

CHAPTER 1-2: IRRIGATION: THE DEVELOPMENT OF AN AGRO-ECOLOGICAL CRISIS

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1. Introduction

Irrigation has historically played a very important role in India's agriculture. The technology of gravity flow irrigation in particular has been used from time immemorial. In the southern part of India, in states like Tamil Nadu and Andhra Pradesh, the hot summer months followed by a vigorous monsoon season meant that farmers had to store surface run-off. 'Tanks' (reservoirs with an embankment on one side) were constructed for this purpose, connected to each other through channels called surplus courses, feeding water downstream to a tank below. Some tanks are also fed through rivers by means of **anicut**s (diversion channels) and canals. Tanks vary in size. Some irrigate a few thousand acres while others feed less than ten. Farmers have also used gravity flow irrigation by bringing spring water from rivers and mountains through open cut canals some 5 to 7 km long. Tanks, springs and other traditional rain-water harvesting systems were the only surface irrigation sources in South India until the advent of the post-Independence dams and canals. Tanks are still one of the main sources of irrigation in many parts of India.

According to the Minor Irrigation Census conducted by the Government of India

in 1985, the total number of tanks in the country was estimated as 200,000 to 250,000 with a combined water spread area of 3 million hectares and a command area of 4.5 million hectares. Tanks being shallow reservoirs, the ratio of the area under submergence to the area irrigated tends to be high, in this case 0.66. In the state of Tamil Nadu, there are reported to be about 39,000 tanks, besides numerous spring channels originating from rivers. However, many of these tanks are in a state of decay, while others are defunct. Spring channels are in an even more pathetic state as most have either been encroached upon and *de facto* privatised or their water supply has seized-up completely. Over the past five or six decades, the net area irrigated under tanks has been declining steadily whereas the area irrigated by open wells has been rising.¹

The condition of tanks has been deteriorating for at least 150 years.² In 1947,

¹Endnotes

1. For a detailed discussion on this aspect and for more statistical information pertaining to tanks in Tamil Nadu and North Arcot district, see Maddumma Bandara, (1977), MIDS, (1983), Janakarajan, (1986), Vaidyanathan and Janakarajan, (1989).

2. For an historical account on the discussion on the deteriorating condition of tanks and legislative measures attempted to revamp the tank irrigation system in then Madras Presidency, see Krishnaswami, (1947), Saradaraju, (1941) and Baliga, (1960). See also Cox (1895).

Krishnaswami wrote:

“There is a general consensus of opinion among officers who have dealt with the maintenance of minor irrigation works and among the intelligent lay public that there has been systematic deterioration, showing itself in the neglected conditions of the supply channel and unremitting silting up of the bed level of the water for the *ayacut* determined by the Tank Restoration Scheme party”, (1947, p. 438).

So, the symptoms of the degeneration of tanks have been silt accumulation, encroachment in the catchment area, neglect of the supply channels and lack of incentives for the users of tanks to maintain tanks and channels and collectively to manage water. The main reason for these symptoms is groundwater irrigation. Private access to subterranean water has destroyed the incentives for collective action to maintain tanks.

A recent study of 15 tanks of the age-old Palar Anicut System in North Arcot district suggests that *it is the complex interaction of several institutional, technical and physical factors which have contributed to the decaying condition of the tanks,*³ such as the rapid shift in the land ownership from **brahmins** and other

³. For more details see Vaidyanathan and Janakarajan, (1993a). See also Harriss,

upper castes to the cultivating castes, the emergence of owner-cultivation as the dominant mode of production and the development of groundwater as the most critical source of irrigation both in the tank commands as well as in the dry lands (which accompanied the introduction of the high-yielding bio-chemical technology for rice). In six of the 15 tanks studied, the traditional irrigation institutions were defunct. These are also the villages in which the density of wells was highest. In the seven villages in which the irrigation institutions were effective, well densities were found to be either much lower or the tanks were in an advantageous position at the head of a canal system with an assured supply of water. So one of the most significant factors to affect the functioning of tanks has been the rapid growth of well irrigation.

(1982), Bandara, (1977).

