LOCAL MANAGEMENT OF TANK IRRIGATION IN SOUTH INDIA: ORGANIZATION AND OPERATION

Ruth Suseela Meinzen-Dick

Cornell Studies in Irrigation, Number 3
372 Caldwell Hall
Cornell University, Ithaca, NY 14853 USA

EXECUTIVE SUMMARY

Much of the emphasis in irrigation development policies has been focused on formal management institutions, and understanding of nonformal cultivators' associations has not been commensurate with their importance. This paper examines the local management of tank irrigation in Tamil Nadu, with particular attention to the structure and system management activities of the cultivators' association. The study is based upon field research in a small-scale irrigation tank in Tirunelveli District. It makes use of the ecological perspective, in which water management activities are discussed in relation to the physical and socioeconomic environment. The effects of tank management are seen not only in surface irrigation, but also in the recharge of wells, which form part of the same hydrological system.

Tanks, or small earthen reservoirs, are an important source of surface irrigation and groundwater recharge in South India. Many of the tanks in Tamil Nadu are centuries old and were historically managed by autonomous local bodies. As the state grew in strength, its administration took on increasing responsibility for tank irrigation, and local institutions appear to have declined.

Results of the field study indicate that nonformal local cultivators' associations make an important contribution to the overall performance of the irrigation system, even where government agencies are formally responsible for irrigation. Such organizations mobilize local resources for use in a wide range of irrigation-related tasks, including inspection and repair of physical structures, acquisition and distribution of tank water, and interaction with government bureaucracies on tank-related issues. However, an important aspect of these organizations is that they are accountable directly to the cultivators, and are neither created nor controlled by a government agency.

The existence of active, nonformal associations for tank management among cultivators of different social and economic positions demonstrates that the traditional institutions of kinship, caste, village, religion, and party are not the only organizing forces in Indian rural society, nor are they necessarily obstacles to cooperation for economic purposes. A thorough attempt to understand and encourage existing local institutions and water management practices could provide a means of improving the performance of tank irrigation systems in South India.

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CHAPTER 1: INTRODUCTION

In its strategy of increasing agricultural production, India has emphasized irrigation as a basis for improving productivity and cropping intensity, and as a complement to the use of high-yielding varieties of major crops (Venketesan, 1982). While the government has been involved in the construction and major repairs of irrigation facilities, responsibility for the maintenance of terminal structures and for the distribution of water within blocks of fields has been left with the cultivators. Thus, local institutions for irrigation system management play an important part in the delivery of water to the fields. This is particularly true of minor irrigation works because the government provides less administrative infrastructure than for large-scale projects.[1] However, attention to and knowledge of the structure and system management activities of local institutions have generally not been commensurate with their importance (Chambers, 1980:28-30). Much of the emphasis in irrigation development policies has been focused on the role of formal irrigation institutions, particularly the government bureaucracies. The role of nonformal local associations has not generally been included in the conceptualization of irrigation system management. Moreover, the great variation in the degree of activity and forms of such organizations and the difficulties of studying them in depth have hindered the development of a widespread understanding of how local bodies contribute to the management of tank irrigation systems.

This paper presents a field study of one nonformal organization involved in maintenance and water management for a small-scale irrigation tank in southern

Tamil Nadu. While such a localized study is limited in its generalizability, it provides information on local irrigation practices and insight into other similar irrigation associations by identifying important structural patterns and principles of operation. It is argued that local organizations make an important contribution to the management of tank irrigation by mobilizing local resources for use in a wide range of irrigation-related tasks.

Tanks are small reservoirs that store runoff water for irrigation and sometimes for domestic water supply. They are formed by constructing an earthen dam, or bund, across a natural drainage basin. If tanks are to be used for surface irrigation, there will be one or more sluices that allow water to flow under the bund to reach the fields in the ayacut.[2] In some areas, there are percolation tanks without sluices designed to recharge the ground water table. Most of the tanks in Tamil Nadu are designed primarily for surface irrigation, with inadvertent percolation that recharges the water table. The ayacuts of these tanks range from less than ten hectares to several hundred hectares. Tanks may be classified into two general categories based on the source of their water supply: nonsystem tanks that receive water only from an adjacent catchment area, and system tanks that are connected by channels to other tanks and often to rivers or seasonal streams, which provide water to supplement the runoff from the tank's catchment area.

Tanks are found in several areas of Asia, including Sri Lanka, Bangladesh, Burma, Thailand, Cambodia, and throughout India. Within India, they are most important for irrigation in the southern states of Tamil Nadu, Karnataka, and Andhra Pradesh (von Oppen and Subba Rao, 1980a:12). Tamil Nadu has approximately 39,200 tanks, irrigating up to 928,000 hectares (Sakthivadivel et al., 1982a:3). In 1975-76, tank irrigation accounted for 30.4 percent of the net irrigated area and 12.5 percent of the net sown area in the state (Tamil Nadu, Department of Statistics, 1978). In a state in which the average annual rainfall is less than 1,000 mm., this form of irrigation is important for agricultural production.

Local management is particularly crucial for tank irrigation in South India. In all three states where this technology is important, the government bureaucracy is responsible for major repairs and allocation of river water to tanks; however, the bureaucracy is involved in the allocation of tank water only from the few large tanks with command areas of more than 200 hectares (Venkataram, 1980). In most tanks, all maintenance and water distribution activities below the bund are left to the cultivators. Local management of tank irrigation therefore requires that cultivators mobilize resources to distribute water, maintain the distributary channels, minimize internal conflicts over irrigation, and interact with the bureaucracy.

In the past five years, there has been increasing attention to tank irrigation in Tamil Nadu on the part of both government agencies and scholars. There is particular concern with improving the efficiency of water use as an estimated 92 percent of the surface water potential and 60 to 70 percent of the groundwater potential is used for irrigation (Jeyabalam, 1982:3; Sakthivadivel et al., 1982:3). Another reason for this interest is that the area under tank irrigation has not grown since British rule in the late nineteenth and early twentieth centuries, and the proportion of irrigated land under tanks has declined relative to the two other major sources of irrigation in the state, canals and wells. For example, the gross area irrigated by tanks in Madras Presidency (which included most of present-day Tamil Nadu) was 1,290,570 ha. in 1908-09, and 1,284,900 ha. in 1944-45 (Royal Commission on Agriculture, 1928:257; Krishnaswami, 1947:89). Table 1.1 shows that, since independence, the net area irrigated by tanks has fluctuated considerably and even declined, while the area under canals, and particularly under wells, has increased. However, major canal projects benefit only certain areas;

Table 1.1: Area Irrigated in Tirunelveli District and Tamil Nadu By Source.

Year	Canals	Tanks	Total Wells	Wells Sole*	Wells** Supplement	Other	Net Area Irrigated
1960-61							
District	22,701	93,495	41,023	40,721	302	1,069	157,986
State	881,771	936,400	675,477	597,926	77,551	46,164	2,462,251
1965-66							
District	19,690	85,169	45,124	44,867	257	654	150,380
State	799,147	902,545	761,963	659,177	102,786	37,695	2,398,574
1970-71							
District	21,372	68,911	62,385	58,565	3,820	1,036	149,884
State	883,661	897,923	898,675	774,627	124,048	35,625	2,591,836
1975-76							
District	20,772	46,133	62,061	59,128	3,473	184	126,217
State	910,441	749,828	1,005,458	869,593	135,865	35,258	2,565,120

Source: Madras State, Department of Statistics, 1963, 1968, 1974; Tamil Nadu, Department of Statistics, 1978.

*Wells outside the command of surface irrigation sources, included in net area irrigated.

**Wells supplementing surface irrigation sources on the same land, not included in net area irrigated.

wells require considerable amounts of energy to lift water for irrigation, and this has contributed to severe shortages of electricity and diesel fuel. These factors are encouraging greater appreciation of tanks for their geographic dispersion, relatively low capital intensiveness, and use of gravity flow for irrigation (Palanisami and Easter, 1983:9-11; Venkataram, 1980:2).

As Table 1.2 indicates, the total number of tanks in Tamil Nadu has increased over the past two decades by 27 percent. Although this increase is not as striking as the 96 percent increase in the number of wells as the sole source of irrigation, it is somewhat surprising that the area irrigated by tanks has not also increased. This indicates that a significant number of tanks are not irrigating as much land as they formerly did. The growth in the number of wells supplementing surface irrigation sources (particularly tanks) supports the notion that tanks are not performing as well as formerly. This is probably due to a combination of factors including (1) decline in rainfall; (2) siltation of tank beds and other deterioration of physical structures; and (3) a decline in the effectiveness of management of tanks and tank water.

In response to this, the Tamil Nadu government and the Center for Water Resources at Anna University, Madras have undertaken a pilot project of "tank modernization" to increase water use efficiency, primarily through technical means (see Sakthivadivel et al., 1982a; Shanmugham, Sakthivadivel, and Savadamuthu, 1982; Tamil Nadu Public Works Department, 1979). Other tank improvement projects are under consideration for sponsorship from the World Bank and the European Economic Community. Scholars at several institutions have been involved in research on tanks; among these are the Center for Water Resources, Anna University (Elumalai, 1981, 1982; Sakthivadivel et al., 1982; Shanmugham, Sakthivadivel, and Savadamuthu, 1982), Tamil Nadu Agricultural University, Coimbatore (Palanisami, 1982; Sivanappan, 1982), Indian Institute of Management,

Table 1.2: Number of Minor Irrigation Facilities in Tirunelveli District and Tamil Nadu.

Year	Tanks >40 ha.	Tanks <40 ha.	Total Tanks	Wells Sole*	Wells** Supplemental	Total Wells	Pumpsets
1960-61							
District	356	2,051	2,407	39,932	17,909	57,841	770
State	7,150	22,753	29,903	652,521	221,168	873,689	35,078
1965-66							
District	656	1,751	2,407	42,731	19,351	62,082	925
State	8,611	26,730	35,341	691,747	344,321	1,036,068	49,610
1970-71							
District	477	1,940	2,417	61,201	21,764	82,965	2,576
State	8,544	27,278	35,822	919,932	323,973	1,243,905	41,231
1975-76							
District	559	2,311	2,870	93,453	14,025	107,478	37,272
State	7,386	30,593	37,979	n.a.	n.a.	n.a.	411,389

Source: Madras State, Department of Statistics, 1963, 1968, 1974; Tamil Nadu, Department of Statistics, 1978.

*Wells outside the command of surface irrigation sources.

**Wells supplementing surface irrigation sources.

n.a.: Not available.

Bangalore (Sundar and Rao, 1982), Economics Program of the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in Andhra Pradesh (Doherty, 1982; Venkataram, 1980; von Oppen and Subba Rao, 1980a, 1980b, 1980c), and the Agricultural Economics Department of the University of Minnesota (Palanisami and Easter, 1983). Much of this work was collected in a "Workshop on the Modernization of Tank Irrigation: Problems and Issues " held in Madras in February 1982.[3]

These studies highlight the importance of irrigators' associations and local management for the overall performance of tank irrigation systems. However, there have thus far been no in-depth reports or analyses of nonformal associations at the local level. This study represents a first step toward filling that gap by examining a nonformal "ayacut association" that provides local management for a system tank. The study uses what Chambers (1980:32) has termed a "middle-outward view of irrigation organization." Thus, the ayacut association and its activities at the tank level provide the focus of this paper, but attention is also given to the management of other parts of the irrigation system, looking "up" to the river system that feeds the tank and "down" to the field channels and wells that provide water to the ayacut fields. In terms of levels of organization, attention will be given to the ayacut association's relationships with the government bureaucracy on the one hand, and with the individual cultivators on the other.

The basic data for this study were collected during a visit to southern Tirunelveli District in the summer of 1982. Research activities included extensive semi-structured interviews with various cultivators, ayacut association leaders and employees, and government officials involved in the administration of tanks. Particular attention was given to Sananeri Tank, a system tank irrigating approximately 174 hectares, which receives water from the Hanuman River. The research also involved numerous trips to Sananeri and other tanks, their command areas, and various points along the Hanuman River. Although personally lacking engineering expertise, I was accompanied by local cultivators and/or the Junior Engineer of the Public Works Department, who explained the operation and problems of the tank and other physical structures. This work was supplemented by information from the records of the Public Works Department and the Revenue Department, and by comparative information from research on tanks in other districts.

Most of the published field studies on Tamil Nadu have been conducted in districts that are not very representative of statewide conditions. However, conditions in Tirunelvelvi District are much closer to state averages with respect to irrigation sources (Ludden, 1979:347-348). In practical terms, my personal background and contacts in the southern part of the district facilitated the research process, particularly in the early stages of establishing rapport, so that it was feasible to attempt a field study in three months.

Within Tirunelveli District, the selection of a tank on which to focus research was based on the criteria of tank type, location, and size. A system tank was selected for three reasons: the Public Works Department is involved with both maintenance and water allocation; system tanks are connected to other tanks with which they share a common source of water, and thus present the opportunity of studying interaction between cultivators or organizations of different tanks; and system tanks are more likely to have water during the Southwest Monsoon period, when research was conducted.[4] A tank near the head of a system was similarly selected so that there would be a possibility of seeing some water in the tank during the period of research. However, in order to ensure that the tank's water supply was not so reliable as to make it highly unrepresentative, neither the top tank in a seasonal river system nor a tank connected to the perennial Tambaraparni River were selected. Sananeri Tank was selected because it met these criteria, and its size was large enough that the ayacut would have a large number of cultivators (more than 100), yet small enough that I could become familiar with the physical features of the tank and its ayacut.

The first stage in the fieldwork involved identifying the organizations and individuals who were involved in the local management of tank irrigation, both in government bureaucracies and among the cultivators. Next, key people involved in the management of Sananeri Tank were interviewed, often in conjunction with a visit to the tank, fields, or other important irrigation structures. This produced a great deal of information on the physical and institutional environment, the problems of tank irrigation, and relationships within and between organizations. This information was then compared with other field studies of irrigation systems both in South India and elsewhere in order to identify general patterns in the organization of irrigation system management.

Research of this kind has several clear limitations. The first is that, as a field study of a single case observed over a short period of time, it lacks temporal and spatial depth. Some comparative information has been drawn from studies carried out in other tanks in the Hanuman River system, but these works are not completely comparable.

Another limitation of this study is the short time spent doing field research. The need to rapidly identify the key figures in the ayacut association and to conduct interviews limited the amount of information that could be gathered about the irrigation association and its physical and social environment. Because the work was conducted during the kar (Southwest Monsoon) season,[5] rather than the main pisanam (Northeast Monsoon) season, it was not possible to observe many of the irrigation-related activities or to see irrigation in the entire ayacut. However, my familiarity with the area and the help of several contacts who provided introductions to key people in the ayacut association and the bureaucracy partially offset these problems.

Administrative records provided a means of verifying and supplementing observations on the physical environment. And although the kar season is not the main irrigation season for Sananeri Tank, it is a good time to study irrigation for the following reasons:

1. Because it is not the main season, cultivators and others involved in irrigation have more time to talk and explain their activities.
2. The fact that the tank and channels were not full made it possible to examine the physical structures and their condition more easily.
3. There was some water in the Hanuman River and Sananeri Tank during the period of study, which made it possible to observe the management of scarce water resources.
4. Because more diverse cropping patterns are used during the kar than the pisanam season (when only paddy and bananas are grown), conducting research during this season allowed observation of the variety of crops grown in the ayacut.
5. During the 1982-83 agricultural year, the kar season was the only one in which irrigation could be observed; the Northeast Monsoon that provides water for the pisanam season failed; and Sananeri Tank received virtually no water.[6]

Despite its limitations, the field study method can provide detailed information on the structure and function of an organization such as the ayacut association and the physical, social, and bureaucratic environment with which it interacts. These data are necessary in identifying the important issues in local system management. They can also serve as a basis for developing surveys or comparative studies of additional local tank management associations.

The subsequent chapters of this study present the historical development of tanks (Chapter 2) and the contemporary environment in which they are used, with particular attention to Sananeri Tank (Chapter 3). Chapter 4 provides a description of the operation of tank irrigation at the local level. In this chapter, Sananeri Tank is treated as part of a physical and organizational system that includes not only the tank itself, but also the river that feeds it and the wells that receive recharge from the tank and are used to supplement tank water. Information is given on activities of the ayacut association, on the activities of the government bureaucracy, on the management of well irrigation, and on the relationships between the government, the ayacut association, and the individual cultivators. The costs, benefits, and strategies of the local association for irrigation system management are discussed in Chapter 5. Chapter 6 concludes the study with sociological implications, directions for further research, and some points for consideration in attempts to improve the management of tank irrigation systems.

CHAPTER 2: HISTORICAL DEVELOPMENT OF TANK IRRIGATION IN TIRUNELVELI DISTRICT

Origins of Tank Irrigation

Tank irrigation can be traced back two millenia in Tamil Nadu. There are references to tanks in the Sangam literature from the early centuries A.D.[7] Stone inscriptions referring to specific tanks are available from the eighth century A.D. and later, particularly in Chingleput and North Arcot districts. One inscription refers to a large tank built in the seventh century A.D. that served fields 13 to 14 kilometers distant; another inscription from the ninth century describes a tank with a bund seven kilometers long (Minakshi, 1977:120,124). A tank at Ambassamudram in Tirunelveli District is mentioned in an inscription from 1287 A.D. (India, Central Board of Irrigation and Power, 1954:18).

Both construction and renovation of irrigation works were considered to be religiously meritorious acts. Gifts of tanks and tank repairs served to legitimize the position of both the Pandyan kings and numerous petty chieftains. Ludden (1979:349) explains that in the Tirunelveli area:

> Traditionally, the scale of irrigation works determined who their sponsors would be. Schematically speaking, rich peasants dug wells, chiefs built tanks, and kings built large dams, while local landowners dug channels, village distributaries, paddy fields, and other relatively small works like temporary dams. The pattern of irrigation development through the ages has arisen from the conditions facing each type of sponsor over time.

The Pandyan kings in Madurai were too remote to directly rule the Tirunelveli area. Their links were largely confined to the lands irrigated by the Tambaraparni River. In the drier regions in which tanks and wells provided most of the irrigation, petty chieftains invested in irrigation works and collected land revenue. Thus, the system of tanks in the Tirunelveli region was segmentally built up by local chiefs working directly with the urs, or village councils (Ludden, 1978b:7-8).

The epigraphic record is valuable not only for tracing the antiquity of tank construction, but also for the information it provides about maintenance and repairs of tanks. It would appear that while charitable individuals or temples might sponsor major repairs to a tank or give an endowment for its upkeep, the daily management and supervision of the tank was under local village control. In the Chingleput area, village assemblies, or sabhas, had special tank committees (erivariya perumakkal) that were selected annually (see India, Central Board of Irrigation and Power, 1954:11-13; Jayaraman, 1947:3-12; Minakshi, 1977:130-151). Their powers and responsibilities included administering any endowments of gold or land and using the interest (sometimes as high as 15 percent) to pay for desilting and repairs. According to Mookerji (1920:155):

> In the absence of suitable endowments or private charity the assemblies themselves offered land from the culturable wastes of the village as an inducement to undertake such works; and where such wastes were not available, and private enterprise and charity failed, they themselves undertook them at the joint expense of the villagers who all benefited by same.

The latter form of financing repairs by contributions from all beneficiaries could be locally sanctioned by withholding water from anyone that did not pay, or could in some cases be enforced by the ruler. The contributions ranged from 1.25 percent to 5 percent of the crop, or from 0.42 to 1.27 cubic meters of paddy per hectare (Appadorai, 1936, v.1:215-217). Other sources of income for the tank fund that were mentioned included local fines, the sale of fishing rights in tanks, and the impoundment of land of those who failed to pay their dues. The tank committees also enforced irrigation rules and arbitrated disputes over water use. Minakshi (1977:134) cites references to nervayam—a form of fine for excessive water use—as an indication that the amount of water used was also regulated at times.

Not all villages had a formal tank committee or tank fund. In the absence of these institutions, informal groups of cultivators or leading individuals might mobilize resources for irrigation. Village leaders arbitrated disputes and negotiated with other villages to acquire rights to water by gift or sale (Appadorai, 1936, v.1:227-229). The responsibility for a tank could also lie with an individual or family who either constructed the tank or did major repairs to it at their own expense. Such persons would be given an *inam*, or tax-free holding of wet and dry land provided they maintained the tank properly. If they failed to fulfill this condition, their land could be transferred to others who would maintain it (Appadorai, 1936, v.1:216). This system continued in some places until at least 1800, when an early British traveler observed it and commented (Buchannan, 1807:453-454):

> The tanks to which there is a person of this kind are notoriously kept in better repair, than those which the government supports, either when they have been constructed originally at the public expense, or when the *Enam* (*inam*) of the founder, from a failure of heirs, has reverted to the sovereign. The reason assigned for this by the natives is perfectly satisfactory. They say, that they can compel the holder of the free estate to perform his duty, but the state has no master.

