LOCAL PERCEPTION AND USE OF THE MULTIFUNCTIONALITY OF TANKS IN TWO VILLAGES OF TAMIL NADU SOUTH INDIA

Victoria Reyes-García[1], Olivia Aubriot[2], Pere Ariza-Montobbio[4],
Elena Galán-del-Castillo[4], Tarik Serrano-Tovar[4], Joan Martinez-Alier[4]

Abstract

Interventions aiming to devolve water management to local populations can be problematic if they overlook socio-cultural aspects, such as local perceptions and uses of water management systems. We used ethnographic and survey data collected in two villages in Tamil Nadu, India, to analyze local perceptions and uses of tanks, a traditional irrigation infrastructure. We found that informants recognize the importance of tanks for irrigation, but also acknowledge other socio-economic uses and ecological functions. Our data also suggest that marginal segements (i.e., Scheduled Castes) use tank resources in more diverse ways than other segements of the population. International organizations working on the revival of tanks aim to transfer water management to farmers for the purpose of irrigation. By recognizing that tanks benefit people other than farmers and in ways other than providing irrigation water, organizations working on tank rejuvenation could achieve a more equitable management of tank resources.

1. INTRODUCTION

Over the last two decades, irrigation researchers, policy-makers, and donor agencies have become increasingly disenchanted with large-scale irrigation systems (Hussain and Hanjra, 2004; Moris and Thom, 1990; Webb, 2006) and have shifted their focus to farmer managed irrigation systems (Watson et al., 1998). The shift has ocurred parallel to a trend to decentralize water management programs from the state to local users (Parker and Tsur, 1997). Research suggests that interventions by outside agencies that aim to devolve water management to local populations can be problematic (Meinzen-Dick and Zwarteveen, 1998; Webb, 2006). Issues such as the appropriateness of technology, forms of social organization (including gender considerations), and patterns of resource rights have significant implications for conventional top-down approaches (Meinzen-Dick and Zwarteveen, 1998; Watson et al., 1998). Social scientists have long argued that if interventions aimed at improving the developmental role of indigenous water management systems are to be effective, planners need to not only reconsider technical, but also socio-cultural factors (Gleick 2000; Pahl-Wostl et al. 2007; Diemer and Huibers 1996). Despite the claim, many development programs still fail to effectively include socio-cultural considerations, often because of the scant research on the topic.

In this article, we analyze local perceptions and uses of a locally-managed irrigation system, the tanks. tanks are an old irrigation infrastructure widespread in the semi-arid areas of southern and central India (Vaidyanathan, 2001). tanks are shallow reservoirs ranging from a few to over a thousand hectares and are formed by constructing earthen embankments that extend across the natural drainage flow and that dam in situ

[1] Researcher, ICREA and Institut de Ciència i Tecnologia Ambientals, Universitat Autònoma de Barcelona, 08193 Bellatera, Barcelona, Spain

[2] Researcher, French Institute of Pondicherry, Puducherry, India

[3] Faculty, UPR 299, CNRS, 7 rue Guy Môquet, Villejuif cedex. France

[4] Institut de Ciència i Tecnologia Ambientals, Universitat Autònoma de Barcelona, 08193 Bellatera, Barcelona, Spain

rainfall and seasonal runoff. Tanks are mainly found in regions where rainfall is moderate (350–800 mm), inter-annual variability is high, and there are clay soils with low permeability, which reduces seepage into the ground (Agarwal and Narain 1997; Gunnell and Krishnamurthy, 2003). Tanks are mainly meant for irrigation but research shows that they also provide other socio-economic uses and ecological functions that benefit sectors of the society beyond farmers (Gunnell and Krishnamurthy, 2003; Palanisami and Meinzen-Dick, 2001; Shan and Raju, 2002).