Groundwater exploitation, however, has led to the secular lowering of the water table in several parts of the state (Janakarajan, 1993b). Maddumma-Bandara, a geographer and hydrologist, another member of the 1973 survey team, already then concluded that the expansion of groundwater irrigation had reached a stage in North Arcot district, when any further development would have serious hydrological consequences. "...Further expansion of lift irrigation may lead in the near future to unwelcome hydrological consequences such as lowering of water tables and dwindling surface-water resources, unless suitable preventive measures are introduced in time. If the present trend continues, extraction of surface water may, before long, become a form of self-defeating 'agricultural mining'", (1977, pp. 337-338). This analysis was based on rainfall patterns and their association with river water flows as well as water table readings recorded from wells. Monthly rainfall data for 12 stations for the period from 1920 to 1974 was used to arrive at the important conclusions that the incidence of rainfall in North Arcot district has the characteristic of secular fluctuations; rainfall has a tendency for 'persistent trends' in which declining or increasing trends have persisted for several years. These trends then correspond with the flow of water in rivers and tanks. However, when the flow of water in the Cheyyar river, measured at Uthiramerur for the period from 1958-70, is related to rainfall over its catchment area for the corresponding period, an increasing gap between rainfall and flow of water is discovered. Since the period covered for this analysis was not long enough for a meaningful time series analysis, Maddumma-Bandara was not very

sure of the reason for the gap between rainfall and surface water flow. If the gap is real (and not random), it could occur either because of the over-use of water in the upper reaches, or because a larger proportion of the rainfall at the beginning of the rainy season replenishes the lowered ground water table, or both. One important point emerges from this analysis: a persistent declining trend in rainfall, under continuous drought conditions, will have a more damaging effect both on the surface and the sub-surface waters for a more prolonged period than has been observed before. Furthermore, it was also clearly demonstrated that access to well irrigation was found to be the most essential condition for the adoption of the HYV technology (Chinnappa, 1977).

Given this hydro-ecological history, three aspects of water management will be updated in this chapter : - the traditional tank irrigation system (section 2 and 3); the extraction of groundwater (section 4); and the impact of irrigation on the agrarian economy of the study villages (section 5). The resurvey conducted during 1993-95 in three villages (Nesal, Vinayagapuram and Veerasambanur) of the present Tiruvannamalai district (the southern of the previously undivided North Arcot district) had a special focus on water and its use. This is the source of information for this chapter.⁴

⁴. For details on the survey and the methodology, see Janakarajan, (1996). For details on the original survey and the first resurvey, see Farmer, (1977) and Hazell and Ramasamy, (1991) respectively.

5. The **Brahmin** landlords' interest in the tank may be judged from the fact that

2. Traditional Irrigation Systems of the Study Villages

Table-1 lists the traditional irrigation sources with their respective registered command areas in each village. Except in Veerasambanur, tanks are fed by the river Cheyyar. The agrarian economy of Veerasambanur is less developed than that of the other villages. However, the present condition of the tanks in all three villages is remarkably similar. There is clear evidence of the complete neglect not only of the tanks and the associated earthworks, but also of the inlet channels (which are either encroached upon or completely silted up).

they possessed five out of 18 shares of the fishery rights (**machcha maghasul**) as per the village 'A' Register.

Table-1: Traditional Sources of Irrigation in the Selected Villages ^a

Village	Name of the tank	Ayacut (acres)	Source of supply	Surplus goes to
Nesal ^b	Nesal big tank	100.00	Kamantala aaru	
Vinayagapuram	1. Peria Eri	69.03	Chey yar river	Nariyam.tank
	2. SK Thangal	10.37	Surplus from AK Thangal	Peria Eri
	3. AK Thangal	12.76	Chey yar river	Peria Eri
	4. Spring Channel	76.64	Chey yar river	Peria Eri
Veerasambanur	1. Peria Eri	74.01	Rainfed	Not available
	2. Malavan Eri	36.05	Rainfed	Not available
	3. Palayateri ^c	1.03	Rainfed	Not available

Notes:

a) There is discrepancy in the **ayacut** details collected from various sources. **Ayacut** is the land below a tank irrigated from it.

b) Nesal revenue village has two other tanks which do not serve the Nesal hamlet.

c) Palayateri has now disappeared.

Source: Village records; N.B. 1 acre is 0.41 hectares

2-1. Traditional Irrigation Institutions - the History

The irrigation institutions seem to have functioned effectively in all the villages until the early 1970s. There were two layers of irrigation functionaries, one to enforce the rules and the other to execute the work. While the high-caste

landlords invariably constituted the first category, which is a high status position, the scheduled caste labourers were employed in rotation (from among selected families who had right to such work) for the second type, which involved heavy manual work. The dignified managers of the system were generally known as **nattamai / maniyakkarar / oor gounder** or **kavaimaniyam** when solely designated to supervise the irrigation work. The irrigation workers were called **neerkatti** or **kammukutti** or **thotti**. These irrigation workers were paid in kind at the end of each season by the community of water users according to the area commanded under the tank. There are clear indications that, in the past, the irrigation institutions were quite effective in all the three villages. Let us quickly go over the manner in which the critical functions of water management were organised.