The period from 1330-1556 was a period of political upheaval in the Tirunelveli area as the Pandyan rule was replaced by conquests by the Cheras from the west and the Muslims of Vijayanagar from the north. During this period, the local chieftains, or *palaiyakkarans*, increased their military and administrative control. In the late sixteenth century, the Vijayanagar empire consolidated its power in the south by integrating the palaiyakkarans as feudatories of the state.

During this period, irrigation development was given impetus by individual state agents and palaiyakkarans who then personally benefited because of increased revenue from the irrigated lands. Ludden (1979:357) explains:

> Most funds for construction and maintenance of irrigation continued to come from landowners, no doubt, but wealthy

> state agents and poligars[8] could provide finances and services without which no large project could succeed. They could donate funds directly, or through their powers of taxation; they could arbitrate disputes between parties connected by new works; they could protect the work, help in labour recruitment, and enforce contracts, using coercive powers if necessary.

During this period, the scope of irrigation development increased. New works integrated numerous existing tanks and channels through construction of dams and permanent anicuts, or weirs, with channels leading off to irrigate fields and feed successive tanks. This represented two advances in irrigation: the replacement of temporary weirs with permanent stone structures, and the development of detailed knowledge of local topography, which allowed tanks and channels to be interconnected so as to make full use of the available surface water (Ludden, 1979:355).

British Colonial Rule (1801-1947)

Vijayanagar collapsed in 1565!

In 1755, the British East India Company formed an alliance with the Vijayanar rulers in Madurai. Several local chieftains rebelled, and the British sought to break their powers in the Poligar Wars, which lasted from 1755 to 1800. In 1801, the British began to administer and collect revenue from the Tirunelveli area.

The British rule in the Madras Presidency was more centralized and bureaucratic than any of the preceding regimes. They were directly involved in the collection of revenue, and hence had greater extractive powers than their predecessors (Ludden, 1978b:12; Stein, 1969:197-198). In 1864, a Settlement Survey was begun to determine the exact boundaries of agricultural holdings and estimate the productive capacity of each plot in order to calculate revenue assessments more precisely.

long before 1864!

The productive capacity of a plot was based primarily on the type of soil and irrigation, using the criteria shown in Tables 2.1 and 2.2. Most system tanks in

Table 2.1: Classification of Soils for Revenue Assesment.

SOIL SERIES	CLASSES	SORTS
A) Alluvial and exceptional	A1) Alluvia A2) Permanently improved	a) Best
B) Regar or black cotton	B1) Clayey (67% clay)	b) Good
C) Red ferrunginous	B2) Loamy (33-67% clay, rest sand)	c) Ordinary
D) Calcareous	B3) Sandy (67% sand)	d) Inferior
E) Arenaceous		e) Worst

Source: Krishnaswami, 1947:55.

Table 2.2: Classification of Irrigation Quality for Revenue Assessment.

CLASS	DEFINITION
I.	Perennial source based on anicuts and reservoirs
II.	Supply for 8 months and over
III.	Supply for 5 months and over, but less than 8 months
IV.	Supply for 3 months and over, but less than 5 months
V.	All sources giving supply for less than 3 months

Source: Venkataram, 1980: Appendix X.

southern Tirunelveli District were designated as irrigation class III. No separate water cess was charged; rather, payment to the government for irrigation from public sources was included in the land revenue. Land irrigated by wells was assessed as dry land unless it was also irrigated by tanks or channels. Based on this, Ludden (1979:358) calculated that surface irrigation produced more than 50 percent of the revenue in Tinnevelly District.[9]

Throughout the Madras Presidency, the British Government initially emphasized investment in a few large-scale "productive" works rather than in the many smaller works that were dispersed throughout the countryside. In Tinnevelly District the British, like the Pandyan and Vijayanagar rulers before them, concentrated their support largely on the already securely irrigated zone of the Tambaraparni River system. Ludden (1978a:332) attributes this to their lack of manpower, their alliance with wealthy mirasidars of that area, and the official policy favoring "productive," as opposed to "protective" works. The most important new construction was the Srivaikuntam Anicut on the lower Tambaraparni River, completed in 1893. It extended irrigation by 16,760 hectares, primarily by diverting the river water into a series of existing tanks. Throughout the district, most of the British investment in irrigation consisted of piecemeal repair or upgrading of existing structures rather than construction of new ones. However, Ludden (1978a:331) concludes that: "small tanks everywhere, and especially rainfed tanks, were neglected by government, relative to their importance for total irrigated acreage and the food supply."

By the end of the nineteenth century, the British government in Madras began to direct more attention and resources to minor irrigation, particularly tanks. Two factors were influential; famines in much of the Presidency, particularly from 1866 on, generated greater concern for social welfare. In 1878, the Famine Commission recommended that efforts be made to restore tanks to their original capacity and that other "protective irrigation works" (as opposed to "productive works" that would yield a certain increase in revenue) be built as a buffer against drought and famine. Wells were also encouraged to protect crops in drought-prone areas. A second reason for turning attention from river irrigation to tanks and wells in Tinnevelly District was that the irrigation capacity of the Tambaraparni River was almost fully exploited. By 1917, for example, 94 percent of the Tambaraparni lands were double-cropped (Ludden, 1979:361). In contrast, tanks showed considerable potential for improvement. In 1856, it was reported that out of 43,000 tanks in the Madras Presidency, 10,000 were in need of repair (von Oppen and Subba Rao, 1980a:4). The decay of existing tanks was indicated by the fact that on numerous occasions crops had failed and taxes had to be remitted on tank-irrigated lands, even in years when there was no shortage of rain (Krishnaswami, 1947:439).

Following the recommendations of the Famine Commission Report, the Tank Restoration Scheme was begun in 1883. The first stage of this was a survey of all tanks in the Presidency. A detailed memoir was written on each, giving technical specifications for the restoration of the tank. Because of a shortage of engineering staff, much of the repair work was done under contract by the village headman and mirasidars, or wealthy landowners. These local leaders then mobilized labor to do the job and collected payment from the government (Matthai, 1915:118-119). The role of government officers was limited to inspection of the finished work. During the period of 1883-1944, the government spent Rs. 25,000,000 on bringing the tanks up to specifications in 87 percent of the Presidency (Krishnaswami, 1947:89).

Although this was certainly an ambitious project, it had its limitations. As Krishnaswami (1947:440-443) points out, the specifications that were used in restoring the tanks were in many cases outdated and inappropriate. Many surveys were done in 1890-1900, before a major increase in population, cultivation, and deforestation in the province. According to the census, the population of Madras Presidency increased from 30,868,504 in 1881, to 39,129,111 in 1911, and to 49,341,810 in 1941, a total increase of 60 percent (Krishnaswami, 1947:10). The expansion of cultivation into the forests of Tinnevelly District is noted by Caldwell (1982:229): "The thick impervious jungles which covered most of the plains and which had for generation after generation furnished the haunts and hiding-places of banditti have disappeared (perhaps only too completely), and cotton and food grains cover those tracts instead." In numerous cases, by the time the tanks were restored, the amount of rainfall and available runoff in the catchment area had declined. Madduma Bandara (1977:323-324) also notes that:

> . . . the clearing of the natural vegetative cover due to the increasing pressure of people and animals on land must have led to a gradual dwindling of available surface-water resources and to attendant hydrological consequences such as the silting of river beds.

Consequently, the number of fillings the tank received during the growing season and the amount of land that could be irrigated were less than indicated in the memoirs.

A second problem with the Tank Restoration Scheme was that it did not set up a permanent technical staff for ongoing repairs of the tanks after their restoration. All tanks under 200 acres (81 hectares) were turned over to the Minor Irrigation Department (under the Revenue Department) to administer, while those above 200 acres came under the jurisdiction of the Public Works Deprtment (Krishnaswami, 1947:90). From 1936 to 1942, the District Collectors of Tinnevelly used the Circle System to ensure periodic inspection and repair of the tanks but this did not take root as a general policy (Ludden, 1979:362).

While the British government became the major patrons of irrigation, local participation and investment still existed and was encouraged by the government.

For example, the Famine Commission Report of 1880 recommended that (quoted in Matthai, 1915:117-118):

> Tanks irrigating over 50 acres (and under 200 acres), if found to require repairs, should be brought up to the necessary standard by the Public Works officers at the cost of the Government, and then handed over to the village officials to be maintained. Those irrigating less than 50 acres should be handed over to the village officers, the Department of Public Works doing only masonry work. . . . The smallest class of tanks, irrigating less than 10 acres might be handed over entirely to the ryots.

This left less responsibility with the local communities than they had traditionally had, but at least acknowledged that villagers could maintain their local irrigation tanks.

The increase in private wells during the latter half of the nineteenth century is another form of local investment in irrigation that was encouraged under British rule. Wells had been constructed primarily by individual farmers to irrigate lands outside the commands of channels or tanks, or as a supplement to surface irrigation. However, because of the high labor costs of raising water to the surface with the picotah (counterpoise) or kamalai (bullock-drawn) lifts, well irrigation was usually reserved for high-value crops. According to Ludden (1979:353): "For this reason the growth of well irrigation is both historically and socially linked to the development of commercial agriculture." The British rule in Tinnevelly District and the supression of the poligars favored trade and the expansion of commercial agriculture. During this period, there was a marked increase in the number of wells. The British government favored well irrigation as a form of private investment in irrigation. The government assisted farmers who dug wells by not taxing well-irrigated land any more than equivalent land without wells, by providing liberal takkavi loans,[10] by furnishing equipment for boring, and by conducting some hydrological surveys. During the Grow More Food campaign of 1943-1949, subsidies of Rs. 300 to Rs. 500 each were also given for well construction. Official records show an increase in the number of agricultural wells in Tinnevelly District from 18,907 in 1850 to 46,502 in 1900 (Ludden, 1978a:354).

Another form of local participation in public irrigation facilities that the British sought to encourage was the kudimaramat system of communal labor for maintenance and repairs. This system is akin to the rajakariya duties in Sri Lanka (see Leach, 1980:122). Kudimaramat was presumed to be based on the traditional obligations of cultivators to contribute to the upkeep of their irrigation system.

However, the institution apparently declined before or during the British rule. Krishnaswami (1947:449) cites the breaking up of communal life in villages and the increase of absentee landlordism as factors contributing to the decline of kudimaramat (cf. Roberts, 1980:201). Another factor may have been the government's direct involvement in village administration, including irrigation maintenance. Jayaraman (1947:17) explains that:

> All this meant that much of the work that was for ages associated with the village community was being done by outside agencies, and psychologically the villagers were made to look for help more and more to the respective Government departments.

Apparently the custom died out soonest with respect to desilting larger tanks, especially those that served cultivators living in several villages. This has been attributed to the difficulties associated with collaboration among several villages (Krishnaswami, 1947:449). Another possibility to be considered is Doherty's (1982:18) hypothesis that village management of irrigation would be relatively more effective where there is dependence on tank irrigation for a significant portion of village income by all enfranchised members of a local community. This would not generally obtain when the cultivators under one tank lived in several villages. Matthai (1915:118) suggests another factor in the neglect of tank desilting: the effect of siltation in the tank is gradual and apparent only over relatively long periods, whereas channels—either feeding into the tank or from the sluices to the fields——are smaller and more critical in the acquisition and distribution of tank water. Any siltation of the channels is readily apparent and damaging, and so will be dealt with by the cultivators. A final factor should be noted at this point: desilting channels is not as organizationally complex as desilting tanks. Whereas channels can be cleaned by a few men in a relatively short time, desilting a tank requires either a large labor force or, as in ancient times, the enlistment and payment of a full-time staff. Therefore, it appears natural that with the decline of local institutions to support irrigation, the tasks requiring more complex organization would be first to be neglected.

If the British rule saw the decline of kudimaramat, it was not the result of a conscious policy. On the contrary, the Indian Irrigation Commission of 1901-1903 reported (quoted in Matthai, 1915:123-124):

> We were repeatedly assured that the maintenance of the tanks was not satisfactory, and that kudimaramat was practically dead. . . . We are ourselves reluctant to admit that so valuable an institution is really dead and past restoration.

Although there was considerable controversy over the exact nature of this tradition and the extent to which it was still practiced in the nineteenth century (see Matthai, 1915:113-131), attempts were made to encourage and enforce kudimaramat through legislation. The Madras Compulsory Labour Act of 1853 empowered officers in charge of irrigation works to call on village labor in emergencies if it could be established that this was part of local custom. This latter condition made the law virtually unenforceable (Matthai, 1915:122). In 1869-1870, the Public Works Commission sought to change the compulsory labor to a cash fee. This was opposed by legislators as a legal requirement, but Matthai (1915:121) reports that it was not unusual to find it in practice:

> The tendency to substitute a voluntary cess has been specially noticeable in regard to channels which supply water to a number of villages, in which case the machinery of communal labour would be more difficult to employ. It is

> so clearly to the interests of the villagers to promptly pay the cess that the want of legal sanction has not been felt as a distinct weakness.

This was given legal recognition in the Madras Irrigation (Voluntary) Cess Act of 1942. Under this law, the government would enforce the payment of a fee for specific repairs to an irrigation project provided that the holders of 66 percent of the land to be benefited agreed to the fee. This law avoided some of the problems of the Compulsory Labour Act. It was more in keeping with the customary contributions for tank maintenance, which were often in cash or grain rather than obligatory labor. It left the initiative with the local community, rather than imposing either corvee labor or cash contributions on the cultivators according to the decisions of an outside government agency. There was therefore no need to prove a preexisting custom of kudimaramat.[11] The work to be done would then presumably be what the cultivators felt was important, rather than being a residual category of unskilled labor that the government agency chose not to carry out. Another problem with corvee labor was that notices for kudimaramat work were issued at the government's convenience, often during peak times of sowing and transplanting, when labor was scarce (Krishnaswami, 1947:450). Payment of a fee would presumably have minimized this problem.

If the institution of kudimaramat in the form of communal labor declined during the British rule, local contributions to irrigation were not absent. In 1879 an official reported (Arundel, quoted in Matthai, 1915:124):

> During the (revenue) settlement of Tinnevelly District more than Rs. 250,000 were raised by subscription (local contributions) and by sale of waste land, and expended upon objects of public utility, chiefly irrigation works. On one channel alone the ryots built forty-six substantial sluices. . . . In another village Rs. 1,000 was subscribed by the ryots, and expended in clearing away accumulations of silt from neglected public channels. Four villages united to subscribe Rs. 2,500 to build regulating works to apportion the water supply.

This money was collected by the cultivators and entrusted to the government for use on specific projects. Local landowners contributed cash and constructed segments of the Srivaikuntam Anicut project. The cultivators in the command area of one damaged tank raised Rs. 10,000 to pay for 25 percent of the estimated cost of the repairs (Ludden, 1978a:327). Such contributions represent a substantial mobilization of local resources to repair and improve irrigation works in Tinnevelly District. It was also done under local initiative and management, without much solicitation from government officials. It shows cooperation among villages and an ability to handle skilled work such as constructing masonry sluices and water regulators in addition to desilting.

Independent India (1947 A.D. To Present)

When India achieved independence in 1947, much of the framework of the British administration was retained. Irrigation was put under the control of the states, but the central government was given an important role in regulating interstate water disputes and providing much of the financial support for irrigation development.

In Tamil Nadu, the Revenue and Public Works Departments initially shared responsibility for tanks as they had before independence.[12] In 1958, a three-tiered system of panchayat institutions was established for local self-rule, and local Panchayat Unions and Block Development Officers were given responsibility for some aspects of the operation and maintenance of tanks.

The reorganization of the panchayat system in 1958 provided the administrative and technical facilities for the panchayats to become involved in tank management. Groups of up to twenty village panchayats were joined into Panchayat Unions. Each representative Panchayat Union was associated with a Block Development Office (BDO) of the Community Development Scheme. The

BDO was assigned a staff of administrative and technical personnel employed by the state, including an extension supervisor-cum-junior engineer who is responsible for tank maintenance (Saraswathi, 1973:45). The Block Development Offices were placed under the supervision of District Development Councils.[13]

At present, the engineer in the Block Development Office is responsible for the maintenance of tanks with an ayacut of less than 40 hectares if they are not directly linked to a river system. The number of these tanks is given in Table 2.3. The circle system of inspection and maintenance is used. Under this system, one-fifth of all tanks in each Panchayat Union are inspected each year, ensuring that all tanks are inspected once in each five-year cycle. In cases of emergency such as flooding or breaching of a bund, a tank may be inspected and repaired out of its turn in this cycle. After inspecting each tank and noting needed repairs, the engineer prepares an estimate of the cost, submits it to the Highways and Rural Works Department for approval, then opens the job for local contractors to tender bids. After the job is completed, the engineer again inspects the tank to ensure that repairs were done correctly.

The Public Works Department (PWD) is responsible for maintaining all river irrigation systems, all tanks with a command area of 40 hectares or more, and all tanks connected to river systems, regardless of command area. Although as Table 2.3 shows, there are fewer of these types of tanks than Panchayat Union tanks in both Tirunelveli District and Tamil Nadu, these tanks are important because of their size and/or because, as system tanks, they have the most reliable water supplies. The PWD does not use the circle system of inspection; instead, an engineer inspects a tank when a need arises and the farmers in command bring it to the attention of the PWD. Except in an emergency, a tank will not be inspected more often than once in three years. After the inspection, the procedure for repair of a tank is much the same as for the BDO engineer; an estimate is prepared,

Table 2.3: Types of Tanks in Tamil Nadu By District.

District	Public Works Department Rainfed 40 ha.	System *	Total	Panchayat Union 20 ha.	20-40 ha.	Total	Ex-Zamin	Total
Chengalpattu	1,202	5	1,207	1,241	542	1,783	756	3,746
North Arcot	632	537	1,169	1,482	602	2,084	482	3,735
South Arcot	573	184	757	1,213	553	1,766	79	2,602
Salem	188	0	188	449	100	549	-	737
Dharmapuri	98	3	101	1,451	128	1,579	154	1,834
Coimbatore	57	2	59	42	22	64	-	123
Thanjavur	5	680	685	338	153	491	-	1,176
Pudukottai	369	161	530				58	
				4,609	725	5,334		6,394
Tiruchy	173	85	268				214	
Madurai	288	483	771	3,142	249	3,391	331	4,493
Ramanathapuram	1,378	130	1,508	642	691	1,333	7,367	10,208
Tirunelveli	289	397	686	806	159	965	445	2,096
Kanyakumari	24	960	984	1,062	12	1,074	-	2,058
Nilgiris	-	-	-	-	-	-	-	-
Total	5,276	3,627	8,903	16,477	3,936	20,413	9,886	39,202

Source: Sakthivadivel et al., 1982:2.

*Includes all system tanks, regardless of size.

sanction given by higher officials in the PWD, and the contract given out on bid. The work is carried out by a private contractor and is inspected upon completion by the engineer.

Both the BDO and PWD are responsible for the beds, bunds, sluices, and waste weirs of the tanks in their charge. The PWD is also responsible for weirs on rivers and for major man-made channels connecting the rivers and system tanks. The responsibility of both agencies stops at the bund; neither is responsible for distributaries or field channels below the sluice. The natural tributaries or supply channels feeding into the tanks are also outside the purview of both agencies.

The Revenue Department is in charge of collecting land revenue and any extra water cess charges. It is officially responsible for auctioning the annual rights to the fish and trees in the tanks. The Revenue Department shares responsibility with the Panchayat Union for nonsystem tanks of less than 40 hectares command area. Those tanks that have been surveyed and brought up to standards since the beginning of the Tank Restoration Scheme have been handed over to the Panchayat Unions. The income from fish and trees in these "transferred" or "vested" tanks is credited to the Panchayat Unions. Tanks in the former zamindari areas[14] that have not been surveyed and brought up to standards are termed "nontransferred" or "nonvested" tanks, and are officially under the Revenue Department. Table 2.3 shows that these are particularly important in Ramanathapuram District. In Tirunelveli District, most of the ex-zamindari tanks are located in the northern areas, the former strongholds of the palaiyakkarans. The BDO maintains the "nonvested" tanks under a special grant, but the Revenue Department, rather than the Panchayat Union, receives the income from the fish and trees.

Authority over water regulation is also shared by the PWD, the Revenue Department, and the panchayats. The PWD controls water along the river system and issues water from each anicut, or river weir. Officially, the Revenue Department is responsible for water regulation in tanks with a command of 40 hectares or more, and the village panchayats for regulation of water in tanks of less than 40 hectares of command area (Venkataram, 1980:51). However, water regulation from the tanks is generally left to the farmers themselves, without any official interference.

The involvement of one other government agency in tank irrigation should be noted: the Forest Department is responsible for planting trees on any public, or peromboke land. Since 1963 it has been particularly active in planting karuvelan (Acacia arabica) trees on the foreshore of tanks under a social forestry project supported by the Swedish International Development Agency (Palanisami and Easter, 1983:22). After the trees are established, they are sold for 50 percent of their market value to the panchayats, which then manage them until they are ready to be cut for making plows or firewood.