Researchers concur that the importance of tanks for irrigation in South India steadily fell during the nineteenth and twentieth centuries (Aubriot 2008; Janakarajan 1993; Palanisami and Meinzen-Dick, 2001). Despite the decreasing importance of tanks for irrigation, researchers claim that tanks can provide a locally managed alternative to groundwater irrigation and to the controversial construction of big infrastructures such as dams (Agarwal and Narain, 1997). For the last two decades, Indian and international organizations (including the European Union, the World Bank, and the ADB) have invested considerable resources in the revival of tanks (ADB, 2006; Sakthivadivel et al., 2004). Two common traits are found in tank rehabilitation projects. First, tank rehabilitation projects mainly focus on irrigation and water storage (ADB, 2006), but neglect most alternative uses of water or other tank resources (except fish cultivation). Second, tank rehabilitation projects promote the participation of land-owners in tank management (Meinzen-Dick and Zwarteveen, 1998), thereby excluding other sectors of the population.

In this study, we used data collected in two villages in Tamil Nadu, South India, to analyze local perceptions and uses of tanks. Differently from previous social research on the topic (Palanisami and Meinzen-Dick, 2001; Shah and Raju, 2002), we analyzed local users perceptions of the benefits provided by tanks. Our emic approach complements the etic understanding of the socio-economic and ecological benefits of tanks provided by previous literature. By analyzing responses from farmers and non-farmers, we assess whether tanks are locally perceived and used for proposed other than irrigation. We propose that a better understanding of local people's perception and uses of tanks might help improve the design and implementation of tank rehabilitation projects.

2. TANKS IN SOUTH INDIA

Originally, tanks were mainly constructed for agricultural purposes. By impounding runoff water from the monsoon rains, tanks support cultivation in the reservoir command area (Jayatilaka, et al., 2003). Research shows that tanks also provide other socio-economic uses and ecological functions (Palanisami and Meinzen-Dick, 2001; Shan and Raju, 2002). Water from tanks provide many economic (example, fisheries) and domestic (example, fresh water) uses. Tanks, as they are not full most part of the year, also provide other resources, such as silt, trees, and grass. Socially, tanks are repositories of symbolic resources and are central elements of villages (Mosse, 1997). Tank management systems have been interpreted as public institutions that express social relations, status, prestige, and honor (Singh, 2006). Tanks, as other common property resources (Freeman III, 1993), provide many environmental services and ecological functions. Tanks provide direct environmental services (such as irrigation water and drinking water) as well as indirect environmental services (such as contributing to flood control and providing habitat for a variety of species (Ratnavel and Gomathinayagam, 2006).

Tank resources and ecological functions benefit different sectors of the society. In theory, access to water for irrigation is available to all farmers in the tank command area. Water is available to the entire population, not only farmers, but also for domestic uses (i.e., washing clothes, bathing). Other benefits from the tank resources (e.g., extraction of silt) also reach the entire population in a village (Palanisami and Meinzen-Dick 2001). More importantly, rights to fish, trees, and grass along the tanks are often auctioned. Funds generated from auctioned tank resources are often expended on village social activities such as temple construction or village festivals (Janakarajan 1993; Meinzen-Dick 1984; Mosse 1997; Prabhakar 2008; Wade 1987).

3. THE SETTING AND THE PEOPLE

There are around 39,000 tanks for about 15,000 villages in Tamil Nadu. The Public Works Department (PWD) of Tamil Nadu has control over 8,903 tanks that have a command area of more than 40 ha. Panchayat Unions have control of the 20,413 tanks that have a command area of 40 ha and less. There are also 9,886 tanks called the Ex-zamin tank. Individual local chiefs called Zamindars once controlled these tanks. Nowadays, the PWD is responsible to undertake repair works in these tanks. Tanks were the main source of surface irrigation in Tamil Nadu until the 1960s (35% of total irrigated area) and they still accounted for about 17% of irrigated area in 2004-2005 (Season and Crop reports of Tamil Nadu, cited in Aubriot 2008).