Maintenance:

In all the villages, there was a standard procedure to mobilise users of tank water: as soon as the upstream tank received water, the **maniyakkarar** announced this fact to the tank community by the beat of the **neerkatti**'s drum. He also announced the labour requirement for work. This was usually fixed on the basis of one person per acre or per **kani** (1 kani = 1.32 acres or 0.54 ha). Those who abstained from the work for whatever reason had to compensate for their labour either with a cash equivalent of a forfeited day's wage or by providing substitute labour. Those who failed to do both were fined.

In Vinayagapuram, where the spring channel was an important source of irrigation water, maintenance work was organised slightly differently. Although it passes through at least one other village upstream, the water in this spring channel is the exclusive right of this village. For 5 km., the channel runs beside and slightly below the bed of the Cheyyar river, so as to tap the water seeping from the river. When the water started flowing in the river, the first work done by irrigation workers was to lie down in a line in the river bed so that sand built up against their bodies making a diversion bund which facilitated the flow of water into the channel. The next day, a **neerkatti** announced through the beat of the drum at 6.00 a.m. that the **aathu kaalvai** (spring channel) work would begin that day. Then, he departed to inspect the channel. At 9.00 a.m. another **neerkatti** would beat the drum for people to follow him and the **maniyakkarar**. Normally, the work obligation for a farmer with - say - 2.5 acres of land receiving irrigation water either directly from the channel or from the tank was to dig, broaden and de-weed the 3-feet-channel each day (by himself or by a proxy worker). If a farmer had five acres of land, he would be required to undertake a 6-feet-length channel each day and so on. In normal years, the work used to begin during the Tamil month of **Avani** (early August) and went on until **Panguni** (early April) every day except during the Pongal festival. The spring channel had got its own direct irrigation **ayacut** as well as feeding that of the tank. Until the end of January, it fed the tank, after which it irrigated the **ayacut** directly. Users of water from both sources were required to join in maintenance work. Many **Brahmin** land owners and the other well-to-do farmers used to hire **koottalis** (permanent

labourers) specifically for this purpose.

On many occasions, the village had taken collective action to assert their rights over water. In the early 1950s, for instance, the spring channel was completely silted up with river sand after heavy flooding. The people of Vinayagapuram could not clear it unaided. In the upstream village (Konayur), through which the channel passes, people approached the **thasildar** to allow them to take over the channel. The people of Vinayagapuram were provoked to approach the government for funds (Rs. 20,000) to de-silt the channel and install a permanent structure at the head to reduce silt flow. On another occasion, in the late 1960s, a major dispute was triggered between these villages, when a farmer belonging to Konayur pilfered water from the channel. The people of Vinayagapuram caught the pilferer, tied him to a tree and beat him severely. The **eetram** equipment which he used for lifting water was seized and auctioned off. The infuriated people of Konayur by way of retaliation beat five of Vinayagapuram's men: a sufficient enough cause for police intervention. In order to meet the court expenses, even those who did not benefit from the channel water contributed liberally since the pride of the village was at stake. In the end, however, everything was patched up. As late as the 1960's, the entire responsibility for irrigation management was in the hands of **Brahmin** landlords. Their good rapport with government officials helped to secure the rights of the village on several occasions.⁵

System of Water Sharing

In all the villages, the opening and closure of sluices was dictated by the **maniyakkarar**. As a rule, the deepest sluice was opened for irrigation first. Only when the water level receded below the level of the deepest sluice, were other sluices opened. When tanks were full, which was rare, no rotation of water rights was needed. More usually, the system of water allocation (**murai**) was based upon a rotation system in which the entire tank command area was broken into divisions and a ration of one hour's water supply per acre was allowed. Since the **maniyakkarar**'s land was always in the head reach under the deepest sluice, the rotation started with the segment of the **ayacut** in which the **maniyakkarar** possessed land. In the big tank of Nesal, the **ayacut** was divided into 4 divisions⁶, in Vinayagapuram 18 and in Veerasambanur 4.