Since the time of Vijayanagar rule, government bureaucracies have become progressively more involved in various aspects of the management of tank irrigation systems. In doing so, they have taken over many of the tasks that were traditionally performed by local communities, particularly tasks associated with the maintenance of physical structures and the management of peromboke. Today, only activities below the tank bund——such as distribution of tank water and maintenance of field channels——are formally left to the local cultivators. Government involvement has been important in coordinating the irrigation systems, overcoming local disputes, and making available some financial and technical resources that would often be beyond the ability of local communities to mobilize (Ludden, 1978a:326, 1979:357). This has been instrumental in the development of a network of rivers, channels, and tanks that divert, collect, and store much of the available surface water for irrigation.

There are some indications that local institutions for tank management——particularly the custom of kudimaramat——have declined. This has been variously attributed to the period of warfare that preceded British rule (Harriss, 1982:73); the disintegration of village communities, with increasing stratification and individualism in the social order since the advent of the British (Krishnaswami, 1947:448, cf. Roberts, 1980:201); and to excessive dependence on the government (Jayaraman, 1947:17) with a consequent deterioration of local organization and skills (Djurfeldt and Lindberg, 1975:104-106).

While local communities may not have the responsibility for tanks that they once had, effective use of tank irrigation systems still depends to a large extent on the involvement of cultivators in the management of tanks at the local level. Therefore, it is important to investigate the local customs and organizations for tank irrigation that still function. This is done in the subsequent chapters, with particular reference to Sananeri Tank in the southern part of Tirunelveli District.

CHAPTER 3: ENVIRONMENT OF SANANERI TANK

In this chapter, a basic description of the physical and social environment of Sananeri Tank is presented. This provides a frame of reference for subsequent discussion of the operation and maintenance of the system and for potential comparisons with other irrigation systems. Factors such as rainfall, soil, vegetation, and technology provide constraints and opportunities for effective provision of water to crops. The size of irrigation systems and the amount of land irrigated by any single structure (such as a tank, sluice, or field channel) affects the size and structure or organizations for water management. Socioeconomic factors such as caste composition and landholding patterns of cultivators in the command area affect the ability of local groups to organize for irrigation management. Information about the environment also provides a basis for comparing irrigation systems. For example, when comparing the tank irrigation system described by Leach in Sri Lanka with those in Tamil Nadu, it is important to realize that the former receives 1,270 to 1,950 mm. of rainfall per year (Leach, 1961:15), whereas the annual average in Tamil Nadu is 945.7 mm. (Tamil Nadu, Department of Statistics, 1978:40).

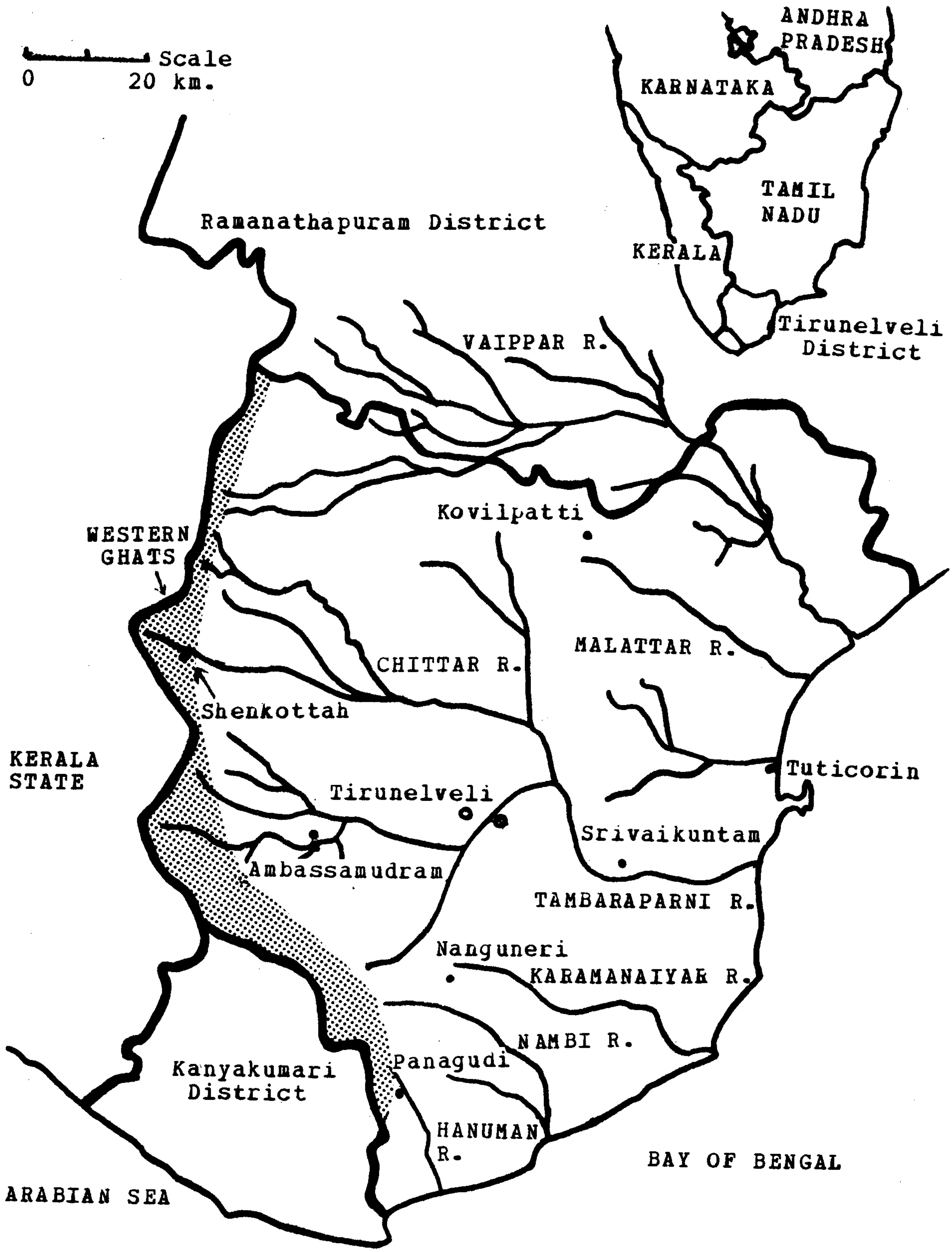
No historical records are available to provide specific information on the historical context of Sananeri Tank, but it is likely that both the tank and its links to the river system were constructed before the beginning of British rule in 1800. The revenue settlement records of 1914 report that this tank provided five to eight months of irrigation per year (Madras Presidency, Revenue Department, 1914). The official boundaries of the ayacut and the peromboke, or public lands, of the tank have been fixed since then, but the physical structures have changed through an ongoing process of silt deposition, deterioration of structures, and periodic repairs and improvement. Even since the time of the field research for this study, a major program of desilting the tank bed, reinforcing the bund, and repairing the various other structures have been undertaken in Sananeri and five other tanks in the Hanuman River system as part of a rural employment program created in response to the severe drought that occurred when the 1982-83 Northeast Monsoon failed in Tamil Nadu. The description that follows reflects conditions during the 1982 kar season, but it should be recognized that although the tank systems may be ancient their condition is not fixed. Just as tanks affect the way in which humans organize for agricultural production, so also human activity affects the physical condition of tank irrigation systems.

Geography and Climate

Tirunelveli District is bordered by the Bay of Bengal to the east and by Ramanathapuram District to the north. The Western Ghats separate this district from Kerala State to the west and Kanyakumari District of Tamil Nadu to the south (as shown on Map 1). These ghats, or mountains, rise to a height of over 1,200 meters (Hunter, 1887:29). The elevation at the foot of the ghats is approximately 225 meters, and decreases toward the east at a slope of 8 to 10 degrees. Below the 75 meter contour, the slope is generally less than 1 degree and the ground is less undulating than at the foot of the ghats (Ludden, 1978a:26). Because of this topographic pattern, most of the larger and deeper tanks are located in the western part of the district rather than in the flatter eastern portion.

Two major soil types are found on the plains of Tirunelveli District: red soils and black "regur" soils. Red soils predominate over most of the area while black soils are limited to the northeastern part of the district. As seen in Table 3.1, the

MAP 1: TIRUNELVELI DISTRICT



black soils are slightly alkaline clays with good moisture retention, whereas the red soils have lower base status and cation exchange capacity, and are freely draining. The texture of the red soils range from sand, especially in the east, to loams and clay loams near the ghats (Govinda Rajan and Gopala Rao, 1978:15-19,30; Raychaudhuri et al., 1963:141).

Table 3.1: Characteristics of Dominant Soils in Tirunelveli District.

GENERAL CHARACTERISTIC	RED SOILS	BLACK SOILS
Depth:	Shallow, up to 1 m.	Deep, up to 4 m.
Texture:	Clay loam to sand	Clay
Water retention:	Low	High
pH:	6.0 - 8.0	8.0 - 8.5
Cation exchange capacity:	5-25 meg./100 gms.	30-70 meg./100 gms.
Dominant clay mineral	Kaolinite	Montmorillonite
USDA classification equivalent:	Alfisols (Haplustalfs and Rhodustalfs)	Vertisols if cracks $>$50 cm., otherwise Inceptisols or Entisols

Source: Govinda Rajan and Gopala Rao, 1978:15-19,30; Raychaudhuri et al., 1963:141.

The Western Ghats have an important effect on rainfall in Tirunelveli District. During the Southwest Monsoon, they block the moisture-laden winds, causing most of the rain to fall on the Kerala-Kanyakumari side of the mountains, away from Tirunelveli District. Only through a gap such as the Shenkottah Pass at the head of the Tambaraparni River do the rains from this monsoon regularly pass into a portion of Tirunelveli District. Thus, during June through September, most of the district is in a rain-shadow zone. As Table 3.2 shows, Tirunelveli District averages 109.5 mm. of rain during this season, compared to 617.3 mm. in Kanyakumari District.

Table 3.2 Average Rainfall in Tirunelveli District, Kanyakumari District, and Tamil Nadu.

Period	Tirunelveli District	Kanyakumari District	Tamil Nadu
Southwest Monsoon (June-September)	109.5	546.2	307.3
Northeast Monsoon (October-December)	485.8	564.0	449.7
Winter (January-February)	80.4	47.0	50.9
Hot Weather (March-May)	139.1	312.5	137.8
Total Annual	814.8	1,469.7	945.7

Source: Tamil Nadu Department of Statistics 1978:33-40.

During the lighter and more erratic Northeast Monsoon, the mountains serve to catch most of the moisture-bearing winds on their eastern side, and the rainfall and runoff provides water to Tirunelveli District. As a result, the district receives an average of 485.8 mm., or 60 percent of its annual rainfall, during October to December (Table 3.2). Rainfall is generally lowest (less than 500 mm.) along the eastern coast and increases toward the west to approximately 1,000 mm. per year in the ghats (Ludden, 1978a:20,22). Annual mean daily temperature ranges from 24.9 to 33.7 degrees Celsius, and annual evaporation is approximately 2,500 mm. (Island of Peace, 1974; Tamil Nadu Public Works Department, Vol. 2, 1979). The Tambaraparni-Chittar River System, which flows eastward from the ghats to the sea, is the only perennial river in Tirunelveli District. During the Northeast

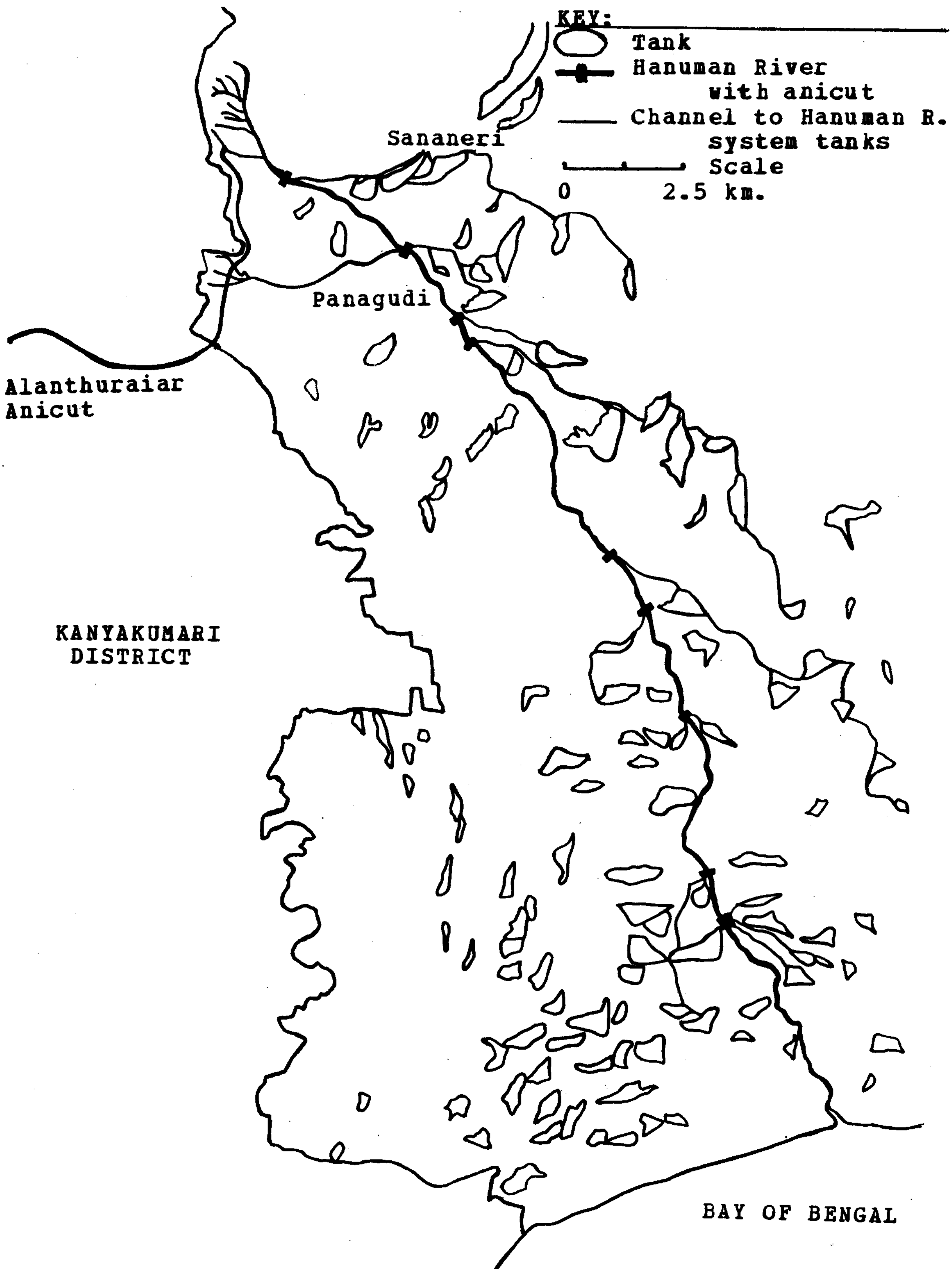
Monsoon, several seasonal rivers also carry water to feed chains of system tanks on their course from the ghats to the sea.

The scarcity of rainfall and its concentration during a few months of the year place a severe constraint on rainfed agriculture. The black soils can grow dry (i.e., unirrigated) crops because of their high water retention, but few crops will succeed in the red soils without irrigation. Along the Tambaraparni River, land is securely irrigated by channels leading from anicuts across the river. Outside this area, some form of storage is necessary to provide irrigation for one or more crops per year. Thus, tanks for surface storage and wells that tap groundwater storage are the major sources of irrigation in much of Tirunelveli District.

Irrigation Structures: The Hanuman River System and Sananeri Tank

Sananeri Tank is fed by the Hanuman River, one of the southernmost seasonal rivers in Tirunelveli District. Like the other rivers in the district, the Hanuman flows from the Western Ghats to the sea, as shown on Map 2. However, it differs from the others in that it does not rely exclusively on runoff from the eastern slopes of the mountains but also receives water from the southwestern side of the ghats via the Alanthuraiar Anicut and a contour canal. These structures, completed in 1978, divert 40 percent of the water of the Alanthurai River from Kanyakumari District. Because Kanyakumari District receives plentiful rain during both the Southwest and Northeast Monsoons, the Alanthuraiar Anicut improves the reliability of the water supply in the Hanuman River. This transfer of water from the wet side of the ghats to the dry side is facilitated by the fact that no state borders are crossed, and that the entire area is under the same Superintending Engineer of the PWD in Tirunelveli.

MAP 2: HANUMAN RIVER SYSTEM



There are nine anicuts on the Hanuman River that divert water to fifty-four tanks, with a total command area of 1,172 hectares. Not all tanks receive water directly from the channel leading from the anicut; some are dependent on the surplus water of the tank above. This has important implications for access to water, for such tanks cannot receive river water until the tank above has completely filled and is overflowing.

The first anicut, made of stone and masonry, diverts water from the river to six tanks, including Sananeri. It is approximately 23 meters long and 2 meters high. At one side of the anicut are two regulators with vertical lift gates on screws that control the flow of water down the river. Two similar regulators at right angles to the anicut can be opened to allow water to flow into the channel feeding the first chain of tanks. The PWD has responsibility for operating these gates, using a specially-fitted wrench.

The channel leading to the tanks is an average of 5 meters wide. It is lined with stones and mortar or cement on the apron of the anicut and at the bifurcations leading to the individual tanks. At the bifurcation, this lining serves not only to reinforce the junctions against erosion, but also to fix the proportions of water each branch and tank is to receive. For example, at one bifurcation along the channel from the first anicut, the branch that feeds the first tank (with a registered ayacut of 43 ha.) plus some channel-irrigated land is 3 meters wide; the branch feeding the remaining five tanks with a total registered ayacut of 264 ha. is 6 meters wide. These proportions have been determined on the basis of registered ayacut and relative water rights of the areas served by each branch.

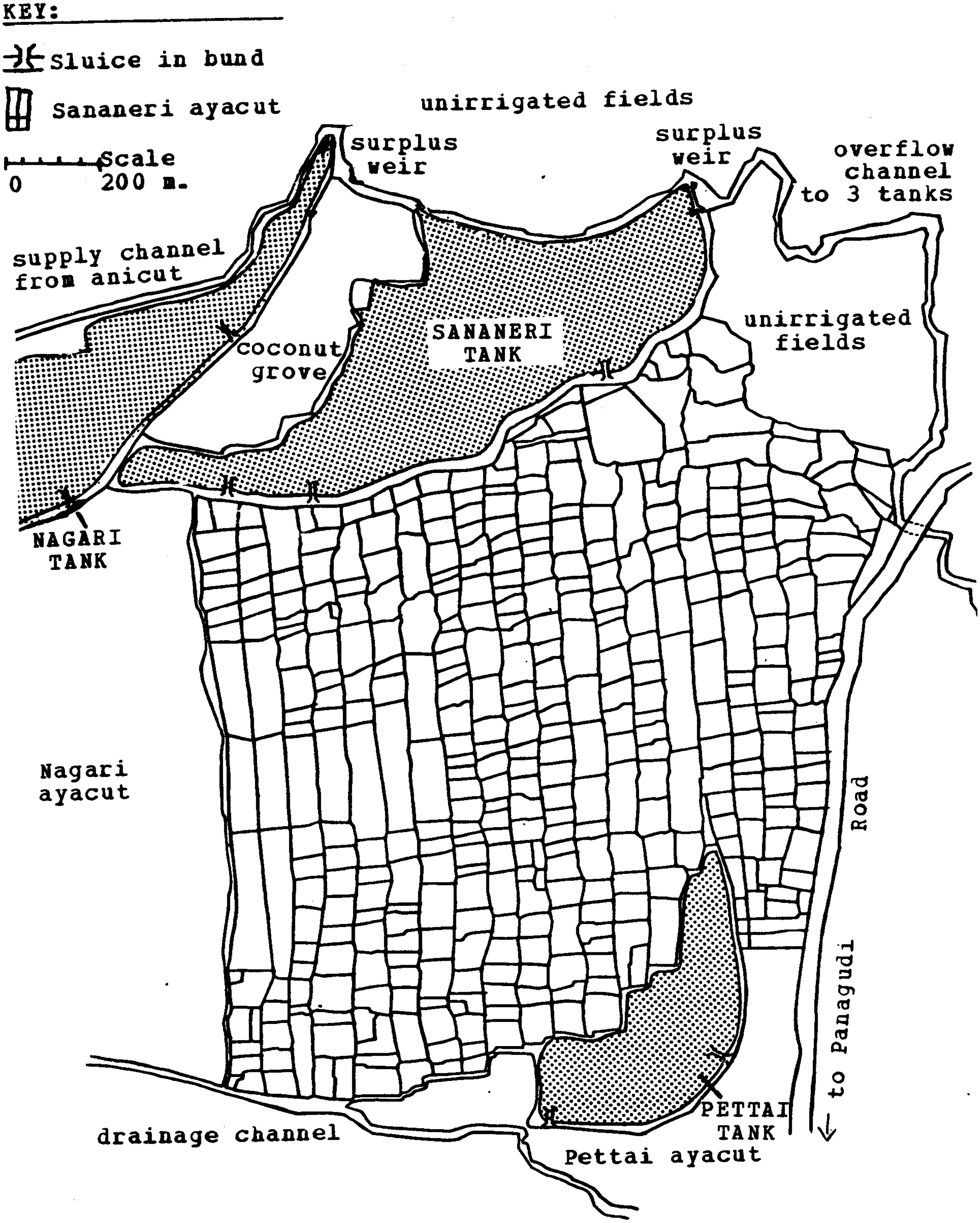
Sananeri Tank is the third and last tank to receive water directly from the first anicut channel. Three more tanks are designated to receive water from the Hanuman River through the surplus weir of Sananeri Tank. Water from the channel enters Sananeri on the northern side and flows across the tank bed to the bund on the southern side. To the west, the tank adjoins the bund of Nagari Tank, the second tank to receive water from the first anicut, as shown on Map 3.