For the purpose of this research, we selected villages with tanks still in use for agriculture. We conducted research in two villages in the Villupuram District (Tamil Nadu): Attur and Endiyur (Table 1). Both villages are located about 5km away from the nearest city, Tindivanam (about 200,000 people), in a pediplain rocky zone of the Kaluvelli watershed. Agriculture and cattle rearing are the two main economic activities in the studied villages. The main crops grown in irrigated land are paddy, sugarcane, banana, casuarina, and cotton, and the main crops grown in non-irrigated lands are groundnut, black gram, finger millet, cotton, and chili. The two villages experience permanent and seasonal migration.

Table 1 - General characteristics of the two study villages

	Source	Attur	Endiyur
Total Population	Census of India 2002	1508	2683
Population from Scheduled Castes	Census of India 2002	658	0
Landless population (%)	Village Administrative Office	37	17
Wells for irrigation	Well census 2004	274	227
Tanks command area (in ha)	Village Administrative Office	115	62
Rainfed cultivated area (in ha)	Village Administrative Office	256	252

Each village has a large and a small non-system tank (i.e., rainfed tanks not connected to rivers). Irrigation water from tanks is available from October to December-February (according to rains). Tank irrigation is supplemented with groundwater irrigation. At the time of the research, there were 208 electricity lines for agricultural pumps in Endiyur and 55 in Attur, and numerous pumps using diesel engines. The Public Works Department (PWD) is responsible for opening the sluices and maintenance (i.e., repairs and desiltation) of the large tank in each village. The Panchayat Union is responsible for the small tanks. Every year, the PWD and the Panchayat Union alienate the rights to manage the tank resources (i.e., grass, fish) through open auctions. Farmers are responsible for water distribution and irrigation canal maintenance. In Endiyur, there are two Water Users Associations, formed in 2000 with the help of a non-governmental organization working in tank rehabilitation. All farmers in the command area of Endiyur's tanks, and only these farmers, are included in the Water Users Associations, which has the duty of managing the tanks (i.e., implement rehabilitation work with the assistance of PWD, plan the water rotational system, and remove encroachers). Nevertheless, Water Users Associations seem not to be effective in the study villages, and tanks are actually managed by traditional institutions and the Village Panchayat.

4. METHODS

The study was conducted under the umbrella of the Social Water Management program of the French Institute of Pondicherry. Three researchers collected data with the help of two assistants fluent in English and Tamil.

4.1 Data Collection and Analysis

4.1.1 Participant observation

Three researchers lived in Endiyur for a three-month period (February-April 2007). Since Attur is only about 3 km away from Endiyur, the researchers were able to visit this village regularly. During fieldwork, researchers participated in the regular activities of the villages. Notably, they accompanied people in their festive and work activities. Participant observation allowed the understanding of the different ways in which resources from tanks are used. We also conducted group interviews to get a better understanding of the different perceptions and uses of tanks according to different social groups.

4.1.2 Free listing

We conducted free listing to generate a comprehensive list of reasons why tanks are important for villagers (Weller, 1998). We used a stratified sampling strategy (Bernard, 1995), selecting informants from various groups with expected variation in uses of the tanks such as men, women (Meinzen-Dick and Zwarteveen, 1998), and people from different castes (Tiwary, 2006). We also selected people with different occupations (i.e., farmers, shepherds). The total sample for free listing was 54 respondents from 54 households, which represents 6% of the total number of households in the study villages.

Respondents were asked to generate a list of items in response to the question: "Why do you think tanks are important for the village?" We probed respondents to give as many reasons as they could conceive. Once the list was completed, we asked informants to provide a short description of the reasons that were not clear to us when the informant had listed them. Because our question was general, we do not know if people were referring to a specific tank when answering our question. Although free-listing is widely used in anthropological research (Bernard, 1995), the question used here might have biased the answers as it indirectly conveys that tanks are indeed important. Thus, households that might not place a particular importance on tanks, might have given positive answers because of the framing of the question. Unfortunately we did not collect information on the relative importance of tanks in relation to aspects of livelihoods (such as drinking water or sanitation) to weight the bias introduced by our question.

