protected because antecedent to other tanks and because over time the state has heavily invested in them.

It is easy to create a false sense of clarity by restricting the analysis of the impact of the interventions, such as a rehabilitation that increases its storage, carried out only in the command areas of tank systems. Resulting strategies and management practices that exclude certain

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[13] Agarwal 2000 presents evidence that diverting rain water in a large number of small water harvesting structures in a catchment captures and stores more of the scarce precipitation closer tot eh communities in these parts of the world than having a large reservoir downstream.

groups will be resisted. For example, any management strategy also affects well recharge and thus well users, but groundwater users in the neighborhood of a tank are not considered stakeholders.

4. TANKS IN A RIVER BASIN PERSPECTIVE: LESSONS FROM NGO EXPERIMENTS

NGOs working with tanks in Eastern Rajasthan have placed much emphasis on the variety of roles tanks play in their socio-ecologies (see, e.g. Mishra, 1993; 1995). Of particular significance is the work by PRADAN with *paals* and of Tarun Bharat Sangh with *johads.*

PRADAN operates a rain water conservation project in Alwar district that aims at the revival of the traditional *paal* system of rain water harvesting. In Hindi, a *paal* is a bund built along a contour and in many ways is a miniature version of a tank but without sluice gates and canals. A typical *paal* is made of earth is around 8-12 feet high, 12-15 feet wide at the base, and up to 100 meters long. Grass or vegetation is grown along the sides to minimize soil erosion, and the top of the bund is used as a cart road. *Paals* have been built and used by farmers for ages, but have fallen into disuse. One reason for their decline has been the increase in groundwater irrigation in the area. Another major factor was the migration to Pakistan at the time of India's Independence of the *Miya* community whose members were builders and keepers of *paals.* With their departure the skills and the enthusiasm for *paals* were lost. Farmers have ignored the repair and maintenance of the *paals* for decades. PRADAN has tried to revive and improve upon the technique. Starting work on isolated *paals* several years ago, PRADAN discovered early the value of working on a system (or cascade) of *paals* covering an entire micro-watershed to internalize the externalities and maximize the benefits. PRADAN has helped village groups build over 110 *paals* in Alwar in several micro watersheds, keeping in view the macro-watersheds or basins of which these are parts. A series of *paals* is built in a zigzag manner in a micro-watershed to capture and impound the floods flowing downstream with great velocity and force. *Paals* prevent massive soil erosion that flood waters cause and, by reducing the velocity and force of rain water runoff, reduce the pressure that the floods would place on the dams downstream. Each *paal* forms a mini-tank of shallow depth. Water is retained for 50-60 days, during which 50-60% percolates to the aquifer to facilitate well irrigation, while the rest evaporates.

The direct benefits of *paals* accrue to farmers in the tank bed *above* the *paals*. Their land accumulates silt and becomes fertile, needing little fertilization. Farmers above the *paals* sow their crops as the land becomes emptied of water; and a crop like mustard grows entirely on the residual moisture. Wheat requires one or two additional waterings provided from the recharge of wells. In a cascade of seven *paals* in Kishan Garh, the static pre-monsoon water table in open wells has risen to only 8 meters compared to earlier level of 25-27 meters. Before, water from wells could be pumped for hardly any length of time, and had to be left to recoup for days before it could be pumped again for an hour or so; now the well water can be pumped for hours on end without appreciable decline in the water level. A number of abandoned wells have been revived. Pump irrigation markets have sprung up, with the irrigator receiving a quarter of the harvest.

PRADAN has learnt three important lessons: first, groundwater recharge is probably the most valuable benefit of their work with *paals*; second benefits created by *paals* grow exponentially as the density of *paals* increases in a watershed; third, it is difficult to create a sustainable farmer organization around *paals* without understanding and harmonizing conflicting interests of multiple stakeholder groups. Despite intensive and time-consuming organizational work, and although farmers recognize the benefits of building *paals*, PRADAN is still unable to secure the collective action needed to maintain the *paals* in proper condition. Where PRADAN built clusters of *paals* as in Kishan Garh, however, the entire community developed a new interest in the technology because all the wells in the watershed benefited. Wells then became the rallying point of the *paal* program. Therefore PRADAN has gone further upstream in its organizing efforts. For each micro-watershed, it has formed a *Samiti* (Committee) that includes all members benefiting from the *paals*; in Kishan Garh block, 14 such *Samitis* have been grouped into a federation with a broader mandate that provides services including savings and credit, extension support, fertilizer and improved seed supply.

Tarun Bharat Sangh (Young India Association, or TBS) works at the level of Ruparel river basin--in roughly 550 villages spread over 5 sub-divisions of Alwar district. Their water harvesting work covers approximately 6500 square kilometers. Therefore, its impact is visible and generates powerful demonstration effect on the people living in the area. Like PRADAN, TBS works with a variety of water harvesting structures including *bandh* (bunds) and *medbandhi* (farm bunds), but the centerpiece of its work has been the construction of thousands of *johads* build with communal labor. A *johad* checks rain water in *nalas* (drainage channels) where it is impounded for 50-60 days while the land in the submergence area "soaks in the water, quenches its thirst and fills up its stomach as camels do in the Thar desert" (as a local farmer explained to us). Spill-ways are provided to allow excess water to overflow. After the water dries up, crops are grown in the *petta* lands and wells is recharged so that additional irrigation becomes possible. Once the benefits of *johad* development work become visible and the word spreads amongst villages, demand for similar work comes forth on its own. Once there is demand, half the job of eliciting farmers' participation is done. Since 1985 TBS has built large clusters of *johads* in many areas These clusters, encompassing entire watersheds, rather than individual *johads*, have had a dramatic impact on farm economies as well as on the hydrology of these areas. Again, groundwater recharge has been central to TBS' success (see, e.g. GOR, 1999:8). Wells, which a few years ago were completely or almost dry, now abound in water that can be pumped for as long as farmers need. Several small rivers and numerous natural drainage ways that had been dry for decades have suddenly sprung to life and many flow perennially (Patel, 1997; Singh, 1996). Farms that had been given up as wasteland have begun growing crops like mustard, wheat, and maize. To TBS's worry, some sugarcane cultivation has begun, too. Many abandoned wells have been recommissioned. And an area which had become a basket case has become green once again and is poised on the road to rural prosperity. Land values in many TBS areas have shot up from US $ 2000-2400 per ha to US $9000-10000 per ha.