The surplus weir forms the easternmost portion of the bund, where there is a drop of 2.5 meters to the channel leading to the other three tanks in this chain. The entire weir and its water cushion in the channel are constructed of stone and mortar. Below the level of the weir are two emergency shutters, each 1 meter square; however, these have been silted over and are not useable. Rectangular damstones are fixed in the base of the weir, against which a temporary wall of wooden plants, sticks, and mud can be built up to store additional water when available.

The bund itself is 2,000 meters long and somewhat undulating. The top of the bund is approximately 5 meters above the tank bed and is 1.5 meters wide. The side facing the water spread is lined with flat stones and mortar, except for one spot in the center where a gap has been formed in the facing and bund.

There are three towerhead sluices in the bund that allow water to flow into the field channels. These are cylindrical cement structures built into the inner face of the bund. At their base is a cement-lined passage under the bund. A wooden vertical lift gate, similar to those on the anicut regulators, is used to control flow through the sluice. However, unlike the screws on the anicut regulators, these sluice gates do not require the special wrench of the PWD to operate them. Any large spanner wrench can be used to turn the bolt and raise the shutters, but there is a space to affix a large padlock on the side of the bolt to lock the sluice. This difference in technology reflects the difference in organizational control over the two types of regulators. The PWD controls water allocation from the anicut, and its employees, the luskers, carry the specially-fitted wrench to operate the anicut regulators under the orders of the engineers. The local

MAP 3: SANANERI TANK AND ENVIRONS



cultivators control the distribution of water from the tank, and their employees, the neeranis, hold the keys to the padlocks on the sluice regulators.

Two of the sluices have a cement "silt catcher" box approximately 3 meters from the tower, with a cement-lined channel between the tower and the box. This is to slow the water and ensure that silt is deposited before it reaches the sluice opening. The center sluice has the remains of an old stone sluice regulator of the kind described by Buchannan (1807:4):

> The inner end of this sluice is covered by flat stone, in which is cut a circular opening, that can be shut or opened by a plug fixed to a bamboo, and secured in its place by two pillars of stone, which rise above the level of the water.

There are a total of four kaalvay, or distributaries leading from the sluices to the fields. Each of these has four kizhkaalvay, or secondary distributaries. Channels throughout most of the ayacut are unlined earthen ditches with grass along the sides. There are channels to each field, although in the southern or tail reaches of the ayacut these channels become less distinct. Fields are divided by varambu, or small bunds covered with grass. Openings in the channel banks that allow water to enter the fields are called vaamadai. These are closed by constructing a small ridge of sand across the opening, in line with the varambu. If there is a drop of half a meter or more from the channel to the field, a pipe or hollowed section of a palmyrah log may be used as a drop structure.

When the tank is not full, the center sluice receives the most water, while the eastern sluice receives considerably less. This difference is partly due to differences in the heights of the sluice openings and the level of the land commanded by each, but it is augmented by the pattern of siltation in the tank. Overall, the farmers estimate that this tank bed has been raised "the height of a man" by silt deposition. However, these deposits are most marked in the eastern portion of the tank bed. This is consistent with the general pattern of siltation observed by Krishnaswami (1947:442) in which siltation follows the lines of the incoming water and builds up one side of the bed, usually that nearest the surplus weir. The result is that standing water collects in one curve of the bund near the center sluice instead of being distributed along the entire bund. Special channels must be dug in the tank bed itself to ensure that water reaches the eastern sluice when the tank level is low. Silt has been excavated from some areas in the eastern part of the bed for use in nearby brick manufacture.

According to PWD calculations, the full tank has a waterspread of 39 hectares and a capacity of 402,400 cubic meters. It is designated to receive two fillings during the Northeast Monsoon in order to irrigate its registered ayacut of 173.84 ha. According to these figures, the water duty, or water available in the tank per unit of registered ayacut, is only 0.46 meters. This is on the low end of the range of 0.35 to 2.90 meters noted by von Oppen and Subba Rao (1980b:7), and considerably less than the water duty of the two tanks above Sananeri on the same channel. Moreover, the ratio of ayacut to waterspread is unusually high, almost 4.5 to 1. Von Oppen and Subba Rao (1980b:8) report that in the case of very large tanks with tall bunds, the ayacut may be two to four times the size of the waterspread, but the bund of Sananeri Tank is only 5 meters tall. Clearly the fact that Sananeri is to receive two fillings during the Northeast Monsoon reduces the amount of storage and waterspread required, but the ratio of ayacut to waterspread is only 1.6 to 1 for the two tanks above Sananeri, which are also scheduled to receive two fillings.

Rainfed tanks and most system tanks receive runoff directly from an area of free catchment, but Sananeri is almost totally dependent on the Hanuman River for water. On the western side, Nagari Tank intercepts all runoff. On the northwestern edge of the foreshore is a coconut grove that the owner has marked off from the tank with a raised cactus fence. The foreshore east of the supply channel may receive some runoff from the adjoining dry (punjai) fields. The lack of runoff into this tank, and its high ratio of ayacut to storage capacity, make it all the more critical that Sananeri receive two fillings from the Hanuman River. The low storage capacity of Sananeri Tank relative to its command area and its dependence on river water places particularly strong demands on water management.

In addition to irrigating the ayacut, Sananeri Tank is also used for several other purposes. The collection of silt for brick manufacture has already been mentioned. Trees along the foreshore are used for firewood. Sheep, goats, and cattle may graze in the tank bed. Standing water is used to bathe and water animals and to raise fish.

The ayacut has distinct boundaries that make extension of the irrigated acreage difficult. To the north is the tank itself, to the west is the ayacut of Nagari Tank, to the east is a main road, and to the south is a stream through which any drainage water from the fields runs back into the Hanuman River. There are no roads or cart tracks across the ayacut; the varambu that border the fields and irrigation channels are used as pathways into the ayacut.

There has been an increase in the use of groundwater for irrigation in this area since the advent of rural electrification in the mid-1960s. This is because electric pumpsets provide a relatively inexpensive means of lifting water, compared with manual lifts such as the <u>picotah</u> (human-powered counterpoise) or <u>kamalai</u> (bullock-drawn bucket), or compared with diesel-powered pumpsets. The use of pumpsets reduces the labor requirements for lifting water, and electricity is cheaper than diesel. Pattanshetti (1972:64-65) found the operating cost of irrigation to be Rs. 120 per hectare per season for electric pumpsets, Rs. 354 for diesel pumpsets, and Rs. 763 for bullock-powered lifts.[16]

There are 121 private wells in the command area of the tank providing supplemental irrigation water. These are open wells lined with cement and stone, approximately 10 meters square at the surface and up to 18 meters deep. A cement trough often leads from the well to the nearest field. In the interior of the ayacut, some wells have piles of rubble several meters high and up to 10 meters in diameter, where the earth and rock removed from the well have been deposited. The owners of these wells have evidently sacrificed the use of some land for crops because of the difficulty of transporting this rubble away from the middle of the ayacut. Seventy-two wells have adjoining cement pumphouses that shelter elctric pumpsets of 3-5 horsepower used to lift groundwater for irrigation. The other wells are generally equipped with kamalai lifts. The latter each have a sloping earthen ramp, up to 10 meters long, for the bullocks to walk down as they lift a water bucket.

During the main wet (pisanam) season (October to January), Sananeri Tank receives water from the Northeast Monsoon. Unless the rains fail badly, paddy will be grown in virtually the entire ayacut. The main varieties of paddy are: veLLai, viiti maTankan, kaNNici, ponni, kaTTiccambaa, cambaa (samba), IR8, and IR20. VeLLai and cambaa (samba) are traditional varieties requiring six and four month growing seasons, respectively. Viiti maTankan, kaNNici, ponni, and kaTTiccambaa are "government" or "improved" varieties that require four to five months, and IR8 and IR20 are improved varieties that require three to four months. The pisanam crop is planted in late October through early December. Cultivators plan their own planting dates based on their calculations of when the rains will come and whether they have access to labor and bullocks for land preparation and water for raising a nursery. There is an advantage in having access to well water to raise seedlings before the tank fills, so that when it does fill the water will last through more of the crops' growing season. The pisanam crop is harvested from February through April, depending on variety and planting date.[17] During the Southwest Monsoon in June to September, a second (kar) crop of paddy may be grown, depending on availability of tank water or access to well water. This crop is generally planted in June and July and harvested in August and September. Other crops grown during the kar season include chedi, or bush crops such as tomatoes, eggplant, beans, cotton, chilies, and castor. Castor is usually grown around the outside of a field, with another crop in the center. Occasionally pumpkin, bitter gourd (Momordica charantia), or bottle gourd (Lagenaria siceraria) vines may be allowed to grow into the irrigation channels adjoining a field, but these must be removed before the channels are needed for irrigation. A few fields are permanently devoted to coconuts. Bananas are a major crop on some fields throughout the year. Banana is the only crop besides paddy grown during the pisanam season. When either tomatoes or bananas are grown, the soil is ridged so that irrigation water can be precisely directed to each block of six or eight plants. During March through October, herds of sheep are allowed to graze in the fallow ayacut fields, attended by boys who watch that they do not damage standing crops. Sheep may be penned on individual fields at night to provide extra manure.

Most of the land in the ayacut of Sananeri Tank is cultivated by those who own the land; there is little absentee ownership or tenant cultivation. Those who own nanjai, or wet land, in the ayacut often have additional punjai, or dry land, up to several miles away. Land in the ayacut is cultivated with family labor, supplemented by casual and/or permanent hired labor. In general, men do the land preparation activities, sow the seeds, and apply water, fertilizer, and pesticides. Womens' labor is used primarily for transplanting and weeding paddy. Both men and women may be involved in harvesting.

I was unable to obtain a detailed, up-to-date enumeration of landownership in the ayacut of Sananeri Tank. This used to be maintained by the village karnam, but this post has recently been abolished in Tamil Nadu in an effort to rid the villages of hereditary positions. Because of the time constraints of this study and the difficulties of collecting accurate information on landholdings (Mencher, 1974), a census was not conducted to document the size and distribution of holdings. I did obtain access to the Revenue Department Resettlement Survey record for the ayacut area for 1914 (Madras Presidency, Revenue Department, 1914).

This record showed that there was only one very large landowner, a Muslim woman, with holdings in and around the Sananeri ayacut. Informants report that today there are no landowners with large holdings in the ayacut, but the successor to the Muslim woman, a powerful M.L.A.[18] from a nearby village, owns an extensive coconut grove on the northern side of the tank adjoining the waterspread of Sananeri and the bund of Nagari Tank (see Map 3). Although this land benefits from the high water table near the tanks, and the mud wall around the grove blocks some runoff from reaching Sananeri Tank, the owner of this land has no direct involvement in the management of Sananeri Tank.

The Resettlement Record also provides some indication of the caste composition of landowners in the ayacut. Vellalas were the most numerous caste represented in the ayacut, with slightly over 30 percent (54.46 ha.) of the ayacut under their ownership. This is the caste that has traditionally been the major wetland agriculturalists in Tamil Nadu, and particularly in Tirunelveli District (Ludden, 1978a:75). Nadars were next in order of ayacut landownership, with 29.66 ha. This caste has been noted for its upward mobility in caste and economic status, partially by profiting from high-profit garden crops and well irrigation in the vicinity of tanks (Hardgrave, 1969:53-54; Ludden, 1978a:373). Numerous other castes were also represented in the list of landowners, including Muppan, Konar, Asari, Maravar, and the Harijan Sambavar. In addition to this range of castes among Hindu landowners, Muslims and Christians also owned land in the ayacut of Sananeri.

This diversity of the caste and religious background of cultivators in the ayacut has not disappeared since 1914. Moreover, cultivators live in at least six different villages in the vicinity of Sananeri Tank, mostly around the administrative village of Panagudi. Such heterogeneity has important implications for any organization of ayacut cultivators. In such a context, local water management activities are unlikely to be imbedded in the institutions of village, caste, or religion; rather, efficient maintenance, allocation, and conflict management requires a special-purpose organization of ayacut cultivators specifically for irrigation management, with benefits from better water supply as the motive for organizing.

CHAPTER 4: STRUCTURE OF LOCAL WATER MANAGEMENT

The Public Works Department (PWD) is officially responsible for maintenance of the physical structures of the Hanuman River irrigation system, including the structures of the tanks. It is also responsible for allocating water from the river to the tanks. However, all maintenance and water allocation below each tank is left to the local cultivators, as are all tasks related to well irrigation. Thus, proper functioning of the irrigation system to provide sufficient and reliable quantities of water to the fields depends on the performance of both a government bureaucracy and the farmers themselves.

What is particularly interesting about the South Indian system of irrigation, which includes rivers, tanks, and wells, is that bureaucracies, communities, direct appropriation, and private contracts are involved in the ultimate allocation of water to the fields (see Chambers, 1980:33). Thus, it is important to examine the system management activities that are carried out on each of three levels of organization: the government bureaucracy, the association of cultivators, and the individual cultivators.

In this chapter, information on the operation of the Hanuman River system and Sananeri Tank, including details on the actual maintenance activities performed by the PWD and the farmers, is provided. It is important to look at the functions officially assigned to the bureaucracy and to the cultivators, and what level of organization is actually involved in each task. The data in this chapter address these issues, as well as the relationships between the three levels of organization. The focus is on those factors that affect irrigation in the ayacut of Sananeri Tank. While relevant aspcts of the river system and the government bureaucracy are included, it is beyond the scope of this chapter to present a complete view of the entire river system or the Public Works Department. On the other end of the scale, information on well irrigation is also not as detailed as might be desired for a complete discussion of the importance of this type of irrigation. Rather, the focus of this discussion is on the tank, the ayacut association, and its linkages up to the larger system and down to the individual wells, fields, and cultivators, in keeping with the "middle-outward" perspective of this study.

Public Works Department

The official responsibilities of the Public Works Department have already been mentioned in Chapter 2. The Hanuman River system falls under the jurisdiction of two junior engineers of the PWD. The first is responsible for all tanks in the system that lie north of the river, including Sananeri Tank. The second junior engineer is responsible for all tanks south of the river, as well as for the river itself. Each engineer also has other tanks and public buildings in his charge.

The junior engineer in charge of the river system has major control over water allocation within the system. He has two luskers, or PWD-employed watermen, whom he can depute to open or close the regulators of the various anicuts on the river, using the special wrench of the PWD.

Although the PWD is responsible for allocating water to the tanks, in fact its active control does not extend beyond the anicut. The luskers operate the anicut regulators, but they do not follow the water down the channels to the tanks. Some passive regulating devices have been constructed along the channels by the PWD, such as the cemented bifurcations with fixed proportions of channel width leading to different tanks. But these structures can be and are modified by cultivators as discussed below.

According to the normative pattern, the PWD should close off the first anicut, allowing the chain of tanks that it feeds to fill before opening the anicut and allowing water to flow down the river to the next anicut to feed its set of tanks. This pattern would be repeated until water had reached the last anicut and tank. Then a second filling would be given, starting again at the head of the system. In reality, frequent shortages of water prevent the junior engineer from following this pattern of water allocation. In case of shortage, tanks at the head of the system have priority for water, but the engineer must still decide between giving one filling to as many tanks as possible, and giving head-end tanks the two fillings to which they are formally entitled.

Another choice that must be made during the Northeast Monsoon season is whether to fill all tanks in a given chain, or only those that receive water directly from the anicut channel. For example, in the first chain of six tanks, three large tanks, including Sananeri, are fed directly by the anicut channel, and three receive river water only through the surplus weir of Sananeri Tank. For the latter tanks to receive water, Sananeri and the two tanks above it must be completely full. If the sluices of the first three tanks are opened for irrigation, those tanks must be continuously refilled in order to send water down the chain to the last tanks. Unless there is plenty of water in the river, this can only be done at the expense of tanks farther down the system.

Three factors affect the junior engineer's decisions to open and close the anicut regulators and allocate water to each chain of tanks: estimates of water availability in the river during the season, a general principle of giving head-end tanks priority for water, and the requests by cultivators for water allocation.

If the monsoon is strong, the engineer can afford to send water to all tanks in the head chains and still be able to send water to tanks farther down the river. Conversely, if the water flows are low, high transmission losses in the sandy river bed preclude trying to send water very far down the system. Thus, the PWD is more active in water allocation during the heavier Northeast Monsoon than at other times. During the lighter Southwest Monsoon and the rest of the year, most water is diverted to the first chain of tanks, with rare allocations to the second chain.

The general priority of head-end tanks for receiving water may be related to the doctrine of prior appropriation, or to concerns with preventing transmission losses, or both. According to the doctrine of prior appropriation, "whoever first exploits a resource has a right to continue to do so" (Chambers, 1982:12). However, given the antiquity of this system of tanks, it is not clear which were historically the first tanks to receive water from the Hanuman River. Tanks nearest the mountains may have been the first, but Madduma Bandara (1977:323) mentions new tanks and channels constructed upstream from existing tanks, robbing the latter of water.

Concerns over transmission losses provide a rationale for the priority of head-end tanks in terms of efficiency. When river flows are low, little water would reach tail-end tanks after percolation and evaporation along 20 kilometers of sandy river bed. Moreover, a fairly high level of water is required in a tank if it is to be used for surface irrigation. Thus, a greater proportion of the scarce system water can be used for surface irrigation if it is kept at the head of the system, rather than being distributed to all tanks in the system. If there is not enough water for the pisanam crop, concentrating that which is available at the head may be more productive for surface irrigation than distributing it too thinly over the entire area (Chambers, 1982:26). However, the effect of this water allocation on the total hydrological system——both surface and groundwater——is more complex. Losses through percolation are not total losses to the system as they recharge the groundwater table and are at least partially recouped through wells.

The requests and petitions for water made by cultivators in a tank ayacut also affect water allocation along the river system. Representatives of the cultivators present requests in person and in writing to the junior engineer in charge of water allocation. These petitions are a source of information on the availability of water in the tanks as well as of advocacy for the interests of specific tanks. In particular, when the cultivators from the first string of tanks notify the junior engineer that the water in their tank is low, he must decide when to stop giving first fillings to tail-end tanks in order to give second fillings at the head of the system. By this time, the head-end cultivators have standing crops and need more water to bring them to harvest. This provides an additional rationale for giving head-end tanks priority for water.

Important as water allocation is, it takes less of the PWDs' time and resources than does maintenance of the physical structures. There are no formal criteria governing inspection and repair of tanks, except that a tank would not ordinarily be repaired more often than once in three years, except in cases of emergency.

The actual pattern of maintenance depends very much on petitions from the cultivators. These petitions inform the PWD of any needed repairs, and the petitioners try to convince the junior engineer in charge of their tank to come and inspect, then to sanction and carry out repairs. Unlike the smaller tanks under the BDO engineer, which are all routinely inspected on a five-year cycle, the PWD tanks depend on the initiative of the cultivators to ensure proper maintenance.

Ayacut Water Users Association

The preceding discussion has pointed to several activities and responsibilities of the ayacut cultivators. The cultivators not only take care of maintenance and water distribution below the tank, but they petition the PWD for repairs and water allocation from the river, and follow and control water in the channel from the anicut to the tanks.

These activities are conducted by an unofficial ayacut association called a niirpaacanam cankam (sangam) (water users' association) or vivacayikaL cankam (sangam) (cultivators' association).[19] All cultivators in the ayacut of Sananeri Tank are eligible to attend the semiannual association meetings. During these meetings, a core committee of approximately seventeen elders is selected to attend to ongoing business. In addition, the association selects a president and secretary from among their members and employs eight other men for water management: two neeranis for water acquisition and six neerpachis for water distribution. The elders, officers, and water management personnel are all respected men in their communities, usually over forty years old. They are often members of informal caste or village panchayats in addition to their roles in the ayacut association. They do not nominate themselves but are selected by concensus rather than by vote. These men serve until they retire from their post or are removed for unsatisfactory job performance.