From responses to free listing, we calculated: 1) the percentage of people who mentioned each reason, 2) the average rank of the order of mention of each reason, and 3) the saliency of each reason (the weighted average of the inverse rank of an item across multiple free lists, where each list is weighted by the number of items on the list) (Bernard, 1995). The saliency index evaluates, with a range from 0 to 1, the overall importance of an item across all of the lists.

Based on the saliency index, we arbitrarily created four categories: High Saliency ($S>0.5$), Medium Saliency ($S<0.5$ & $S>0.1$), Low Saliency ($S<0.1$ & $S>0.01$), and Marginal Saliency ($S<0.01$). We also used informants' explanations to classify items according to their main use or function (ecologic, economic, and socio-cultural). Among economic functions we differentiate between agricultural, non-agricultural, and domestic. As one particular item might have more than one use or function (example, flood prevention has an economic use and an ecologic function), the results from this classification should be taken with caution.

4.1.3 Survey

We conducted a survey to assess household variation in the uses of tanks. To select informants for the survey, we followed the same sampling strategy that was used to select informants for free listing. The sample for the survey included 96 adults (people over 15 years old) from different households. Of the total, 53 informants were from Endiyur and 43 from Attur.

The household survey included socio-economic questions (i.e., caste, land ownership) and questions related to the use of tanks (Table 2). Questions related to the use of tanks were selected from responses to free listings and refer to economic uses. We did not include questions on social uses or ecological functions because the ecological (example, attract biodiversity) and social (example, source of revenue for village festivals) functions

that appeared in free listing likely do not vary across households. If participants reported the economic use, we coded the answer as 1 and, otherwise we coded the answer as 0; therefore the total score might vary from 0 to 8 uses.

Table 2: Survey questions on the use of tanks in two rural villages in Tamil Nadu (n=96)

Category of use	Question	% Positive answers
Agricultural	Do you use water from the tank for irrigation?	47.9
	Do you use the tank's silt to fertilize your lands?	34.3
Non-agricultural	Do your cattle drink from the tank?	36.4
	Did you participate in the last auction of a resource from the tank?	18.7
	Have you ever bought wood from the person who won the auction of the trees?	11.4
Domestic	Does the grass on your roof come from the tank?	31.2
	Do you use medicinal plants from the tank?	36.4
	Do you wash clothes in the tank?	59.3

Our survey included questions related to agricultural, non-agricultural, and domestic uses of tanks. For each household, we generated a diversity score for each one of the three economic uses by adding the positive answers in each group. We also generated a total diversity score by adding responses to all of the questions. We used t-test and an ordinary least square regression to analyze differences in diversity of use across households with various socio-economic characteristics.

4.2 Results

4.2.1 Why are tanks locally considered important?

Respondents listed 49 different reasons why tanks are important (Table 3). On average, informants listed 8.01 different reasons (SD=3). The shortest list included only two reasons and the longest included 17.

Table 3: Results from free-listing about the importance of water tanks in two rural villages in Tamil Nadu (n=54)

Reasons listed	Category	% resp	Avg rank	Saliency
High Saliency (S>0.5) (n=1)				
Crop production	Econ-Agri	80	2.093	0.69
Medium saliency (S<0.5 & S>0.1) (n=14)				
Irrigation	Econ-Agri	46	2.84	0.37
Drinking water for cattle	Econ- Non Agri	54	3.75	0.37
Favor presence of fish	Ecol	61	5.51	0.28
Drinking water	Econ-Domestic	43	3.78	0.28
Well recharge	Ecol	37	3.70	0.26
Water storage	Ecol	26	2.92	0.19
Wash clothes	Econ-Domestic	35	6.21	0.17
Grass for roofs	Econ-Domestic	28	4.93	0.17