2.2. Neerkattis / Thotti (Irrigation Workers)

The **neerkatti** has had a unique role in the traditional irrigation institution, critical for irrigation maintenance as well as for water sharing. His primary responsibilities were to protect the inlet channel during monsoon months; to guard against any breaches in the channel or pilferage of water; to watch the bunds and surplus weirs; in particular during floods; to open and close the sluices; to irrigate the plots of land in rotation, in particular during scarcity periods; and, above all, to organise cultivators for collective maintenance work. In some villages, like

⁶6. According to Harriss, 1982, there were 10 divisions.

Veerasambanur, the **neerkatti** also assisted in key agricultural operations as well as in community activities like drum-beating during marriages and village festivals.

In Nesal, the irrigation worker is called **thotti** and selected in rotation. His wages were paid in the form of **ari** or ‘paddy on the stalk’ at the end of each harvest by the community of water users. The **thotti** in Nesal used to receive 12 **aris** which is equivalent to about 20 kgs. per kani (1.32 acres). On average, the **thotti** used to collect about 18 to 20 bags of paddy at the time of the samba harvest (the major season) plus some groundnut, harvested during the summer months. In Vinayagapuram, the wage payment was also 12 **aris** per **kani** but this wage had to be shared between two **thottis**. However, since the area irrigated was larger in this village compared to Nesal, each **thotti** used to collect at least 15 bags of paddy at the **samba** harvest besides about 2 bags of groundnut each in the month of April.

The case of Veerasambanur differed from the other two villages as the responsibilities of the **thotti** were quite diverse and heavy. In addition to the irrigation-related operations, they also assisted farmers in certain agricultural operations such as uprooting the paddy nursery, distributing the paddy seedlings to various parts of the field, spreading the news of a death to other villages, disposal of dead animals, beating drums on all important occasions and so on. The wage payment was made in the form of **ari** as in other villages but there were

three types. First, **kumbidu ari**, was a payment made to him for all the menial and servile work. At the time of harvest, the **thotti** would go to the field, salute the land owner by bowing or prostrating and pick up a small bundle of paddy on the stalk which would be granted by the landowner. Second, **kani ari** constituted the major part of his payment, was paid for all the irrigation-related work. Third, **kani ari**, was paid for assisting farmers with agricultural operations. Altogether, the **thotti** used to receive 12 **aris** per **kani**, (16 kgs. of paddy) or a total of about 20 to 24 bags of paddy per annum.

On the whole, these irrigation institutions have now become history but the manner in which they functioned illustrates the social relations of production as they existed. That the managers of the system had a vested interest in tank management is clear from the rules by which the tank water was shared. For instance, in Nesal village, there seems to have existed a water sharing system during times of scarcity. The entire land under the tank command was divided into 4 parts, each associated with a leading land owner. Each part was given a time-slot of water once every 24 hours in a rotation. The biggest part was called the **maniyakkaran veettu vagayara** (meaning the **maniyakkarar**'s close family circle). This family held all the good quality land, having access to the **palla madagu** (the deepest sluice), and this part received water for 30 **nazhigai** or 12 hours. All the other three parts received water for 10 **nazhigai** (or 4 hours). John Harriss (1982) in his account from 1973, notes that the **maniyakkaran veettu vagayara** was one of 10 parts of the tank command area which received water for

12 hours in rotation, once in 48 hours. Though the information about rotation varies over time, the fact remains that the managers of the system were the principal users of the tank water. Thus Harriss writes about Nesal:

Two channels lead from the central sluice (the deepest sluice) and they irrigate principally land which belongs to **Agamudayans**, whereas land belonging to **Yadavas** is irrigated from the secondary sluices. This surely reflects the **Agamudayans'** dominance of the village and their control of more than 60 percent of the village lands. Further, the major part of the land which is most favourable situated in relation to the main sluice belongs to the **naattamaikarar viiTu**, (1982, p. 126).

2.3. Traditional Irrigation Institutions - Present Status

Physical condition

At present, irrigation institutions are more or less defunct, which is characteristic of the post green revolution agrarian scene in many parts of Tamil Nadu. The system is reported to have functioned reasonably well until the early 1970s but failed afterwards. *The tanks and feeder channels in all the villages are completely silted up.* Absolutely no maintenance work has been carried out in Nesal and Veerasambanur during the past twenty years, except during the drought of 1982-83 when two weeks of de-silting of the tank bed was carried out by the Public Works Department. In Vinayagapuram, however, unsuccessful efforts were made as late as 1990 to de-silt the feeder channel. The regulatory structures are in

a sad state in Nesal, while in the other two villages they are reasonably good. In all the villages, *the tank foreshore areas are encroached upon*. In Veerasambanur, for instance, about 10 acres of tank foreshore area is encroached and has been cultivated by a few farmers of the adjacent village for the past 20 years. The revenue authorities have apparently taken no action against them. The major distributaries from the sluices are also silted up and are also encroached upon. After 1970, in Nesal, there is no evidence of a full crop cultivated with tank water. In Veerasambanur, the tank last received water almost to capacity in 1989, after which it has remained dry. The picture is the same in Vinayagapuram, except that monsoon water flowing in the spring channel has kept the channel active until recent times. In all three tanks, however, some water is stored during the monsoon months (though water levels are well below the sluices). *At least tanks provide drinking water to cattle*.