The two neeranis are charged with "bringing the water down," or water acquisition for the tank. The two tanks above Sananeri have one neerani each, while Sananeri has two because of its large ayacut. None of the three tanks dependent on Sananeri's overflow have a neerani.

The specific tasks of the neeranis include bringing water into the tank and letting it out through the sluices. The four neeranis from the first chain of tanks patrol the channel from the anicut to the tanks, checking against potential water theft or damage to structures. If necessary, the neeranis go up to the mountains to ensure that there is no obstruction or theft along the Hanuman River or its tributaries.

In addition to collaborative work, the neeranis also defend the interests of their own tank and service as a check on the neeranis of the other tanks. Neeranis report that quarrels are not uncommon. One particularly important issue for the neeranis of Sananeri Tank is that water be allowed to flow to all three tanks simultaneously, with one-fourth of the total going to each of the two upper tanks, and one-half to Sananeri Tank. The alternative is for the tanks to be filled sequentially, with the neeranis closing off the channel to the lower tanks until their own tank is full. This would put Sananeri at a disadvantage because it has the largest ayacut, but would be third to receive water. The prevailing practice is simultaneous water delivery, perhaps in part because Sananeri has a customary right to twice as much water as either of the other tanks and has twice as many neeranis to defend this right.

The other important part of the neerani's function is to open and close the tanks sluices for surface irrigation during the pisanam season. The neeranis hold the keys to the padlocks on the sluice regulators, just as the PWD luskers carry the special wrench for the anicut regulators. When the rains no longer provide enough water for the paddy crop, the ayacut cultivators approach the neeranis to clear the silt from the sluices and begin irrigation. The association leaders may also be consulted, particularly for the first irrigation issue, but the neeranis have the central role in this. The neeranis open the sluices until they are informed that the entire ayacut is irrigated, whereupon the sluices are closed and locked until the next irrigation issue is needed. When the tank level is too low to irrigate the ayacut, the sluices are left unlocked to allow cultivators to make use of the water on an individual basis.

All three sluices on Sananeri are simultaneously opened and closed to ensure that the entire commond area gets the same number and length of irrigation issues. This would be more difficult to achieve if rotation between sluices were practiced, for not only could there be disputes over the amount of time each sluice should be open, but as water levels in the tank bed decline, irrigation issues from the center and western sluice could lower water so that it would not reach the eastern sluice, given the siltation in the bed around that sluice. Equal water issues from the sluices does not ensure proportionate equality of water at the field level, for the three sluices command slightly different amounts of land. However, this is not perceived as a major problem because each field is assured of a complete wetting and approximately one inch (3 cm.) of standing water during each irrigation issue.

Neeranis personally carry out minor repairs to the tank or its feeder channel, as well as to the PWD-controlled anicut structure. For example, one of the regulators on the first anicut was broken, with the gate raised to allow water to go down the river. The PWD had opened the regulators to send water down the channel to the first chain of tanks, but these tanks would not receive all the water as long as the other regulator was open. The neeranis filled in the opening of the river regulator with mud, sticks, and palmyrah leaves. If major repairs are needed, the neeranis notify the association president, who will either request the PWD to repair it or will mobilize local resources to do the repairs.

The neeranis must be available to work year-round. In addition to their functions of inspection, maintenance, water acquisition, and sluice control, they also serve as communicators with the association leaders and other cultivators. One important aspect of this latter function is their task of announcing association meetings in each village where ayacut cultivators live.

In order to ensure their availability for tank work, neeranis may not have any land of their own. Bravery is considered to be an important criterion in their selection as they sometimes must use force to defend their tank's interests against potential water thieves or other neeranis. The neeranis of Sananeri Tank are almost always from the Nadar caste, which is one of the major castes among ayacut cultivators. In return for their services during the pisanam season, they are paid in kind at the rate of ten pakkas of paddy per kottai of land for both neeranis, approximately 5,800 cc., or 9.0 kg. of paddy per hectare per neerani. This is a total of 11.75 kottais, or 1,550 kg. of paddy per neerani, approximately the same amount that local cultivators calculate is a normal gross yield per acre, or a normal net yield per hectare. For work during the rest of the year they are paid Rs. 50.00 per month of activity.[20]

The other six water management personnel employed by the Sananeri ayacut association are neerpachis, or "water spreaders," charged with watering the fields. Sananeri has two neerpachis per sluice because of its large ayacut, but most tanks have one neerpachi per sluice. This role has slightly less status, responsibility, and remuneration than that of neerani. But while the job itself may be somewhat less prestigious than that of neerani, the men who hold it are, like the neeranis, respected elders in their community. Unlike the neeranis, the neerpachis may have land in the ayacut of Sananeri Tank, but are expected to be fair in water distributions. Holders of this post are generally Nadars or Harijans.

The responsibilities of the neerpachis are more circumscribed than those of the neeranis in terms of function, time, and area. Neerpachis are primarily water distributors, with no obligation to maintain or repair the distributary channels. Neerpachis are employed only for the pisanam season; any water in the tank at other times of the year may be used directly by cultivators in the ayacut. Each neerpachi ensures that one particular block of paddy fields in the ayacut receives a thorough wetting each time the tank sluices are opened during the pisanam season.

When water is plentiful, this task involves checking that the neeranis opened all sluices at the same time and that each distributary channel gets its proper portion of water. Neerpachis also watch that each paddy field is saturated and has one inch of standing water before blocking off the vamadai, or field gate, with a ridge of earth. As water supplies in the tank are depleted, the amount of discharge in the distributaries declines, and the neerpachi directs the water to one field at a time. This requires the construction of an earthern check in each distributary, immediately downstream from a field gate so that water is diverted from the distributary into the field. When the field has received enough water, earth is placed across the field gate, and the check in the distributary is cut open to allow water to flow down to the next check and field gate. When the water level in the tank is too low to irrigate the entire ayacut, the neerpachis go to each cultivator in their area to notify them of the fact. After the neerpachi says he can no longer distribute water to their fields, the cultivators may take any available water for their own use.

The use of neerpachis to distribute irrigation water helps minimize conflicts between cultivators over water in several ways. The neerpachi provides approximately equal depths of water to each field, and his judgment on the depth of water is trusted. As long as there is water in the system and the neerpachis are distributing it, the cultivators may not interfere by taking water directly from the distributary channels. When the water level in the tank is too low to irrigate the entire ayacut, the neerpachi's personal notification assures cultivators that all that is possible has been done. He also legitimizes head-enders' use of tank water by any means, including bailing out the dead storage

Much of the neerpachi's contribution to minimizing conflict is based on cultivators' trust in his personal integrity. This quality is ensured through the selection process and an ongoing informal evaluation of his work. If eight or ten cultivators served by a neerpachi are dissatisfied with his performance, they can discharge him. This keeps the neerpachi accountable to all cultivators in his area of the ayacut.

The neerpachis are paid in kind by the cultivators they serve at the rate of 21 pakka of paddy per kottai of land, approximately 24,500 cc., or 37.5 kg. of paddy per hectare. This is a higher rate per hectare than that paid to the neerani, but neerpachis receive less total income than neeranis because they receive income from less land and are only paid in the pisanam season. They do not receive payment from fields planted to banana or coconut, nor do they allocate tank water to these fields during the pisanam season.

The third major position of responsibility in the ayacut association is that of president. This man is selected by the association and is himself a cultivator in the ayacut. He conducts the association meetings and oversees the ongoing activities of the association between meetings. He manages the finances of the tank, conducts the annual auction of fishing rights, and manages payment of the casual labor or materials needed for any repairs to the tank or feeder channel that the association might undertake. In addition, one of his major responsibilities is to serve as liason between the cultivators and the bureaucracy, representing tank interests before the relevant officials.

When repairs or additional water are needed, the association president approaches the PWD junior engineer to make a personal request and/or submit a written petition. If the engineer does not respond, the petitions may be taken to higher officials in the PWD or to the Agriculturalists' Grievance Meetings held by the District Revenue Collector. At these meetings, petitions are responded to by the district-level officers of the PWD, Revenue Department, Development District Office, Forest Department, and Electricity Department. This is one mechanism for bringing pressure to bear on various bureaucrats to get work done. For all such petitions it is helpful if the president has some contacts in the government administration. The current president of the Sananeri association is not wellversed in dealing with the bureaucracy, so he takes along a younger man who has a master's degree and who knows people in the government.

When the association president is successful in getting the luskers to come to the anicut and open the regulators to the first chain of tanks, or in getting the junior engineer to inspect the tank for repairs, the president often provides tea and a light snack as a courtesy for the service. Sometimes this courtesy can be more elaborate and expensive, such as in one case when a taxi was sent to bring a PWD engineer to inspect a channel. Bribes are not unheard of, although those with good contacts in government offices claim not to need them. In all such activities, the association president is lobbying for the interests of the ayacut cultivators, but also using local resources to assist the bureaucracy in its functions. In particular, the PWD has no formal mechanism or resources for collecting information on local conditions. The association president provides this information directly through petitions and indirectly by providing transportation to enable officials to observe conditions themselves.

When the PWD cannot be persuaded to inspect the tank or do repairs, the association may have the neerani do the work with hired daily laborers. Examples of such work include replacing regulator boards or bolts in the sluices, desilting critical parts of the supply channel, or patching the regulator on the anicut. When this is done, the association president provides money for the laborers' wages and midday meal. Similarly, whenever the neeranis are sent on special errands, such as calling association meetings, the president provides for their travel expenses and meals.

The association president does not receive any salary for this work, but he is reimbursed for his expenses from the tank fund. He keeps an account of all he spends on locks for the sluices, repairs, wages, meals, and refreshments, plus his own travel and meals when going to government offices to submit petitions. The income from the auction of fishing rights is the major source of funds for these expenses. In Sananeri Tank, this usually amounts to Rs. 500 per year. Any expenses above this amount are recouped by levying a contribution of a few rupees per acre on all ayacut cultivators.

Overall, the role of the president is that of coordinator of the activities of the ayacut association. He collects and dispenses the common funds, directs the neeranis, and cultivates linkages between the association and the government bureaucracies. In a sense, he serves as a conduit of information from the neeranis, with their detailed knowledge of the immediate system, to the engineers who are more removed from the immediate locality but must deal with the larger system. However, this is not a passive role as communication is part of an overall effort to ensure that the necessary maintenance and water allocations are done, either by the bureaucracy or by the neeranis and locally-hired laborers.

This type of informal ayacut association is not unique to Sananeri Tank; other tanks in the Hanuman River system have similar organizations. There is an historical precedent for such associations in the tank committees of ancient South India. Other modern studies of tank irrigation in Tamil Nadu and other states mention associations with a common fund (Palanisami, 1982; Wade, 1979) and the use of water management personnel corresponding to the roles of neerani and neerpachi, variously referred to as <u>neerkatti</u>, <u>kambukatti</u>, or <u>Madayan Thotti</u> (Arputharaj, 1982; Palanisami and Easter, 1983:18).

From the information available on other tanks, there appears to be considerable variation in the organizational framework, responsibilities, and remuneration of local water management personnel. Table 4.1 provides a comparative view of the information available on the organization of these water management roles. Remuneration is generally in kind, with cultivators paying a certain amount of paddy per acre directly to the watermen. This means that water

Table 4.1: Comparison of Tank Water Management Positions in South India.

Title	State	Level of Activity	Remuneration	Responsible to	Gov't Involved	Source
NiiraaNi	Tamil Nadu	Sluice	Grain & cash	Cultivators' Association	No	Interview July 1982
Niirppaaycci	Tamil Nadu	Fields	Grain	Cultivators' Association	No	Interview July 1982
Harijan thoddi	Tamil Nadu	Fields	N.A.	Cultivators' Association	No	Chambers, 1980
Madayan thotti	Tamil Nadu	Sluice	Grain	Cultivators' Association	No	Palanisami & Easter, 1983
Neerkatti	Tamil Nadu	Sluice	Grain	Cultivators' Association	No	Arputharaj, 1982
Kambukatti	Tamil Nadu	Sluice	Grain	Cultivators' Association	No	Arputharaj, 1982
Water guide	Tamil Nadu	Sluice	Grain	Cultivators' Association	No	Shanmugham et al., 1982
Watermen	Tamil Nadu	Sluice	Land	Irrigation Panchayat	Yes	Rajagopalan, 1982
Branch water	Tamil Nadu	Field	Grain	Cultivators	No	Rajagopalan, distributor 1982
Neerganti or Nirghanti	Karnataka (pre-1965)	Sluice & fields	Land	Revenue Department	Yes	Bhargava, 1980; Dasgupta, Rao, & Ghosh, 1979
Soudi or Sowdi	Karnataka (present)	Sluice & fields	Government salary	PWD	Yes	Bhargava, 1980; Dasgupta, Rao, & Ghosh, 1979
Nairudi	Andhra Pradesh	N.A.	N.A.	Cultivators	No	Von Oppen & Subba Rao, 1980b

N.A. = Not available.

managers are employees of the cultivators. It is interesting to note that this pattern holds for all cases of locally-organized, informal associations. When the government is involved, remuneration is in the form of land or a government salary, which involves less direct accountability to the cultivators (Bhargana, 1980:82083; Dasgupta, Rao, and Ghosh, 1979:17-18; Rajagopalan, 1982:69).

Another pattern that emerges is that a distinction is often made between water management at the sluice level and that at the field level. This may be because it is too much work for one man to operate the sluices and apply water to each field, but it may also operate as a check against any one part of the ayacut receiving more than its proper share of water. For example, in Sananeri Tank the neerpachis are paid only from the lands they water. If a neerpachi could open the sluices, there might be less assurance that all areas of the ayacut would get their proper share of water because each neerpachi is only accountable to a subgroup of the ayacut cultivators. But the neerani is paid by and responsible to all lands in the ayacut and is more closely tied to and supervised by the president and elders of the association. Therefore, in his role as manager of the common tank water, he has less incentive to favor one part of the ayacut than would a neerpachi who is only responsible for one area.

This type of water management organization is not limited to tank irrigation in South India. There are marked parallels in structure and principles between the Sananeri ayacut association and the village committee for canal irrigation in Andhra Pradesh, as described by Wade (1979). The Andhra organization has three major distinct roles: the neerugantis, or "common irrigators," who distribute water to the fields (akin to the Sananeri neerpachis), the "sluice guards," who patrol the channel upstream to ensure their village gets its share of water (like the neeranis), and the peddamanshula, or committee of elders, who administer the common fund and represent the village irrigation interests to the relevant authorities (the same major functions as the Sananeri ayacut association president). As in the Sananeri ayacut association, the organization in Andhra operates by concensus, without a formal constitution or recognition by the government, and is not involved in politics or religious rituals. The common irrigators apply water to each field until it is "adequately wet," for which they are paid in kind directly by the cultivators they serve. Cultivators are responsible for water distribution in the second season and for maintaining the irrigation ditches.

The existence of parallels between local water users' associations in different areas of South India does not imply that local organizations are homogenous. The work of Chambers (1980) and Palanisami and Easter (1983) show that considerable variation in both form and degree of organization can exist between tank associations within the same district. The same is true of ayacut associations in the Hanuman River system. However, an examination of the patterns that emerge from studies of these organizations is helpful in discovering the strategies and utility of local water users' associations.

Conjunctive Use of Tanks and Wells

Tanks and wells are interdependent forms of irrigation depending on a common ultimate source of water: runoff in the catchment area, often channeled through a river system. Percolation from tanks recharges the water table and this provides for storage of tank water without evaporation losses. Therefore, activities related to either tanks or wells need to be considered as part of the overall irrigation system management.

After the neerpachis have stopped delivering water in the pisanam season, well owners will begin lifting groundwater for their crops. This water is sent through the field channels to the various plots of the well owner. Other cultivators who do not own wells may purchase well water from those with electric pumpsets at the rate of Rs. 5.00 - 6.00 per hour. With the three-horsepower pumpsets that are most common in the ayacut, it takes approximately six hours of pumping to irrigate an acre of paddy, or fifteen hours per hectare. Those who purchase water are responsible for making sure the field channels between their fields and the well are clear enough to transport the water. In order to minimize transit losses, cultivators try to purchase water from a well located as close as possible to their fields. However, since there is an average of one well per 1.4 ha., and the wells are dispersed throughout the ayacut, this is not a major problem for most Sananeri cultivators.

During the kar season there is not only less tank water, but the groundwater table is lower and shortages of electricity are more common. Thus, it is more difficult for cultivators without wells to raise a crop. Lower water tables during this season make it more expensive and uncertain even for well owners to irrigate a full crop. Over half the ayacut is left fallow during this season. Paddy is grown only by head-end cultivators or those with reliable wells. Most of the cultivated area in this season is devoted to vegetables, chilies, and cotton; commercial crops that have a high value but which require less water than paddy.

It is important to note that groundwater irrigation is not used simultaneously with tank water. Well water may be used for nurseries and field preparation before any tank water is released for irrigation, to bring a standing crop to harvest after the tank water is depleted, or to grow a crop in the kar season when there is no tank water. However, as long as there is enough tank water for surface irrigation, well water is not used. Chambers (1980:38) has suggested that this pattern of water use is both inequitable and inefficient because well owners then have access to more water (from the tank plus well) than other cultivators, and if well owners did not not take tank water, it could be extended over a larger area or be made to last longer.

The reasons for the lack of simultaneous use of surface and groundwater irrigation are related to the investment, ownership, and water rights associated with tanks and wells. The surface irrigation system of rivers, weirs, and tanks was built up over time with investment by both government and groups of cultivators. The facilities are public property, maintained and managed by both a government agency and cultivators' associations. All ayacut cultivators have a right to this water by virtue of owning land in that area. This right to tank water is reinforced by paying a wet-land assessment to the government and by participating in the ayacut association through voting, taking responsibilities, and/or paying dues in cash or in kind.

In contrast, wells have been constructed by individual landowners using their own resources with some assistance from the government in the form of loans or subsidy. These wells are then owned and managed privately. Individual owners pay all costs of maintenance, lifting water, and managing their wells. In return, they have exclusive ownership of water from the well.

Well owners in the ayacut of a tank have rights to both surface and subsurface water. The former requires ownership of ayacut land plus annual payments to the government and to the ayacut association or its employees; the latter involves capital investment plus a unit operating cost. Therefore, as long as tank water is available, it is cheaper for well owners to use this than to raise well water for irrigation, since the amount they pay does not vary with the amount of tank water used.

Although tank water might go farther or last longer if well owners did not take it, the costs to the organization for preventing this use are very high. The water goes directly past all fields, regardless of whether or not they have a well. More neerpachis or other water guards would be required to watch that well owners did not take this water. Increased conflicts over water could also be expected.

Moreover, well owners are generally more affluent that other cultivators, and their support is often important to the ayacut association. However, both Chambers (1980:37) and Palanisami and Easter (1983:62) cite instances in which well owners voluntarily agreed not to take tank water during times of scarcity.

Not only is it the wealthiest and most influential cultivators who are most likely to obtain wells and pumpsets, but ownership of this important instrument of production reinforces their power. The construction of wells with pumpsets requires investing considerable financial capital and forfeiting at least 0.05 ha. of land for the well, pumpset, and the deposit of earth and stones removed from the well. Less affluent cultivators or those with small holdings are generally unable to devote such resources to a well. The government provides subsidized loans for well construction and improvement, but a minimum landholding is often required as collateral for this credit (Ghate, 1980:A162). Even where small farmers are given special consideration in obtaining such loans, the application procedures for loans and then for an electric connection for the pumpset involve complex bureaucratic processes. For example, in one study 21 percent of pumpset owners paid bribes for an electric connection, and more than half had to visit officials at least six times (Pattanshetti, 1972:135). Those cultivators with contacts in the government and skills in dealing with the bureaucracy are more likely than others to get a well and pumpset. As noted before, these same assets are important to the ayacut association in getting repairs and water allocations from the bureaucracy.

The new groundwater technology of wells with electric pumpsets has a high fixed cost, but provides reliable water supplies at a lower operating cost than manual lifts. The operating cost of electric-powered lifts is further reduced by subsidized electric rates for pumpsets. During the pisanam season, owers of wells with pumpsets can raise a nursery and prepare their fields before any tank water is issued. This gives them a head start on the other cultivators, so that the tank water will last through more of the paddy growing season.[21] After tank water is gone, well owners can provide additional groundwater irrigation to bring their crops to harvest. Because wells can provide the level of water management needed to take full advantage of the new technology of high-yielding varieties, fertilizer, and pesticides, they also increase yields and productivity. In addition, well owners may cultivate a second crop such as paddy, vegetables, or bananas during the kar season.