Reasons listed	Category	% resp	Avg rank	Saliency
Favor presence of trees	Ecol	39	6.00	0.16
Favor presence of grass	Ecol	30	5.50	0.15
Firewood production	Econ-Domestic	30	6.43	0.13
Bathing	Econ-Domestic	28	6.33	0.12
Formation of silt for manure	Econ-Agri	26	6.92	0.11
Fish auction	Econ- Non Agri	28	7.06	0.10
Low saliency (S<0.1 and S>0.01) (n=22)				
Grass auction	Econ- Non Agri	22	6.91	0.09
Favor presence of plants	Ecol	19	6.30	0.08
Employment creation	Econ- Non Agri	19	6.50	0.07
Grass for cattle	Econ- Non Agri	19	6.50	0.07
Trees auction	Econ- Non Agri	15	8.75	0.06
Increase of production	Econ-Agri	7	4.25	0.04
Favor presence of birds	Ecol	9	7.60	0.04
Temperature control	Ecol	9	7.00	0.04
Wash cattle	Econ-Non Agri	7	6.75	0.03
Favor presence of crabs	Econ-Domestic	7	5.00	0.03
Trees for shadow	Ecol	7	8.00	0.03
Silt formation	Econ-Domestic	7	5.00	0.03
Provides livelihood	Econ- Non Agri	7	6.75	0.02
Males toilet	Econ-Domestic	4	5.50	0.02
Trees attract the rain	Ecol	6	11.00	0.01
Saves pumping electricity	Econ- Non Agri	2	2.00	0.01
Recharge fresh water pond	Ecol	2	3.00	0.01
Favor presence of snakes	Ecol	4	6.50	0.01
Favor presence of snails	Econ-Domestic	4	6.50	0.01
Fruit production	Econ-Domestic	4	7.00	0.01
Wash vehicles	Econ-Domestic	2	3.00	0.01
Trees for erosion control	Ecol	4	11.00	0.01
Marginal saliency (S<0.01) (n=12)				
Learn to swim	Socio	2	8.00	0.008
Flood prevention	Ecol	4	15.00	0.007
Favor honey production	Econ-Domestic	2	6.00	0.007
Soil formation	Ecol	2	8.00	0.006
Ornamental function	Socio	2	5.00	0.006
Provides common area	Socio	2	7.00	0.005
Favor presence of frogs	Econ-Domestic	2	8.00	0.002
Leisure space	Socio	2	8.00	0.002
Festival	Socio	2	8.00	0.002
Liquor from trees	Econ-Domestic	2	16.00	0.002
Temple	Socio	2	12.00	0.002
Domestic water	Econ-Domestic	2	14.00	0.001

Notes: Econ= economic uses, Ecol=Ecologic uses, Socio= socio- cultural uses. Agri=agricultural uses, Non-Agri= non-agricultural uses, Domestic=Domestic uses.

Only one of the 49 reasons recorded fall in the category of High Saliency: crop production. Crop production was listed by 80% of people in the sample and, on average, the reason appeared in the second position on the lists (S=0.69).

The Medium Saliency group includes nine economic and five ecological reasons. Among the economic reasons, we found two reasons related to agriculture (irrigation and silt for manure), two reasons not directly related to agriculture (water for cattle and fish auction), and five domestic uses (example,, fresh water, grass for roofs). From the five ecological reasons in the Medium Saliency group, two relate to water for agriculture (well recharge and water storage) and three to other natural resources (example,, favor presence of fish and trees).

The Low Saliency group is the largest group and includes 22 reasons, most of which were mentioned by less than 20% of the informants, typically at the end of their lists. The group includes one economic reason related to agriculture, seven economic reasons not directly related to agriculture, and six domestic reasons. The Low Saliency group also includes ten ecological functions of tanks (example,, favor presence of plants and birds).