A major ecological outcome of *johad* concentrations is the reduced impact of both floods as well as droughts. In the areas of Alwar district, which has dense concentrations of TBS supported *johads* and other water harvesting structures, the effect of the 1996 flood was minimal or absent all together; elsewhere, floods devastated villages, destroyed *pucca* bunds and in general created great havoc (Ravi and Jain, 1997; Singh, 1995; Singh, nd). A dense system of *johad*s cuts the pace and fury of flood waters that race down the hills with great pace and force, and thus preempts what might otherwise become a flood.

TBS's work also offers important insights about a scaling up strategy in which people take large and growing initiative (TBS, nd). First is its organization design; TBS has its own core staff of less than 100, but has several hundred volunteers chosen from the villages where they work (and paid a modest honorarium). Many members of the staff have spun off into small grassroots organization; and TBS has extended support to these. Second, they enter a new village only on farmer demand, after ascertaining broad-based local support for the initiative. Over the years, they have evolved a set of norms and rules that have become standardized. For example, people who benefit always have to contribute all the labor needed plus some material and cash. TBS tops this up with financial support for hire of tractors and cement. Besides, TBS's own 'home-grown' engineers also provide crucial help in community organization processes: they consider the needs and concerns of participating members and develop a structure capable of addressing these issues. Third, TBS's works are cheap compared to government structures. Moreover traditional institutions for managing water harvesting structures are being revived, and a community-wide dialogue develops on ways of sustaining and enhancing water retention[14]. Recently, farmers along the 30 km long Arwari river (in the Ruparel river basin), which was revived thanks to TBS's concentrated *johad* campaign have formed the Arwari River Parliament with representatives elected from each village. The River Parliament has already formulated a set of norms embodying a new 'water ethic' which, for instance, bans the cultivation of sugarcane in all villages and imposes restrictions on pumping from wells in certain periods. It is early to assess the significance of this institutional development, but the Arwari River Parliament may well be the first spontaneous, grass-roots river basin institution in India.

5. TOWARDS AN APPROPRIATE TANK REHABILITATION STRATEGY?

The present strategy of the Government of Rajasthan for improving the productivity of tanks is based on a limited view of the role of tanks. Tanks are considered pure gravity-flow irrigation systems, their primary function to provide flow irrigation. In addition it recognizes only the command area farmers as stakeholders and overlooks the potential impact of

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[14] In Hammirpur tank, for instance, the land under the *bandh* belonged to a private farmer; the village Gram Sabha persuaded him to give his land for building the *bandh* and compensated him by creating a new holding by cutting up small pieces from the lands belonging to farmers in the submergence area.

rehabilitation on other groups likely to be affected—downstream users, groundwater users, and tank-bed cultivators.

In reality tanks are not very dependable structures for flow irrigation. In our assessment, the rehabilitation program should be based on an alternative concept of tanks as socio-ecological constructs whose benefits, besides flow irrigation in the command area, include groundwater recharge in the entire neighborhood of the tanks (in a radius of as much as 20 km^2 in some tanks), *petta* cultivation, fisheries, and meeting non-agricultural demand for water — such as domestic uses, livestock, and industry.

Moreover, in many river basins, it may be difficult to make significant improvements in one part of the watershed/basin without adversely affecting other parts. By increased storage through de-silting or raised bunds, for example, it may become possible to provide three irrigations to the official command compared to one as at present; but if this means that half the submergence area of the tank belonging to *petta* farmers cannot be cropped with rabi, the gain in the command area can be more than nullified by the loss incurred in *petta* cultivation. Similarly, lining of canals may increase the velocity and out-reach of flow irrigation; but if it reduces the recharge of wells in a significant measure, the net benefits of lining may be greatly reduced. If rehabilitation of tanks makes numerous small *johads* downstream useless and unproductive, the tank command farmers may benefit from rehabilitation but many other farmers may lose. The extent of such interaction effects is an empirical question which the ID needs to address.

Information is needed on issues as the extent of water-loss in tank storage versus aquifer storage due to evaporation; groundwater recharge coefficients in lined and unlined water conveyance systems; the pattern of distribution of run-off capture and storage in different water harvesting and storage structures in a basin; the size of recharge zones of different tanks; and the proportion of tank storage loss explained by evaporation and groundwater recharge. We believe that incorporating technical relationships such as these is absolutely essential before any sensible planning of tank rehabilitation can begin. An approach that is likely to be most effective in such a situation is not the blue-print that underlies the current strategy, but a learning process approach that lays great stress on experimenting with alternative ways of improving productivity of tank systems, and closely studies the implications of each one. Such an approach can result in improved management of water resources provided it recognizes multiple stake holders, conflicting interests, complex structure of rights and obligations in tank systems, and provided it views each tank within the larger perspective of its watershed and its river basin.

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