The profitability of well ownership is further enhanced by the sale of well water to other cultivators in the ayacut. In the Sananeri ayacut, well water is generally channeled through the existing field channels to neighboring fields. Recipients of this water pay the owner of the well Rs. 5.00- 6.00 per hour of water, usually in blocks of four to six hours. Palanisami and Easter (1983:92) reported that in Ramanathapuram District the charge for well water averaged Rs. 4.75 per hour, while the well owners' cost for electricity to run the pump averaged Rs. 0.90 per hour. In some cases, nonowners had to provide special services such as channel cleaning or advance payments to ensure access to well water in times of scarcity (K. Palanisami, personal communication). In North Arcot District, Harris (1982:131) found that well owners received one-third of the crop from those fields that they had supplied with water. Thus, the private ownership of well water creates the potential for major power differences between those cultivators with wells and those who depend on others' wells to save their crops. A more detailed investigation of the arrangements by which cultivators without wells gain access to groundwater and the relationships between well owners and those who buy their water would be necessary to show the extent to which this power differential is being realized and whether such water transfers are purely commercial transactions or whether they involve patron-client ties.

Although tanks and wells are interdependent forms of irrigation with a common ultimate source of water, the structural patterns of ownership and the water allocation principles that apply to each type of irrigation are very different. In terms of Glicks' typology of water distribution systems, tanks follow the "Syrian" model in which water allocation is proportionate to land, and water rights are inseparable from the land. Wells fit his "Yemenite" model, which he describes as "based on fixed time measurement units and associated with the sale of water" Glick, 1970:230). This distinction is most marked where wells are privately owned and tanks are public property, but it holds even under community wells with government sponsorship (see Palanisami and Easter, 1983). The Yemenite system generally requires more technical control of water,[22] and therefore has been associated with greater efficiency, whereas the Syrian system is often viewed as more equitable.[23]

This classification system may not be applicable to all cases, but it serves to highlight two important distinctions in the systems of water allocation under tanks and wells in South India: distribution of water according to depth of water in the fields versus distribution by time of flow in a channel, and water as a public resource versus water as a private commodity. In the case of tank-and-well irrigation systems, the principles of water distribution do change from area-based to time-based in response to shortage, but this change is not unidirectional. Both principles operate in the same year, even the same season, depending on the availability of tank water at any given time. The two distribution systems are controlled by different levels of organization and used with different technologies and immediate sources of water (tanks and wells). This has important implications for total resource management.

Well owners are conscious of time measurement of water delivery because they must pay for fuel (or, in the case of manual lifts, labor). Because they have exclusive rights over both the source and the water available from it, well owners perpetuate the time-based allocation of water by selling water by the hour.

The general association of public water and land-based distribution with larger water sources, and private water and time-based distribution with smaller sources holds because tanks are larger than wells. This may be partly due to the fact that it is easier to achieve the greater degree of technological and organizational control required for time-based distribution in an irrigation unit as small as a well, particularly under private ownership and management. Moreover, the higher unit operating cost of lift technology (compared to gravity-flow irrigation) creates more incentive to employ the tighter control of the time-based system of allocation and for the use of water as a commodity rather than a public good.

The trade-off between efficiency and equity, which Glick implies is involved in the shift from Syrian to Yemenite distribution systems, deserves further consideration at this point. Distribution under tanks is not always equitable (or even necessarily inefficient), as Chambers' (1980:36-38) and Palanisami and Easter's (1983:62-63) studies have shown, but it appears that groundwater tends to be used more efficiently, although all cultivators do not have equal access to it. This is related to the private ownership and the dispersed technology of wells.

Well owners have preferential access to groundwater; nonowners must pay more for it and may be cut off entirely when the water table is low or electricity supplies are limited.[24] Even among well owners, groundwater irrigation may create equity problems. Because there is little public control over groundwater use (except a stipulation by the Electricity Board that a pumpset should not be given an electric connection if it is within 100 meters of another well), drawdown may exceed recharge, causing a temporary or permanent decline in the water table. This has been documented in North Arcot and Coimbatore districts (Madduma

Bandara, 1977:322-338; Sivanappan and Aiyasamy, 1978:21-22), and a deepening of wells in Tirunelveli District seems to indicate a similar process. When this occurs, shallower wells and those with manual lifts may go dry or be unable to lift water for irrigation. It is significant that the surface water in tanks and channels, which is so important to the recharge of the groundwater, is a communal resource. It is only after this water goes underground that it emerges as a private good.

Despite problems of unequal access to groundwater, wells provide a crucial supplement to tank irrigation. And, in many ways, well water is used more efficiently than tank water. One reason for this is that evaporation losses are substantially reduced by storing water in the soil profile rather than in open tanks. Another is that, because well water is relatively expensive and has a unit cost——both to the well owners who must pay for the energy to lift water and to the other cultivators who purchase water by the hour——cultivators take particular care in cleaning field channels and ensuring that the water reaches the crops. Transmission losses are also lower for well irrigation than for tanks because the wells are distributed throughout the ayacut and are closer to the fields they irrigate.

A fourth reason for the efficiency of well irrigation lies in the fact that it is very responsive to the demands of individual cultivators and the needs of individual fields. Tank irrigation is a demand delivery system in that water issues are made to the entire ayacut when there is a general need for water, provided there is still enough water in the tank. However, the entire ayacut is not homogenous with respect to planting and transplanting dates, variety of paddy or other crops, and soil moisure retention, so the timing of water issues will not be optimal for all fields. In contrast, each well provides water to only a few hectares, making it possible to match irrigation issues with the needs of each field. The high cost of well water encourages greater spacing between water applications, so that water is used only when needed. During the kar season when wells are the main source of irrigation, cultivators in the Sananeri ayacut diversify crops grown by including cotton, tomatoes, chilies, and other lightly-irrigated crops in addition to paddy, knowing they will be able to match irrigation issues with the differing needs of each crop. If groundwater is not used optimally for crop needs, it is generally because not enough is available, either because a pumpset needs repair, electricity is scarce, the water table is too low, or, for those who purchase well water from others, because the price is too high (see Palanisami and Easter, 1983:69-71).

Despite the fact that groundwater and wells are under private ownership, there are numerous links between the management of wells and that of tanks. The first is the use of the same field channels. The need to move high-value well water through these channels encourages cultivators to keep them clean and in good repair, which reduces water losses during both tank and well irrigation issues. A second link between tank and well management is that sources of water are related. Water brought into the tank benefits both irrigation subsystems. Well owners, thus, have a double incentive to support the efforts of the ayacut association to acquire water for the tank: its efforts provide them with relatively cheaper surface irrigation and recharges the water table for further groundwater irrigation. But tanks and wells do not reap equal benefits from all water issues to the tank. As noted above, water supplies that fill the tank are best for surface irrigation because they provide sufficient water for all the sluices and make it possible to irrigate the entire ayacut. If a tank receives small quantities of water when the water level is low, this water may not reach the entire ayacut for surface irrigation. Such water contributes more to groundwater recharge and hence to well irrigation in the area.

The presence of contiguous well and tank irrigation creates a potential conflict of interests within the ayacut association. Well owners may ask that the association use its resources (especially the time and government contacts of the president) to get frequent water issues, particularly during the kar season, even if the quantity obtained is low. Those ayacut cultivators without wells may be unwilling to share the cost of activities (such as the president's travel or tea for PWD officials when they come to inspect the need for water) from which they receive little benefit.

The association president of one tank farther down from Sananeri on the Hanuman River system has devised an innovative approach to this problem: In the 1981 kar season, he pursuaded the PWD to give his tank a rare partial filling. When his expenses for the year exceeded the income from the auction of fishing rights, he did not recoup his expenses by charging all cultivators according to the size of their landholding, as was customary. Instead, he charged each well owner Rs. 10.00 per well. Of thirty-three well owners in the ayacut, thirty felt this was a fair practice and paid the amount. This would appear to be a good way of mobilizing additional resources for the ayacut association, while at the same time distributing the cost of its activities among the well owners who receive a double benefit of surface and groundwater supplies from the association's activities.

The difference in technology between wells has important consequences for local organization and action. Wade (1979:15) reports that wealthy head-end cultivators in canal systems can bypass local organizations and use their own laborers or bureaucratic contacts to get water. This is because the technology of canals and the system of bureaucratic allocation allows cultivators to receive water directly. However, wealthy cultivators under tanks receive water from either bureaucratic-communal allocation through tanks or direct appropriation from wells. Cultivators without wells may also acquire water through contracts, but no tank ayacut cultivators can receive water directly from the bureaucracy (see Chambers, 1980:33).

The cooperation or noncooperation of well owners with the ayacut association appears to be an important factor in the efficient management of tanks. Chambers (1980:41), Elumalai (1981:20), and Palanisami and Easter (1983:63) cite cases in which the distribution of tank water suffered because powerful well owners preferred to rely on their wells rather than cooperating with collective efforts to allocate surface irrigation flows more carefully. Palansami and Easter reported that, in one case, well owners cooperated with the other cultivators' efforts to acquire more tank water only when wells, too, were empty. Both Chambers (1980:37) and Palanisami and Easter (1983:62) cite other instances in which the cooperation of well owners improved the delivery of tank water during times of scarcity.

Comments by Wade (1979:17-19) and Palanisami and Easter (1983:63) suggest that the distribution of landholdings affects cooperation. When well owners have a lot of land, they tend to be less involved in the local irrigation association. It may also be that the degree of water scarcity for all cultivators is a major factor affecting cooperation for water acquisition and distribution. When well owners have a secure groundwater supply they may prefer to rely on this rather than on collective action, but where there are no wells or the wells are dependent on recharge from surface water, then collective action that brings more water into the system is in the interests of all cultivators. Further comparative studies may be necessary to specify the benefits that well owners receive from the activities of ayacut associations and the factors that affect the relationship between cultivators and local organizations.

CHAPTER 5: WATER MANAGEMENT IN TANK IRRIGATION SYSTEMS

In order to understand the management of tank irrigation in South India, it is necessary to recognize that tanks and tank water are often tied to river systems on the one hand, and to wells and groundwater irrigation on the other. Hydrologically, irrigation management includes surface water flows, surface storage, and groundwater. In terms of technology, it includes a range of problems from sand checks in unlined earthen ditches, to cement and stone weirs and sluices, to electric pumpsets. Organizationally, government bureaucracies, informal associations, and individual cultivators are included. While it is beyond the scope of this paper to deal with each aspect individually, we will discuss how the local water management association responds to and affects this complex environment by covering the strategies, costs, and benefits of the Sananeri ayacut association, including comparative data from other associations under differing degrees of local autonomy and government involvement.

Three general tasks are cross-culturally fundamental in irrigation systems: water allocation, system maintenance, and conflict management (Coward, 1980a:19; Hunt and Hunt, 1976:390-391). These provide useful categories for analyzing the strategies and activities of local water users' associations.

Water management in irrigation systems is particularly important in times of water shortage. Irrigation organizations may respond to water scarcity with several strategies including regulating demand for water, distributing existing water more carefully, and trying to increase the supply of water available for irrigation. All of these need to be considered as part of water management.

Demand may be limited by growing lightly-irrigated crops in the command area or by restricting the area to be irrigated. The former is an explicit strategy of a local canal irrigation organization in Maharashtra (Patil and Kulkarni, 1982:8) and the government agency managing a major irrigation project in Tamil Nadu (Elumalai, 1981:15-16). Duewel (1981) also mentions this as a form of water management exercised by a local irrigation organization in Java. However, under most tank irrigation in South India, the decision of what crops to grow is left to the cultivators, and they generally grow paddy during the main season.

Restricting the area to be irrigated is a more common means of limiting demand in the ayacut of tanks. According to von Oppen and Subba Rao (1980b:24), in Andhra "the irrigated area is adjusted to the water available and thus yield stability is achieved at the cost of area instability." Chambers (1980:35) found a similar practice under one tank in Tamil Nadu, in which each ayacut cultivator was allowed to cultivate only a fixed acreage of wet land in times of scarcity. Similarly, the government attempts to limit demand by restricting the ayacuts and only designating certain areas as double-cropped land. But Mencher (1978:62) has pointed out that formally restricting the irrigated area, even during the second season, is difficult because of farmers' opposition:

> Each man obviously wants to grow a second crop on his land, and thus wants his share even if it is too small an amount. . . . Thus, despite the fact that some land is listed as single-crop land and some as double, everyone whose land can be watered by a given source will try to somehow squeeze out a second crop.

Thus, restricting demand by an organizational rule limiting the area to be irrigated or designating the crops to be grown is not a common strategy. In the Sananeri ayacut, cultivators may grow punjai, or dry crops on their wet land,[25] or may leave their land fallow, especially in the kar season if they do not think there will be enough water to irrigate a paddy crop in their fields. However, this is decided on an individual basis, not at the level of the ayacut association.

Another strategy which Hunt and Hunt (1976:392) mention for dealing with water scarcity is "a shift in the allocation principles toward water monopolization such that some social segments must suffer more than others." This occurs in the Sananeri ayacut when the water level is too low to irrigate the entire ayacut. Then the neerpachis stop delivering water to all fields, and head-end cultivators may take tank water on an individual basis. The same principle may also be identified in the shift from surface to groundwater irrigation. As long as water remains in the tank in sufficient quantities to irrigate the ayacut, it is a collective resource, but when it is taken from below ground, even though it may be the same water, it becomes a private good.

If demands for irrigation water are not limited, shortages are likely to occur, particularly in semi-arid areas where rainfall is low are variable. When this happens, a common response of irrigation organizations is to distribute existing water more carefully, often through some form of rotation. The warabandi system of water distribution under canals in North India is a major example of this (see Reidinger, 1980:275-279). In South Indian tanks there may not be rotation between sluices, but when water flows are low, there is often rotation at the field level. The field-level water distributors, like the neerpachis of Sananeri Tank, are important in facilitating and supervising this rotation. Any rotation requires some form of organization or cooperation on the part of cultivators, particularly if there are no strong external sanctions to enforce it.

It is somewhat surprising that in the Sananeri ayacut association, neerpachis are only employed to distribute water to the fields in the wet season, and even then they stop distributing water when tank supplies are almost depleted. This appears to run counter to both case studies and generalizations about irrigation systems that have associated increased collective management activities with greater water scarcity. For example, Duewel (1981:21-23) relates how a local irrigation organization in Java allows cultivators to take water themselves during the rainy season, but uses common irrigators to provide greater control over distribution when water is scarce.

But why does the Sananeri association not extend its control over water distribution to the latter part of the pisanam season and other times when there is some water available in the tank? Part of the reason for this is that small quantities of tank water can be used more effectively at the head of the ayacut. Sivanappan (1982:5) has calculated that transmission losses in the tail-end may be as high as 25 to 30 percent of the water released from the tank. If tank water cannot be used to serve the entire ayacut, it would be unfair to those who did not receive water if common ayacut resources were used to distribute water to the head-enders. The switch from collective to individual distribution ensures that all cultivators in the ayacut receive roughly equal benefit from the water distribution activities of the organization. This also lifts the burden of expense and effort for applying water to the fields from the association (all cultivators) to those who receive additional water. As the tank water recedes below the level of the highest sluice, gravity-flow will no longer feed all the sluices, and extra effort is required to dig channels in the tank bed and bail water to supply head-end fields under the higher sluices. Instead of having collective employees do this, individual cultivators must supply the labor for these activities. In return, they are allowed to use the water directly on their fields. Thus, individual appropriation of scarce tank water allows greater matching of each cultivator's expenditure on tank water distribution with the amounts of water received.

This suggests that there is an implicit principle underlying water allocation patterns in the ayacut: those who receive water should be the ones that pay the costs of its acquisition and distribution. This is not formally monitored or enforced through the use of volumetric pricing of tank water, but it is seen in the use of common association resources to control and deliver water to the entire ayacut, but not for the more energy intensive activities required to deliver water to a few fields when the tank level is too low to serve the tail reaches. Another mechanism that ensures that all cultivators receive the benefits they pay for is evident in the rule regarding banana fields during the pisanam season. Banana requires less water than paddy, and often receives enough water from seepage from adjoining paddy fields. Therefore, the neerpachis do not deliver water to banana fields, and the owners of these fields do not pay the neerpachis at the end of the season. Thus, the banana cultivators receive some water for which they do not pay, but they do not receive any distribution services from the neerpachis.

The same principle applies in the case of more energy intensive well irrigation. All cultivators, whether they own wells or purchase groundwater from other cultivators, must pay for the energy, management skills, repairs, and even the initial capital investment for lifting groundwater and delivering it to the fields. The fact that groundwater has a unit cost, both to well owners and water purchasers, increases the precision of the match between payment and water use. Thus, although the pattern of water distribution under both tanks and wells does not provide equal water to all ayacut fields, it is based on a form of equity.[26]

The fact that the neerpachis stop delivering water to the fields when tank water supplies are too low to irrigate the entire ayacut should not be interpreted to mean that as water shortage becomes acute, water management activities or even activities of the organization cease. Rather, strategies of water acquisition become more prominent, both at the group and the individual level.

Hunt and Hunt (1976) refer to three means of increasing the supply of irrigation water: using existing technology to increase supply, searching for new technology, and locating a new source. All three of these are used in some way to augment scarce tank water. Appeals to the PWD for more water make use of the technological apparatus and administrative structure of system tanks that have been used for decades, even centuries. This was the main strategy for Sananeri Tank, implemented corporately using the ayacut association as the vehicle for expressing collective interest. In the Hanuman River system, there is the added possibility of obtaining additional water from another watershed by requesting that the PWD send more water through the Alanthuraiar Anicut. In addition to bureaucratic means, large labor crews of either hired laborers or ayacut cultivators may be mobilized to divert water from a stream or other source (legally or illegally) for both system and nonsystem tanks (Chambers, 1980:40; Palanisami and Easter, 1983:59). In such instances, a show of force is often necessary to protect the interests of a tank against groups from other tanks, regardless of who has official right to the water. Palanisami and Easter (1982:61) report expenses of up to Rs. 9,720 per tank, or Rs. 24.22 per hectare for water procurement activities.

The use of groundwater is another strategy to increase supplies for irrigation. This involves both relatively new technology and a different immediate source of water. Unlike the gravity flow of tanks, wells require lift technology for irrigation. An improvement in this technology through the introduction of electricity and electric pumpsets in the Sananeri area, as in much of Tamil Nadu in the mid-1960s, was responsible for an increase in the number and use of wells. Groundwater is an alternative to surface water as a source for irrigation in that it is taken from below ground, it is available even after all surface water is gone, and its use does not affect the availability of surface water. However, groundwater is not independent of surface water, as it receives much of its recharge from percolation from tanks and channels.

Discussions of the costs of tank irrigation have often focused on expenditures for repairs and not given enough attention to the costs of ongoing water management. For example, von Oppen and Subba Rao (1980b:41) mention the Andhra Pradesh Public Works Department's expenditure of Rs. 7.00 - 11.00 per acre (Rs. 17 - 26 per hectare) of ayacut for repairing tanks, but dismiss expenditure on management by saying:

> The way in which the water management is presently being practiced by the community does not involve any direct costs. Farmers are organizing the water control among themselves.

For Tamil Nadu, Palanisami and Easter (1983:19) report a comparable figure of Rs. 25 - 50 per hectare for PWD expenses on repairs.

However, the cultivators' expenses in organizing water control and repairs are not inconsiderable. In the Sananeri ayacut, the payment of paddy to the neeranis and the neerpachis would be worth a total of Rs. 93.00 per hectare at 1981-82 harvest prices, and approximately Rs. 126.00 at 1982-83 harvest prices, as shown in Table 5.1.[27] Cultivators also make cash contributions to the ayacut association to cover any expenses in excess of the income from fishing rights. This varies from year to year, but a typical amount may be Rs. 0.50 - 1.50 per marakkal land, or approximately Rs. 15.00 - 46.00 per hectare. Thus, the total value of cultivators' contributions to the Sananeri ayacut association ranges from Rs. 108.00 - 172.00 per hectare.

In addition to payments to the ayacut association, cultivators also pay a wet-land revenue assessment to the government. There are no separate water fees to be paid to the government for access to irrigation. Rather, the quality of surface irrigation available to a plot is included with soil type in calculating the land tax assessment. For example, single-cropped good red loam soil in the Sananeri ayacut is charged Rs. 6.75 per acre for state revenue, compared to Rs. 1.70 per acre for

Table 5.1: Sananeri Ayacut Cultivators' Expenses on Tank Irrigation.