Last, 12 of the 49 reasons fall into the Marginal Saliency group. The group includes two ecological functions (i.e., flood prevention and soil formation), four domestic uses (exmaple, favor honey production), and six socio-cultural reasons (example,, provides common area). Socio-cultural reasons appear only in the Marginal Saliency group.

4.2.2 How do villagers use tanks?

Data from the survey suggest that most households in the sample use tanks. The average informant reported 2.76 of the eight uses included in the survey (SD=1.58). Only nine informants reported no economic use of the tank by their household. None of the respondents answered positively to all of the uses and only one answered positively to seven of the eight questions. Forty-one percent of the households in the sample reported no agricultural uses of the tank, 45% reported zero non-agricultural uses of the tank, and 23% did not report any domestic use.

In results from bivariate analysis (not shown) we found that households from Scheduled Castes reported a higher diversity of uses in comparison to households from other castes ($p<0.05$). The difference is due to higher domestic uses (1.7 versus 1.1; $p<0.001$), as we did not find statistically significant differences in agricultural and non-agricultural economic uses of tanks according to caste. Households who owned land reportedly had a higher diversity of uses of tanks than landless households (2.43 versus 1.78, $p<0.05$). Households owning land had a higher number of agricultural (0.42 versus 0.08, $p<0.001$) and non-agricultural (0.72 versus 0.47, $p<0.1$) economic uses than landless households. We did not find differences in the number of domestic uses between the two groups. Cattle owners reported more uses than non-cattle owners (2.64 versus 1.83, $p<0.001$). Cattle owners reported more non-agricultural uses of tanks than households who did not own cattle (0.91 versus 0.32; $p<0.001$), but a similar number of agricultural and domestic uses. Well owners reported a higher diversity of agricultural ($p<0.001$) and non-agricultural ($p=0.07$) uses than households who did not own a well but there was no statistically significant difference between the groups in the number of domestic uses.

Bivariate analysis does not allow us to simultaneously control for several individual level characteristics. In multivariate analysis (Table 4), we ran an ordinary least square regression of our diversity score against the four socio-economic characteristics just analyzed. We found three statistically significant variables. Being from a Scheduled Caste is associated with 0.91 more uses of the tanks ($p=0.06$). Land ownership was associated in a statistically significant and negative way to diversity of uses of tanks. One additional acre of land was associated with 0.11 less uses of tanks ($p=0.054$). Well ownership was associated in a positive way to diversity of uses of tanks ($p=0.02$).

Ordinary least square regression of the score of diversity of uses of tanks against household socio-economic characteristics (n=96).

Explanatory variables	Coef.	RobustStd. Err.	P>|t|
Scheduled Castes	.94	.11	0.07
Number of cows	.16	.04	0.17
Acres of land owned	-.11	.009	0.05
Number of wells	.75	.02	0.02
R2	0.26		

Notes: Regression is an OLS with robust standard errors and clustering by village of residency.

5. DISCUSSION AND CONCLUSION

We organize the discussion around two findings that emerge from our results. First, our data suggests that, without denying the importance of these tanks for agriculture, villagers also acknowledge the multifunctionality of tanks. Second, our data suggest that marginal sectors use tank resources in more diverse ways than other sectors of the population.

The first finding that deserves discussion is the local perception of tanks as multifunctional. In contrast to previous research (Palanisami and Meinzen-Dick 2001), we drew on informants' insights to compile a list of the reasons why tanks are locally appreciated. We found that most, but not all, informants mentioned crop production and irrigation as the most relevant uses of tanks. Thirteen percent of respondents did not mention crop production or irrigation as important reasons for the existence of tanks, which can be interpreted as an indicator that villagers perceive tanks to be important beyond agricultural uses.

Previous ethnographic research on the topic has highlighted the importance of tanks as articulators of social institutions (Mosse 1997; Singh 2006; Wade 1987). Results from our free listing data complement this previous research and suggest that people give more importance to the economic uses of tanks than to the socio-cultural functions. The finding however should be read with caution as the divergence in findings might be due to methodological issues. When asked about the importance of tanks, people might have understood the question as referring mostly to the material importance of tanks. Therefore, our method might not have fully captured the socio-cultural importance of tanks.