Status of the Irrigation Organisations

The traditional organisations for irrigation related operations have either disappeared (as in Nesal and Veerasambanur) or remain inactive. In Nesal, there is no evidence of the existence of any irrigation official. Even the last **Oor Maniyakkarar** who managed the system 25 years ago (who is still alive) has lost interest in the tank. In Vinayagapuram, the **Kavai maniyam** and **Nattamaikarar** exist but are inactive and not respected as they were in past. The existing **Kavai maniyam** (who has held the post since 1980) is unable to mobilise cultivators for channel maintenance work. The irrigation organisation in Vinayagapuram (which till the 1960s remained very powerful under **Brahmin** landlords) is too weak to

prevent clashes in the village and the **Kavai maniyam** was taken to task for swindling public money. In 1991, the **Kavai maniyam** cum **Nattamai** took a unilateral decision to fell a tree in the middle of the village, to construct a Panchayat building, in the fall-out from which he was comprehensively humiliated and factions intensified. In Veerasambanur, as in Nesal, the **Nattamai** is powerless and has no role to play in water management.

However, the lowest grade irrigation functionaries, the **Neerkatti** / **thotti** continue to exist and to receive customary payments. Certain key operations such as drum-beating on the occasions such as village festivals, death ceremonies and so on, removing dead animals, providing a courier service to other villages on occasions such as death etc. are still performed by the **thotti**. However, customary payments to this village worker have been considerably reduced. While in Nesal, the **Neerkatti** collects hardly 2 **aris** per **kani** or a total of 2 bags of paddy per annum (during the samba season), in Vinayagapuram and Veerasambanur the **neerkattis** receive better payments. In Vinayagapuram the two **neerkattis** together collect about 8 bags of paddy per annum, in Veerasambanur, the **thotti** receives about 10 bags.

3. Reasons for the Decay of Traditional Irrigation Institutions

A detailed study of 15 other tanks in the undivided North Arcot district has revealed the reasons for the disintegration of the traditional irrigation institutions (Vaidyanathan and Janakarajan, 1989; Janakarajan, 1993a). The first consists of

changes in land ownership from the upper castes to the lower castes. This has also resulted in the emergence of owner-cultivation as the primary mode of cultivation. When the upper caste landlords such as **Brahmins** and **Mudaliars** were the dominant landowners, they operated land principally by means of share cropping tenancy, which gave them access to the labour of their tenants for operations such as tank maintenance and so on. These landlords played a crucial role in enforcing tank maintenance and providing leadership, for the simple reason that they had the largest stake in the tank water. After the changes in the landownership pattern, which triggered changes in the mode of cultivation (particularly the casualisation of labour, crop technology and the lack of authority of those who purchased the land), the traditional irrigation institutions broke down.

The second factor is the widespread use of groundwater irrigation and the rising density of wells in the tank command area. In the three villages of the resurvey, we do not have much evidence to suggest that changes in the land ownership pattern have contributed to the decline of the system, except in Vinayagapuram, where the village was predominantly in the hands of **Brahmin** landlords until the 1960s. Field notes for Vinayagapuram written in 1973-4 by Robert Chambers and John Harriss recorded that ten big **Brahmin** land-owning families had left the village in 1950, and many more **Brahmin** landlords were leaving the village in the 1970s. Even as late as 1982-83, **Brahmin** families held about one-fifth of the prime wet lands under the tank command, and five of the eighteen shares of the

tank water and the fishery rights were still in the names of the **Brahmin** landlords. In the other two villages, **Agamudaya Mudaliars** remain the major landowners, although in the recent times, **Yadavas** in Nesal and **Vanniars (gounders)** in Veerasambanur have purchased considerable amounts of land.