ITEM	Approximate Cash Value (Rupees/hectare) LOW	HIGH
Paddy for neeranis: 10 pakkas*/kottai** of land (15 pakkas*/ha.)		
at 1981-82 harvest price of Rs. 1.96/pakka*	30.00	
at 1982-83 harvest price of Rs. 2.68/pakka*		40.00
Paddy for neerpachi: 21 pakka*/kottai** = 32 pakka*/ha.		
at 1981-82 harvest price of Rs. 1.96/pakka*	63.00	
at 1982-83 harvest price of Rs. 2.68/pakka*		86.00
Cash contributions to tank fund:		
at Rs. 0.50/marakkal*** of land (x 30.9 marakkal***/ha.)	15.00	
at Rs. 1.50/marakkal*** of land (x 30.9 marakkal***/ha.)		46.00
Labor for channel cleaning: approximately 5 man-days/ha.		
at Rs.12/man-day	144.00	
at Rs. 15/man-day		180.00
Total of locally-mobilized contributions	252.00	352.00
Component of land revenue due to irrigation: (State and local tax for irrigated land minus tax for similar quality dry land, per hectare)		
Single-cropped good red loam (Rs. 58.50-14.70)	44.00	
Double-cropped best red loam (Rs. 94.50-15.00)		80.00
Total Cultivators' Expenses for Tank Irrigation	300.00	437.00

*1 Pakka = 1 Madras Measure = 1,770 cc., approximate weight 1.2 kg.

**1 Kottai of land = 0.66 ha.

***1 Marakkal of land = 0.03 ha.

similar unirrigated (or only well-irrigated) land. The state revenue, or water charge for irrigation, is Rs. 5.00 per acre, or Rs. 12.50 per hectare. However, cultivators must also pay a local cess and surcharge of 2.5 times the state land revenue assessment. Thus, cultivators of quality land in a tank ayacut pay a total of Rs. 58.50 per hectare, Rs. 43.75 more than if the land were not irrigated. Similarly, the best double-cropped red loam would be charged a total of Rs. 94.50 per hectare, compared to Rs. 15.00 per hectare if unirrigated.

Labor for cleaning field channels is yet another of the cultivators' expenses for irrigation system management. The amount of labor required of each cultivator depends on the length of channels adjoining or crossing his fields. Those with land among the main distributaries in the ayacut must clean these as well as any minor distributaries. Cultivators reported that approximately twelve man-days per hectare would be required to clean the channels for the pisanam crop, including both tank and well irrigation issues. At the wage rate of Rs. 12.00 - 15.00 per man per day, this would cost Rs. 144.00 - 180.00 per hectare.

Table 5.1 shows that cultivators pay a total of Rs. 296.00 - 432.00 per hectare per year in cash, kind, and labor for tank irrigation. Thus, cultivators who are members of an active tank organization contribute much greater financial resources for tank management than the PWD spends for repairs.[28] This is approximately the same percentage of the crop as that which was collected for tank funds in ancient times. In cash terms, the Sananeri cultivators' total payments for tank irrigation——to the government, the ayacut association, and for individual labor——are worth approximately 5 percent of the normal gross receipts per hectare of paddy in the pisanam season.[29] Of the total Sananeri cultivators' costs for tank irrigation, Rs. 252.00 - 352.00 are mobilized and managed locally, either on a collective or an individual basis. This represents a considerable expenditure for tank management. Cultivators' total expenses for irrigation would be even greater than this because of the need for groundwater—with a unit cost—to supplement tank water on most fields, even in the pisanam season. In order to understand how an informal organization such as the ayacut association is able to mobilize local cultivators' resources to such an extent for tank management, we turn now to an examination of the benefits cultivators receive from the activities of the ayacut association.

What do cultivators gain from the ayacut association and its strategies of water management? The first and perhaps most important benefit is more water for irrigation. The efforts of the Sananeri ayacut president to obtain water issues from the PWD and the work of the neeranis to ensure that the water reaches the tank benefit all cultivators in the ayacut, although to differing degrees. Palanisami and Easter (1983:61) have calculated that the value of additional irrigation issues that resulted from local efforts to get water ranged from Rs. 44.50 - Rs. 495.00 per hectare. One example of the effectiveness of ayacut associations in acquiring more water is the case of a tank farther down the Hanuman River system from Sananeri. Its president has good contacts in the government, and is willing to put in considerable effort for tank interests. This tank usually receives three fillings from the river during the pisanam season, instead of the two to which it is entitled, and irrigates 2.5 times its registered ayacut.

The second benefit is reliable distribution with a minimum of effort on the part of individual cultivators. By entrusting this task to collective employees such as the neerpachis, or common irrigators, who are expected to be impartial, cultivators can be assured of a fair water allocation to each field without themselves patrolling the field channels to watch against unauthorized usage by other cultivators.

This brings up a third benefit from the ayacut association: a reduction in conflict. In some cases, such as the peddamanshula described by Wade (1979:9), in Andhra the ayacut association may have an explicit judicial role in irrigation disputes, with either a leader or the committee as arbitrator. But even where major disputes are taken to other authorities such as the village panchayat, the police, or the courts, the ayacut association plays an important part in reducing conflict. Because the cultivators are not directly involved in taking water for their fields, they are less likely to accuse each other of taking too much water. Thus, the structure of the organization minimizes interaction between cultivators as a means of reducing conflict.

At the level of the sluices, another potential cause of conflict is reduced by having the neeranis, as collective employees, open and close all sluices at the same time, with the neerpachis checking on this as representatives of particular blocks of fields. The neeranis serve to reduce conflict within the ayacut in another way: they direct attention to the common interests of all ayacut cultivators. They are employed by all the cultivators to call association meetings, maintain the common tank and channel structures, and most importantly, to defend their tank's rights to water against the interest of other tanks. The same principle of reducing conflict by affirming the common interests in acquiring water would be applicable to other collective action, such as constructing diversions or bringing water into a tank, particularly when ayacut cultivators are personally involved.

Better maintenance of the irrigation structures is a fourth benefit from the ayacut associations. Although the PWD is officially responsible for all physical structures from the river down to and including the tank bund and sluices, this government agency lacks the manpower and financial resources for ongoing examination and maintenance of every tank. Thus, in Sananeri Tank there is a physical and organizational overlap of responsibilities of the PWD and the ayacut association, from the first anicut or even further up the river, down the channel to the tank and its sluices. The neeranis, with their frequent patrols along the channel from the anicut to the tank, take care of minor repairs much more quickly than the PWD with its time-consuming procedures of inspection, preparation of an estimate, and procurement of bids from contractors to carry out the repairs. If the repairs are too great for the neeranis, the association may mobilize labor to do the work or may use their contacts in the government to get the PWD to expedite its work. The ayacut association is not involved in field channnel maintenance, but Palanisami and Easter (1983:83) suggest that effective ayacut associations encourage better maintenance of these structures, as well. Because proper maintenance of the tank and its channels improves its ability to receive, store, and distribute water, these activities potentially benefit all ayacut cultivators.

In addition to these benefits, ayacut associations offer cultivators greater local control over their tank. This includes control over the maintenance and management of water supplies, other aspects such as rights to any fish and trees in the tank bed, and a degree of autonomy in their relationships with higher authorities. One area in which this is demonstrated is the local auctioning of annual fishing rights, an important source of income for the ayacut association in Sananeri Tank and others in the Hanuman River system. In some areas where the Fisheries Officers at the Block Development Office stock the tanks, the Panchayat Union may hold an auction for the fishing rights to the tanks. But Palanisami and Easter (1983:83) report that an effective ayacut association may still control and get the income from fishing by ensuring that only one bidder attends the auction and takes the bid at a low rate. Then the association reauctions the fishing rights with open competition and uses the difference for the tank fund. Wade (1979:8) reports a similar reauctioning of the toddy (liquor) license in Andhra villages to benefit the local irrigation association.

Other aspects of local control include preventing encroachment onto the peromboke, or public lands of the tank's foreshore and bed. Cultivation on the foreshore is detrimental to the tank because it blocks some of the runoff water and increases the silt flowing into the tank. Cultivation in the tank bed is problematic because it may decrease the available storage for the tank and because those cultivators with crops planted in the tank bed may try to drain the tank to protect their own crops from flooding (Krishnaswami, 1947:446-447; Palanisami and Easter, 1983:76).

One aspect of tank use over which ayacut associations appear to exercise little control is the removal of silt. The silt, which is deposited in tanks and feeder channels, reduces capacity to store or transport water, but can also be a valuable resource. The fine deposits are rich in plant nutrients. Deposits in the tank bed with a high clay content are also good for making bricks, while the sandier deposits common in channel beds may be used in making concrete or other mortar for buildings. Both of these uses are important around Sananeri Tank and the Hanuman River, and depressions where lorry- or tractor-beds full of sand or silt have been excavated are common. Where the "borrow pits" from which earth has been removed are not connected with the main water flows, they create isolated pools of standing water that cannot be used for surface irrigation. Moreover, the vehicles and workers that remove the silt or sand often break down embankments or other structures, particularly in the narrow riverbeds and feeder channels. The PWD attemps to regulate this by requiring that anyone removing silt obtain permission from the junior engineer in charge, but this is generally ignored, and the PWD officials are not present in the tanks enough to enforce this rule. It would seem that ayacut associations would be in a better position to regulate the way in which silt is removed because they are closer to the daily operation of tanks. A small fee for permission to remove silt might also provide extra income for the association. There appears to be an historical precedent for this in ancient tank committees, which often were directly responsible for silt removal or regulated private groups that took the silt (Appadorai, 1936:213). The major obstacle to greater local control over silt removal in Sananeri Tank today is that the builders and brick manufacturers who take the sand and silt are wealthy businessmen from nearby towns, not local agriculturalists. Because the brick-makers are not part of the ayacut association, and it has no formal legal authority——only traditional sanctions over its members——the ayacut association cannot control the activities of the brick-makers.

In addition to the collective goods——extra water, better distribution, reduction in conflict, better maintenance, and local control——which the ayacut association provides for all its member cultivators, the benefits of percolation should also be considered. However, the beneficiaries of this are not specifically the cultivators in the ayacut, but rather are the owners of wells around the tank. This is one case in which there is less matching between payment and benefits for ayacut well owners do not generally contribute more to cultivation than other cultivators, and well owners outside the ayacut contribute nothing. The efforts of the ayacut association president, who charged well owners an extra Rs. 10.00 for the tank fund, were an attempt to redress this. However, the amount charged was nominal, and neighboring well owners outside the ayacut paid nothing.

Why is there less matching of payment and benefits for groundwater recharge than for the other collective goods? One reason lies in the unmeasurable and uncontrollable nature of percolation. The ayacut association cannot measure the extent of benefits or even, given the uncertain nature of aquifers, specify which wells received the benefit. Even if this were possible, the association could not withhold percolation water from any that did not pay as they could with surface water. Not only does the ayacut association therefore lack physical sanctions against "free riders" among the well owners, but it also lacks traditional legitimacy to assess contributions on the basis of wells rather than land within the ayacut. Furthermore, it has no traditional authority over anyone outside the ayacut. Even the state's revenue assessment has not taken wells into consideration in fixing the land tax for over a century. Thus, the ayacut association president who did try to charge well owners encountered three refusals (9 percent) among the ayacut well owners, and did not get any money from other neighboring well owners. However, this may be because the increase in well irrigation is relatively new in comparison with the traditions of tank irrigation. Efforts such as this association president's to include wells in the overall strategies and support of the ayacut association could establish a tradition. However, without physical sanctions or legal authority it seems unlikely that this would extend to other well owners outside the ayacut.

One important similarity of the ayacut associations along the Hanuman River and most other local organizations for tank management is that they are not formally organized; they have no written constitution and no official recognition from the government. In this they differ markedly from some local irrigation organizations in Southeast Asia, such as the zanjeras of Ilocos Norte in the Philippines (Coward and Siy, 1983; Lewis, 1980), the subaks of Bali (Geertz, 1980), and the Dharma Tirta of Java in Indonesia (Duewel, 1981), from the vel vidane as described by Leach (1980) in Sri Lanka, and especially from the water users' associations set up by the Command Area Development Programme in India (Ali, 1982; Hart, 1978).

Efforts to support and perhaps improve the performance of existing ayacut associations or to encourage the establishment of local organizations for tanks where they do not currently function may raise the question of whether the government should give formal standing to an ayacut association for each tank. This idea may have several advantages to recommend it, particularly from the government's standpoint. If, as Palanisami and Easter (1982:82) have argued, the functioning of ayacut associations is associated with better distribution of water and higher yields, it would seem advantageous to institute such bodies for all tanks, especially because they mobilize local resources and participation at very little cost to the government. Formalizing these associations could make it easier for government agencies and officers to deal with the local cultivators on tank-related matters.

From the local point of view, these associations do benefit the cultivators, and official recognition might give their leaders greater leverage with the bureaucracies for promoting the interests of the ayacut cultivators. Lack of standing was cited as a problem for at least one informal organization of the large Dusi-Mamandur Tank in North Arcot District (Elumalai, 1981:15), but the presidents of Sananeri and one other tank in the Hanuman River system did not feel it had hampered them in their dealings with the bureaucracy. The junior engineers and other administrators with whom they have dealt may have been very responsive to local needs and leadership, and/or these leaders' contacts in the government may have served as a substitute for official recognition of their role as representatives of the ayacut cultivators.

Despite the apparent advantages of giving official recognition to local ayacut associations and their relationship to the government, there are two related ideas that are somewhat more problematic: formalizing the structure of existing associations and creating organizations where they do not now exist (or where officials assume they do not exist). The problems of implementing the latter idea are exemplified by the difficulties experienced by the Command Area Development Programme in establishing active water users' associations. This may be because these associations have often been set up in areas where irrigation was recently introduced, and therefore cultivators have had no prior experience in organizing to carry out the common tasks of irrigation. However, Hart (1978) has argued that the government's paternalistic involvement in establishing these associations has reduced local initiative and collective responsibility.

The ordinance setting up pipe committees under Command Area Development shows the major differences between these government-established water users' associations and the existing nonformal ayacut associations of tanks. The first paragraph of the ordinance state that: "The Irrigation Officer should have the power to appoint a pipe committee for each pipe outlet . . . who shall be the land holders under the pipe outlet" (Section 5 of the Ordinance of Command Area Development, quoted in Ali, 1982:Appendix 4). This committee is selected by a government official, not by the cultivators in the command area. It is therefore accountable to the government, not to the cultivators and their interests. This is reinforced by the responsibilities and functions of the pipe committee, which include ensuring that cultivators fulfill their obligations to the irrigation system: collecting from cultivators to pay for local maintenance; enforcing warabandi (rotation) and regulating water supplies as directed by the Irrigation Department; guarding against any infringements by cultivators; and any other tasks that may be prescribed (Ali, 1982:Appendix 4). These functions all involve extraction from or control of the cultivators in the Irrigation Department's interests, not service to the cultivators or representation of their interests.

In comparison, the Sananeri ayacut association also takes care of most of these tasks: it ensures maintenance of physical structures, including some that are officially the responsibility of the Public Works Department; it provides for water regulation (according to cultivators' demands, not any externally predetermined schedule); and it collects from the cultivators to pay for this work. However, all of this is done in the interests of the cultivators and under their control. The cultivators' control is ensured by the structure of accountability in the organization: cultivators select the leaders and employees of the ayacut association, they pay for services directly in a face-to-face meeting with the person responsible (e.g., president, neerani, neerpachi), and they can recall any of the "officers" at any time.

The problem with formalizing the structure of existing ayacut associations is that of preserving their accountability to the cultivators. One mechanism for getting around this problem might be to give ayacut associations a constitution that requires periodic elections (similar to the village panchayats since they were formalized as institutions of local self-government). The problem with this approach is that it is likely that party politics would then affect the organizations. This was a major concern for the informal organization for Dusi-Mamandur Tank after their experience with a more formal Irrigation Panchayat Board (Elumalal, 1981:15). There is a vast difference between democratic-style elections and the process of selection that is currently practiced in many ayacut associations, including Sananeri. The former are based on majority rule, while the latter require concensus; thus, elections seem to favor factionalism while concensus requires negotiation and the selection of mutually acceptable leadership. Government support of elected officers could further entrench the position of the incumbents, thus enhancing their power and making them less susceptible to recall from their constituents. The fact that village panchayat elections have not been held regularly in Tamil Nadu in recent years should be taken into consideration if there are any plans to replicate this model for "irrigation panchayats."

At present, the Sananeri ayacut association's sanction against candidates "putting themselves forward" for an office operates to minimize overt competition for the control over water resources that a leadership position bestows, and the cultivators' right to recall any officers provides a check against the misuse of this power. However, this control over competition would be withdrawn if there were constitutional elections, and formal ayacut associations would be susceptible to the same problems of competition for and monopolization of resources that face village panchayats (see Dharampal, 1972:154-155; Harriss, 1982:168-169; Heginbotham, 1975:66).

The evidence from three other cases of government-organized bodies for local tank management is somewhat mixed. The Dusi-Mamandur Tank has a formal Irrigation Panchayat Board, but the last elections for the formal board were conducted by the Revenue Department in 1960. Since this body was not operating, cultivators organized unofficially in 1977. Although the latter association had many of the same members as its official predecessor, it was apolitical and very active in mobilizing labor and financial resources for maintenance, water distribution, and particularly for water acquisition (Elumalai, 1981).

The Irrigation Panchayat Committee for another large tank in Ramanathapuram District has both elected cultivators and statutory members from several government agencies. According to Rajagopalan (1982), this organization appears to be functioning adequately, particularly in maintenance tasks because the organization is empowered to do urgent repairs and then be reimbursed by the PWD. It is also useful in that it provides a regular forum for cultivators and representatives of government agencies to meet to discuss tank problems. However, the larger formal organization has difficulty collecting fees from the cultivators, whereas the informal organizations along the distributary channels can collect contributions to recover their expenses quite easily (Rajagopalan, 1982:16). This may be related to the smaller size of the latter organizations, or may indicate the cultivators' judgment of the performance of the two groups. A third possibility is that cultivators see the government's involvement in the Irrigation Panchayat Committee, and feel that if the government, with its vast resources (particularly in comparison to the resources of individual cultivators) is supporting the committee, there is no reason for cultivators to also contribute.

A third case of increasing government involvement in tank management supports this idea: in Karnataka the honorary nirghanti and village patel were responsible for maintenance, water allocation, and representation of tank interests before the government authorities. They were remunerated by the use of village inam (tax-free) lands. Since 1965, the nirghantis have been replaced by PWD-employed soudis, who receive a salary from the government (Bhargava, 1980:82; Dasgupta, Rao, and Ghosh, 1979:17-18). Bhargava (1980:83) reports that this has been accompanied by complaints of mismanagement of water, and goes on to say:

> However one thing is clear that in the earlier system communities as a whole used to face water management problems and used to show active concern in solving them. In the present arrangement, Ryots (cultivators) increasingly depend on the Government for everything.

This seems to be borne out in Sundar and Rao's (1982:22,28) study, in which Karnataka cultivators expressed unwillingness to organize among themselves and a feeling that more government soudis were necessary for proper distribution of water.

The theme of reliance on the government undermining local initiative and investment in managing tanks dates back to the decline of kudimaramat as the British became involved in irrigation. If communal contributions for maintenance were reduced when the government began constructing and repairing the irrigation systems, it seems likely that local cultivators' contributions for tasks such as water allocation may also be reduced if the government becomes directly involved in the activities of ayacut associations.

Most of the problems that have been raised refer to government involvement in existing ayacut associations. But what of those tanks without functioning nonformal organizations? Would the management of these irrigation systems be improved by government-sponsored water users' associations? This seems to be the assumption of the Tank Modernization Programme. In its proposal for all eight pilot projects to be "modernized," the Public Works Department (1979, Annexure 6:6) states:

> Presently there is no defined and recognized authority for water regulation from the tank, as well as within the command area. However in order to ensure smooth and efficient functioning of this regulation, it is proposed to constitute two committees comprising of official and non-official members.

The first committee, responsible for water distribution from the sluices to 10 ha. blocks, is to include the assistant executive engineer of the PWD, the district agricultural officer, and three "progressive farmers" nominated by the engineer. Similarly, the committee for water management within 10 ha. blocks is to comprise the panchayat president and three "progressive farmers" nominated by the district agricultural officer.

There are several problems with this proposal. First, it is certainly true that, from an official standpoint, no "defined and recognized authority" for water management exists; however, this does not mean that no local body is currently carrying out the important management tasks. Before assuming a vacuum and creating a new organization, there should be a thorough attempt to identify any local organization and water management practices. Conversely, if such an effort is not made, the superimposition of a government-sponsored water management organization may undermine the existing local institutions that have been functioning.

A second problem lies in the structure of the proposed organizations. They are appendages of the PWD and responsible to the government, not the cultivators. Cultivators are not even allowed to select their own representatives on either committee; the members are selected by second-level officers who are unlikely to have a detailed knowledge of the leadership potential of particular villages. The criterion for selection is that the nominated committee members should be "progressive" (i.e., wealthy or successful) farmers. While these may at times be the same persons the cultivators would have chosen as representatives because of their contacts and influence, this is in no way assured.

The third problem lies in the extent of government manpower commitment. While it may be possible for second-level officers to work with committees for eight pilot tanks, this could not be extended to a large number of tanks without consuming the greater portion of these officials' time. Thus, it is important to take note of Bottrall's (1981:78) warning against the "temptation of making full projects as well as pilot projects achieve 'success' by the injection of administrative and other inputs which make them incapable of extension elsewhere." There seems to be little value in creating water management committees that cannot realistically be expected to work. Indeed, the superimposition of these organizations over existing nonformal associations can even be detrimental to overall water management by undermining local institutions that are already functioning.