The second finding that deserves discussion is the distribution of uses of tanks across the population. Our data suggest that marginal sectors (Scheduled Castes and people with less land) use water resources in more diverse ways than other sectors of the population. Scheduled Castes have historically had less access to land and irrigation than other castes, and they often live far from tanks (Tiwary 2006). In Attur people from Scheduled Castes lived in proximity to tanks, and our data suggest that currently they use tanks in more diverse ways than people from other castes. Much of the difference is due to a higher diversity of domestic uses. Although domestic uses of tanks might be economically less relevant than agricultural uses, these uses might have high value in terms of household consumption, nutrition, and health, especially for the poorer.

Future research needs to tackle the validity of this finding paying especial attention to an important omitted variable in our analysis: income. Poor people might be more dependant on tanks for their livelihoods than rich people. Since people from Scheduled Castes are typically among the poorest, our finding might just point at the importance of income, rather than cast, as a relevant explanatory variable to understand the importance of tanks in rural livelihoods. Future research should decouple the relative role of cast and income in their association with diversity of uses of tanks.

We conclude by hightlighting some policy issues that emerge from our analysis. Our findings suggest that local population seems to benefit from the multiplicity of uses and functions of tanks, irrespective of whether they use tanks for irrigation. These findings pose at least three issues that need to be addresed by policies on tank management. First, which of the uses and services generated by tanks are exclusive? What are the potential trade-offs between different uses and services? Second, if there are trade-offs between uses and

services, which ones should be maintained? Our research gernerated a ranked list of the uses and services provided by tanks to the local population. Future research should analyze the size of those uses and services for different sectors of the population. Third, should beneficiaries of relativelly less salient uses and services participate in tank management? If not, how can users other than farmers have a voice to ensure than "non-irrigation" uses and services are maintained? We suggest that in addressing those complex policy issues, organizations working on tank rehabilitation can achieve a more equitable and socially sustainable management of tank resources if they recognize that tanks benefit people other than farmers and in ways other than providing water for irrigation.

ACKNOWLEDGEMENTS

Research was funded by a Marie Curie International Reintegration Grant (CT-2006-036532). Ariza-Montobbio, Galán-del-Castillo, and Serrano-Tovar benefited from an internship at the French Institute of Pondicherry to conduct field work and to get logistic support. Our thanks go to I. Prabakhar (IFP) for his help and advices, to R. Nithya and Anamalai for daily support in the field, and to ICRISAT-Patancheru for office facilities to Reyes-García. Thanks also go to the people in Endiyur and Attur for their patience with our questions. J. Bouma, M. Celio, D. Tabara, JP Venot, and one anonimous reviewer gave valuable comments to previous versions of this article.

REFERENCES

Agarwal, A and S Narain (1997), Dying Wisdom. Rise, Fall and Potential of India's Traditional Water Harvesting Sytems. State of India's Environment: Centre for Science and Environment, New Delhi.

ADB (2006), Rehabilitation and Management of Tanks in India - A Study of Select States, Asian Development Bank, Philippines.

Aubriot, O (2008), Tank and well irrigation in crisis. Série Sciences Sociales. Puducherry: Institut Français de Pondichéry.

Bernard, H.R. (1995), Research Methods in Anthropology. Qualitative and Quantitative Approaches. Altamira Press, Walnut Creek

Census of India (2002), Census of India 2001. Ofice of the Registrar General, Delhi.

Diemer, G. and FP Huibers (Eds.) (1996), Crops, People and Irrigation. Water allocation practices of farmers and engineers. Intermediate Technology Publications, London.

Freeman III, AM. (1993), The measurement of environmental and resource values: theory and methods, *Resources for the future.*

Gleick, P. H. (2000), The changing water paradigm: a look at twenty-first century water resources development. *Water International,* 25:127-138.