Where there really is no functioning local organization for tank management, it is important to consider whether any constraints in the physical or social environment inhibit collective action. In the same study in which they associate better water distribution and higher productivity with tanks that have ayacut associations, Palanisami and Easter (1983) also find a relationship between a highly unequal distribution of landholdings and the absence of an ayacut association. If this pattern holds more generally, then a somewhat even distribution of landholdings may be a precondition for effective local cooperation in water distribution. Mandating the creation of water users' associations in such cases will not solve the problem and may reinforce the largest landowners' control over resources, particularly water, and perhaps also over government contacts.

Although promoting ayacut associations might appear to cost the government a minimal amount, they involve considerable cost to the cultivators. Thus, it is always important to consider what cultivators under a particular tank would gain from the establishment and/or formalization of such organizations. This involves an examination of the physical and social environment and the structure of the organizations.

A primary factor to consider is the amount of water a tank receives in most years. In tanks where there is very little rainfall, a limited catchment area, and/or no reliable supplemental water from streams, cultivators may have given up organizing because there is too little water available to distribute. In the Hanuman River system, the first three tanks along the channel from the first anicut have active ayacut associations with neeranis and neerpachis, but the next three tanks in this chain do not. Because the latter tanks are dependent on water from Sananeri's overflow, rather than from a direct channel from the anicut, they rarely receive river water. The small size of their ayacuts also limits the resources these tanks could draw upon for an association; hence, there is a general feeling that the costs would be too high and the benefits (in terms of water supply) too small and uncertain to warrant the establishment of a distinct ayacut association. This emphasizes the need to take care of major problems in the system to assure cultivators that water can and will be made available before expecting cultivators to manage it more carefully.

In terms of the social structure, the same principle applies. If there are a few large landowners who monopolize the water supply, the other cultivators may be unwilling to contribute to an ayacut association that only increases water supply without also assuring them of a greater share in the water. By the same token, large landowners may be reluctant to support an ayacut association that could threaten their preferential access to tank water or that might reduce other cultivators' dependence on the purchase of well water. In such situations, active collective support of the associations would require the establishment of mutually agreeable objectives and strategies.

The third factor affecting whether ayacut associations are worthwhile for the cultivators lies in the organizational structure: to whom is the association accountable? If the association serves the interests of the government, then it becomes a form of additional state appropriation of local resources. On the other hand, if it is under the control of the cultivators and serves primarily their interests, then the associations can potentially benefit the cultivators by providing greater and/or more reliable water supply to the tank, better distribution of tank water (as determined by the cultivators), a reduction in internal conflicts, improved maintenance of the physical structures, greater local control, and representation of tank interests before the government administration. When the cultivators deem the association's activities to be worth the cash, grain, labor, and organizational effort that they contribute, the ayacut association will be a viable and effective organization.

A promising alternative to the government mandating the creation and structure of formalized water users' associations is the approach used in Sri Lanka. The emphasis here is on the bureaucracy working with existing local water users' associations without interfering with their structure. The Minister of Land and Land Development and Mahaweli Development, Gamani Dissanayeke expressed the basics thus (quoted in Levine and Hart, 1980:11):

> In this respect, I wish to caution the institutional planners against superimposing new models against the traditional organizations which are delivering goods in the desired manner. Such traditional organizations must be preserved provided they are fulfilling the objectives

> expected of them. In the draft amendment (to the Irrigation Ordinance, 1980), I am happy to state, special provision has been made to retain such traditional organizations which are effectively operating in consultation with the farmer community.

Where such organizations are not functioning, there have been attempts in the Gal Oya project, not to set up government-sponsored water users' associations, but rather to use "Institutional Organizers" to work with cultivators in promoting informal groupings for collective action. However, all decisions about whether to organize and what structure, activities, and rules the organizations should have are left to the cultivators. The irrigation bureaucracy is then instructed to include cultivators in the process of rehabilitating the physical system.

It seems that these same principles would be useful for the institutional and physical revitalization of tank irrigation in Tamil Nadu. The following points seem particularly important:

1. to give recognition to existing ayacut associations as they are;
2. where ayacut associations do not now function, to encourage their organization by cultivators, using local ideas for the organizational structure, and designed to meet cultivators' needs;
3. to encourage the bureaucracies to work with the ayacut associations in rehabilitating the physical structures and in the ongoing management of tank irrigation.

CHAPTER 6: CONCLUSION

After studying the management of tank irrigation at the local level, it becomes apparent that tanks cannot be understood in isolation. The irrigation of each farmer's fields in the Sananeri ayacut is part of a complex hydrological system involving not only the tank and its field channels, but also rainfall and runoff in the watershed, the river and channel system that collects and diverts surface water to the tanks, and all the tanks that must share the available water. It further includes water from the Kanyakumari watershed, which is diverted into the Hanuman River system through the Alanthuraiar Anicut. The groundwater table and wells are also components of the system because they receive and store percolation water from the tanks and channels, and then provide supplementary irrigation water for crops in the tank's ayacut.

Just as the hydrological system is complex and interrelated, so also the coordination, maintenance, and operation of tank irrigation systems involve multiple agencies and levels of organization. Individual cultivators maintain field channels and build, maintain, and operate wells. At the local collective level, the ayacut association has several functions, including acquisition and distribution of tank water; monitoring and minor repairs on the tank, its feeder channel, and structures along the Hanuman River; minimization of conflicts within the organization; and defense of tank rights and interests. At the government level, the Public Works Department take care of major repairs to the physical structures; allocates water both along the Hanuman River system and to this system from the Alanthuraiar Anicut; and has a role in managing conflicts, particularly between cultivators from different tanks. Other government agencies may also be involved in the administration of tanks. These include the Revenue Department, which collects land and water fees; the Block Development Office, which maintains nonsystem tanks with ayacuts less than 40 hectares; the Panchayats, which own the trees in the tank bed and on other public land; the Forest Department, which plants and maintains the young trees for the social forestry program on the foreshore of the tanks; and the Electricity Department, which supplies much of the energy for lifting groundwater for irrigation.

In all of this, the ayacut association has a central role. Not only does it perform a wide range of critical tasks, but it also provides a link between the government agencies and the cultivators. It mobilizes the resources of cultivators on the one hand and taps the resources of the various bureaucracies on the other. It is important that the association is both organized by and accountable to the cultivators, not the government. The contacts between ayacut association leaders and government officials are initiated by the association leaders in order to advance the needs and interests of the tank and the ayacut cultivators. However, these contacts, either personal interviews or written petitions, also serve to inform the government agencies of conditions at the local level.

The accountability of the Sananeri ayacut association to the cultivators is seen not only in the representation of tank interests before the government, but also in the association's activities to defend the tank's water rights against interference from cultivators from other tanks, to guard the physical structures, and to distribute the tank water among all ayacut cultivators according to local standards of equity. Although there is no formal constitution, the organizational structure of the ayacut association reinforces its accountability to the cultivators by requiring selection of leaders and employees by concensus of the cultivators; subjecting the leaders and employees to recall if a number of cultivators becomes dissatisfied with their performance; and requiring the president, neeranis, and neerpachis to collect contributions or remuneration for their work directly from each cultivator, thereby giving the latter an opportunity to personally express an evaluation of the association's or individual's performance.

The tasks that the Sananeri ayacut association performs are not identical to those left to the cultivators by the government. The official government definition of responsibilities for tank irrigation assigns only water distribution from the tank to the fields, maintenance of field channels, and construction, operation, and maintenance of wells to local cultivators; all else is to be done by some government agency. The ayacut association does allocate tank water, but it is not involved in maintenance of field channels. However, the ayacut association's functions go beyond these tasks and overlap with the officially-designated responsibilities of the government bureaucracy, particularly the PWD. These overlapping tasks include maintenance of the tank, bund, sluices, the feeder channel, the anicut, or the river. Although most of the repairs the ayacut association makes on these structures are minor or temporary (e.g., the mud and leaf obstruction placed in the opening of the broken anicut regulator), the promptness with which the association identifies such problems and acts to fix them helps keep the system functioning until the PWD, with its slower-moving bureaucratic processes, can carry out more permanent repairs.

One criterion for selecting the leaders and employees of the ayacut association is that they should be respected members of their own communities. As such, they often have other roles such as village panchayat membership. Thus, there may be an overlap between positions of responsibility in the ayacut association and civic or communal institutions. However, there is no formal role imbeddedness in the sense of leadership in the ayacut associations being tied to other local leadership roles——either religious, caste, or political (cf. Hunt and Hunt, 1976:396). Because of the diversity of social backgrounds among the ayacut cultivators, it would be difficult for any civic or religious leaders to have the legitimacy to deal with matters affecting the water supply to all cultivators. Ayacut association personnel have this legitimacy by virtue of their specific selection by ayacut cultivators to carry out tank-related tasks.

The existence of active, special-purpose organizations, such as the Sananeri ayacut association, demonstrates that the traditional institutions of kinship, caste, village, religion, and party are not the only organizing forces in Indian rural society, nor are they necessarily obstacles to cooperation and organization among cultivators with different social backgrounds for economic purposes (see also Wade, 1982). The Sananeri ayacut association is composed of cultivators from several villages, castes, religions, and parties; the association itself is not organized along any of these lines, nor do these factors seem to affect its structure or operation. The ayacut association is concerned only with managing tank irrigation, and receives support from the ayacut cultivators because it improves the performance of the irrigation system, which is vital for agricultural production.

Directions for Further Research

This study has provided an analysis of the structure and operation of an active ayacut association and outlined some of the relationships between this association and the government bureaucracy, on the one hand, and the individual cultivators on the other. However, the conclusions from this work are limited in their generalizability because they are based primarily on one case. Further research that systematically compares ayacut associations in different areas is necessary in order to draw conclusions about the extent of local organization for tank management and the way in which these organizations are shaped by and respond to their environments.

The study of other ayacut associations is necessary to show the range of activities and organizational patterns possible in water users' associations. Careful examination of the context of these organizations would show the effect of various factors in the natural or man-made environment (e.g., water scarcity, system or nonsystem tanks, distribution of landholdings, or local political power structure) on the operation of ayacut associations.

This study has identified some important features to look for in ayacut associations: structural patterns that encourage local accountability, forms of resource mobilization, and the tasks that must be performed. The latter include not only the common irrigation tasks of maintenance, water distribution, and conflict management, but also acquisition of water and articulation with the bureaucracies. The distinction between acquisition and distribution is important at the tank level, although at the system level both are part of overall water allocation. The names of positions in the ayacut association and the exact assignment of tasks to each position may be expected to vary. However, examination of the Sananeri ayacut association and other examples in the literature suggest that there are three important roles in the organizations: the leader and representative of the association, and two types of water distributors——those who operate primarily at the tank level, and those who are mostly concerned with distribution to the fields. The absence, overlap, or elaboration of any of these roles, along with the number of persons holding each position, could be seen as an indication of the relative importance of the associated tasks for the particular tank. A systematic documentation and comparison of the environment and structural features of the ayacut associations should allow for generalization about the organization and management of tank irrigation in Tamil Nadu.

The next steps toward a more complete understanding of the systematic nature of tank irrigation should be to study the organization and activities of the government bureaucracies as they relate to tanks. Particular attention should be given to the way in which the officials deal with the representatives of the cultivators. Because government agencies such as the PWD have an important role in the management of tank irrigation systems throughout South India, and even the lowest levels of officials are responsible for many tanks, a study of the bureaucracy itself would be applicable to a much broader area than the study of a local ayacut association (Hunt and Hunt, 1976:407).

On a more micro level, further study of the management of wells would also contribute to the understanding of tank irrigation systems. This should give information on the relative importance of surface and groundwater irrigation within the ayacut, the effect of landholding size on access to groundwater (through well ownership or water purchase), and the influence of well owners on the maintenance and water allocation in the tank and its ayacut. It might also devote attention to measuring the benefits well owners receive from tank water recharging the water table, and how this affects well owners' cooperations with and support of ayacut association activities. Such research is particularly important because of the increasing use of wells for irrigation. Groundwater is a valuable supplement to tank water. However, it is at present unclear what effect the increase in well irrigation will have on the relationships between cultivators and on the overall management of the irrigation system.

Ayacut associations can and do make a substantial contribution to the management of tank irrigation systems by filling the gap between the individual cultivators and government agencies. Not only do they act as liaisons between the two, but ayacut associations also take care of those recurring tasks that neither individual cultivators nor the government are organized to perform. In filling the gap between cultivators and the government, ayacut associations help both parties. Ayacut associations also benefit the government because they improve the overall performance of tank irrigation systems using local resources rather than drawing heavily on government manpower and finances.

The local resources on which ayacut associations draw include not only the measurable economic resources of cash, grain, and labor, but also the organizational skills and knowledge of local situations that the association leaders, employees, and members possess. Proper timing and equitable distribution of tank water in the Sananeri ayacut makes use of the neeranis' knowledge of when water is needed in the ayacut amd the neerpachis' knowledge of the soils and water needs of each field. The cooperation of the cultivators is also instrumental in reducing conflict. Similarly, frequent examination of the physical structures and knowledge of their relative heights enables the ayacut association to identify maintenance needs and to see to repairs in a way that government engineers could not do in a periodic inspection. And the advocacy skills and influential contacts of the association leaders are useful in ensuring that a tank receives timely and sufficient repairs and water allocation. This last point may not seem to be a great advantage to the government, but the petitions from ayacut association leaders provide important sources of information on tank conditions.

The activities of ayacut associations are not confined to water distribution and maintenance below the bund, responsibilities that the government has formally assigned to cultivators. Rather, the ayacut associations often inspect and repair structures that are officially the responsibility of a government agency. The fact that the PWD does not use the circle system to ensure periodic inspection and repair of tanks in its charge makes this contribution of the ayacut associations especially valuable.

In order to encourage and make use of these contributions from ayacut associations, government agencies need to listen to association representatives and respond to their major needs. Chambers' (1980:42) point is well taken that:

> In general, government should unambiguously avoid doing what communities can do for themselves in their own interests, but should intervene when exceptional problems are beyond a community's power to overcome.

But this implies that the government must first know what the capabilities of a community are. Specific abilities will vary from tank to tank, but studies such as this provide a first step toward identifying important aspects of local associations and building a framework for further analysis. Local administrators should consult with local ayacut association leaders to find out what is being done and to identify the most pressing needs of each tank. It is particularly important to consult with local leaders before beginning any major work on tanks. Local leaders can provide valuable information on tank conditions and cultivators' needs, and their involvement is vital for the ongoing management of tanks after the project has been implemented.

It is in the tasks of water distribution and ongoing management of tanks that Chambers' caution against excessive government involvement is particularly appropriate. For the government to become involved in setting up formal committees where ayacut associations already function is superfluous and might even reduce local cultivators' participation in and control over their own tanks. A more fruitful approach would be for the government to work with existing associations. Where these do not presently function, attempts should be made to identify and correct the factors that inhibit collective action, and to encourage cultivators to organize themselves. However, the government should avoid imposing a formal structure or appointing "leaders" for water management, since this would make the organization responsible to the government, rather than to the cultivators. Ayacut associations can mobilize local resources——including indigenous skills and knowledge——for tank improvement, but if they are to continue to do so in the long run, they must be responsive to the needs of the cultivators under their tank.

The effective delivery of water to the fields in the command of tank irrigation systems ultimately depends upon action at three levels: the individual cultivators, the local collectives, and the government bureaucracies. Because tanks are part of interconnected systems, coordination between the cultivators and the organizations involved is essential. Ayacut associations have a central role in this, both in terms of the tasks they perform and their function as liaison between the government and cultivators. Therefore, any attempts to improve the operation of tank irrigation systems should include efforts by scholars and officials to understand and work with these local organizations.

NOTES

[1]Minor irrigation includes all projects with a command area of 2,000 hectares or less (Palanisami and Easter, 1983:1).

[2]The term ayacut is a Tamil word referring to the area irrigated by a tank or other irrigation source. It has been used extensively in the literature on Indian irrigation. In keeping with this, in this report ayacut will be used synonymously with command area.

[3]For a summary of the papers presented at this conference, see Palanisami and Easter, 1983.

[4]Although in many areas of India the Southwest Monsoon is the main wet season, Tirunelveli District and much of Tamil Nadu are in a rain-shadow during this period and receive most of their rainfall during the Northeast Monsoon.

[5]The most common English spelling of a Tamil word is generally used in this paper. When no accepted form exists for a word, transliteration from Tamil follows the format used by Harriss (1982).

[6]Research during the 1982-83 pisanam season could, however, have provided valuable information on the response to severe drought.

[7]The Sangam literature includes an extensive body of Tamil poetry by scholars at the literary academies patronized by early Pandyan kings, which is generally attributed to the first four centuries A.D. It is one of the major sources of information on ancient Tamil political and social life.

[8]"Poligar" is the anglicized version of the Tamil word palaiyakkaran.

[9]The British administrative division, which included present-day Tirunelveli District plus two taluks, or subdistricts, of present-day Ramanathapuram District, was called Tinnevelly District.

[10]Takkavi refers to cash advances from the state treasury to cultivators for agricultural inputs or capital investments in agriculture. See Whitcombe, 1972:110-113.

[11]Many of these same features of flexibility and local participation, plus support from government matching grants are cited by Roberts (1980:188-193) as contributing to the success of the "Paddy Lands Irrigation Ordinance (No. 9) of 1856" in mobilizing local resources for irrigation system improvement in parts of Sri Lanka.

[12]Tamil Nadu was called Madras State until 1968.

[13]In Tirunelveli District, there are 1,016 administrative villages, 910 village or town panchayats, 31 panchayat unions, and 2 development districts (Dharampal, 1973:14,16). See also Dharampal, 1973:63-64.

[14]Zamindars were landlords or tax farmers who held title to large tracts of land from which they, in turn, collected revenue. Many of these were the successors of the palaiyakkarans. See Krisnaswami, 1947:34-49.

[15]Anicut refers to any diversion weir on a river.

[16]These figures are not adjusted for the actual amount of water used. See also Moorti, 1971:17 and Shukla, 1971:18 for further data on comparative costs per unit of water.

[17]For more information, see Madras State, Director of Statistics, 1965:4-11.

[18]Member of the Legislative Assembly, a locally-elected position in the state government.

[19]An English literal translation lacks the specific connotations that are important in this discussion. "Water users' association" is somewhat of a generic term that has been applied to a wide range of local bodies in the literature on irrigation. It is used in this study when comparing different organizations. "Cultivators' association" is an even broader term that does not imply a commality of interest in a specific irrigation system. Therefore, the term "ayacut association" will be used to refer to a nonformal organization of cultivators whose lands are irrigated by a single tank.

[20]During the time of fieldwork, the exchange rate was approximately Rs. 9.50 = US$ 1.00.

[21]Those cultivators without access to well water at this point in the season would have to wait for tank water for land preparation and raising a nursery, and therefore run a greater risk that the tank will dry up at an early stage in the crop's growth.

[22]Note, however, that the unit of measurement both in the model and under well irrigation is time, not volume of water delivery.

[23] The terms "efficiency" and "equity" have been defined in numerous ways. In this discussion, efficiency refers to application of water to the fields in such a way as to provide maximum benefit to the crops. This implies both engineering efficiency in terms of minimal transit losses and agronomic efficiency in terms of optimal timing of water applications to meet crop needs. Equity refers to access to water by all ayacut cultivators.

[24] These two factors often coincide because much of Tamil Nadu's electricity is generated by hydropower. During a drought, surface water becomes more scarce and demand for groundwater increases. The water table declines because of increased withdrawal with low recharge. At the same time, water levels in the reservoirs for generating electricity are low, and the state electricity board limits consumption by rationing, power blackouts, or both.

[25] For a discussion of the practice of nanjai mel punjai, see Nakamura (1982).

[26] Note that this form of equity differs from the definition given earlier in that it does not imply equal access to water; rather, it is based on delivery of water to those who pay the management costs. This form of equity is less readily apparent to outside observers of an irrigation system because it requires knowledge of the various costs involved in water management.

[27] These provide a good indication of the range of cash value because 1981-82 prices were somewhat low due to a good harvest, and 1982-83 prices were exceptionally high due to a severe drought.

[28] Note that the figures of Rs. 25-50 per hectare that the Tamil Nadu PWD spends on repairs (Palanisami and Easter, 1983:19), or the Rs. 17-26 per hectare for the Andhra PWD (von Oppen and Subba Rao, 1980B:40-41), do not include the costs of maintaining the PWD bureaucracy, which is a major aspect of the government's overall contribution to repairs and water allocation in tank irrigation systems.

[29] Cultivators reported that a "normal" yield was 12 kottais of paddy per acre, or 1,584 kg. per hectare. Because research was not conducted during the pisanam season, an empirical average of yields was not obtained.

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