Gunnell, Y and A. Krishnamurthy (2003), Past and Present Status of Runoff Harvesting Systems in Dryland Peninsular India: A Critical Review. Ambio 32, no. 4:320-324.

Hussain, I and MA Hanjra (2004), Irrigation and poverty alleviation: Review of the empirical evidence. Irrigation & Drainage 53, no. 1:1-15.

Janakarajan, S (1993), In search of tanks : some hidden facts. Economic and *Political Weekly,* A53:A60.

Jayatilaka, C. J.; R. Sakthivadivel, Y. Shinogi, IW Makin and P. Witharana (2003), A simple water balance modelling approach for determining water availability in an irrigation tank cascade system. Journal of Hydrology 273:81-102.

Meinzen-Dick, R. Local management of tank irrigation in south India: Organization and operation. Cornell University. Cornell Studies in Irrigation, Ithaca, NY.

Meinzen-Dick, R. and M. Zwarteveen (1998), Gendered participation in water management: Issues and illustrations from Water Users' Associations in South Asia. Agriculture and Human Values 15, no. 4:337-345.

Moris, J. R and D. J. Thom (1990), Irrigation development in Africa: lessons of experience. Boulder, CO: Westview Press.

Mosse, D (1997), The symbolic making of a common property resource: History, ecology and locality in a tank-irrigated landscape in south India. Development and Change 28, no. 3:467-504.

Pahl-Wostl, C; M Craps, A. Dewulf; E. Mostert; D. Tabara and T. Tailleu (2007), Social learning and water resources management. Ecology and Society 12, no. 2.

Palanisami, K. and R. Meinzen-Dick (2001), Tank performance and multiple uses in Tamil Nadu, South India. Irrigation & Drainage Systems 15:173-195.

Parker, D. D and Y. Tsur (1997), Decentralization and Coordination of Water Resource Management. Boston: Kluwer Academic Publishers.

Prabhakar, P. I (2008), Institutions of Tank management. In Tank and well irrigation in crisis, edited by Aubriot, O. Série Sciences Sociales. Puducherry: Institut Français de Pondichéry.

Ratnavel, SM and P Gomathinayagam (2006), In search of Ancient Wisdom - Irrigation tanks. Madurai: DHAN foundation, Madurai.

Sakthivadivel, R, R Gomathinayagam, and T. Shah (2004), Rejuvenating Irrigation tanks through local institutions. Economic and Political Weekly, no. July 31:3521-3526.

Shah, T and K. V. Raju (2002), Rethinking rehabilitation: socio-ecology of tanks in Rajasthan, north-west India . Water Policy 3, no. 6:521-536.

Singh, N (2006), Indigenous water management systems: Interpreting symbolic dimensions in common property resource regimes. Society and Natural Resources 19, no. 4:357-366.

Tiwary, R (2006), Explanations in Resource Inequality: Exploring Schedule Caste Position in Water Access Structure. IWMI-TATA Water Policy Program APM.

Vaidyanathan, A. (Eds.) (2001), Tanks of South India. Centre for Science and Environment, Delhi.

Wade, R (1987), Village Republics: Economic Conditions for Collective Action in South India. Cambridge University Press, Cambridge.

Watson, E., W. M. Adams and S. K. Mutiso (1998), Indigenous irrigation, agriculture and development, Marakwet, Kenya. *The Geographical Journal* 164, no. 1:67-85.

Webb, P (2006), When projects collapse: Irrigation failure in the Gambia from a household perspective. Journal of International Development 3, no. 3:339-353.

Well census (2004), Government of Tamil Nadu, State Ground and Surface Water Resources Data Centre (Unpublished report).

Weller, S (1998), Structured interviewing and questionnaire construction. In Bernard, H. Russell (Eds.),The Handbook of Methods in Cultural Anthropology, Walnut Creek: Altamira Press.