However, in all three villages, groundwater extraction has grown rapidly. In Nesal, as early as 1973, John Harriss found an association between the rapid spread of mechanised lift irrigation and the declining fortunes of the tank irrigation system. He wrote,

“...we have seen that although well irrigation has long been ‘traditional’ in Randam, [his pseudonym for Nesal] it has undergone a substantial expansion in the last fifteen years; and the agricultural system of the village is now heavily dependent upon it. The question that arises as to whether the supply of water in the tank was more reliable in the past, and further whether its present unreliability might be due in some way to expanded exploitation of groundwater, or to a failure of local or official organisation”, (1982, pp. 71-72).

Elsewhere, he emphasises the utter lack of interest and non-cooperation in tank management of the large land owners whose lands have better access to groundwater irrigation. To quote:

“the tank is of slight importance in village agriculture today, however, the fact that five of the richest farmers in the village own lands which are mainly well-irrigated and are remote from the tank, compared with only two from the group of ‘magnates’ whose lands lie near the main sluice, shows how groundwater irrigation has now reduced the importance of control of tank water”, (1982, p. 130).

The spurt in mechanised lift irrigation should not be viewed as an isolated event. If we look at statistics for the number of wells for the North Arcot district, there is a sharp rise in the mid 1960s, which was the period of the introduction of the HYV technology a precondition for which was a reliable, assured and controllable source of irrigation. Moreover, tank water was adequate for only one crop, whereas the HYV seeds had the potential for three short duration crops. In addition to that, the application of HYV technology presupposes the timely availability of water, so that chemical inputs could be applied with precision. Moreover, it was around this time that most of the villages in the North Arcot district were electrified. So a combination of all these factors facilitated the rapid growth of well irrigation. The expansion of lift irrigation on such a massive scale reduced the collective interest in tank maintenance.

4. The Ground Water Status of the Study Villages

Table 2, showing wells in the study village since 1973, confirms a tremendous

expansion of lift irrigation after the introduction of the HYV technology. Nesal witnessed the most rapid increase in the number of wells, registering a 78% rise over the period of past two decades. While Veerasambanur registered an increase of 39%, Vinayagapuram registered a modest increase of 15% since 1973. Similarly, the density of wells in the respective villages shows an increase of 0.11 wells per acre in 1973 to 0.19 in 1993 in Nesal; of 0.17 to 0.23 in Veerasambanur and of 0.17 to 0.19 in Vinayagapuram.

Table-2: Number of Wells in the Villages, 1973-1993

Particulars /		Villages		
Year		Nesal	Vinayagapuram	Veerasambanur
Number of wells				
	1973	73 (100)	124 (100)	89 (100)
	1993	130 (100)	142 (115)	124 (139)
Wells per acre ^a				
	1973	0.11	0.17	0.17
	1993	0.19	0.19	0.23
Wells not-in-use ^b				
	1973	NA	NA	NA
	1993	28	25	32

Notes:

a) Well density is calculated for the total area under wet and dry lands in each village.

b) 'Wells not-in-use' are those which have not been used for irrigation in the last five years.

Source: C. Ramasamy et. al (1991) and Survey, 1993-4.

While Nesal has virtually given up on tank irrigation, in the other two villages, tank irrigation was active until recently - in particular in Vinayagapuram, where the spring channel was yielding reasonably good water supply until the 1980s. Table 2 shows that while, in the 70s, the farmers of these villages were drawing water for irrigation from the conventional surface sources, these villages are now completely dependent upon lift irrigation. The density of wells is so high that there is one well for each five acres of combined wet and dry lands. The incidence of abandoned wells in the 1993 survey is quite high: 26% in Veerasambanur, 21% in Nesal and 18% in Vinayagapuram. Although we do not have a comparative picture of the wells not in use in 1973, there is every reason to believe that wells have been increasingly abandoned from 1973 to 1993.⁷ There is no comparative data with which to examine this issue. Nevertheless, in 1993-4 we conducted a (random) sample study of one-sixth of the total wells (covering wells located both in wet and dry lands) in the three villages to quantify the decline of the water table. Two simple questions were posed to all the sample well owners: i) what was the original depth of the well at the time the well was first dug? and ii) what is the current depth of the well? The answers have been tabulated and presented in Tables 3 to 5 separately for each village.

⁷. This has happened in the other parts of the district as well as the State (Vaidyanathan and Janakarajan, 1989; and Janakarajan and Vaidyanathan, 1996).

It is evident that *the gap between the original and the current depths is quite significant*, more so in the dry land wells than in wells located in the wet-land. From Table 3 for Nesal, at least one sample well in the wet-land and five in the dry-land were originally in the shallowest depth band (of less than 20 feet), whereas, by 1993 no wet-land wells and 4 dry-land wells were so shallow. All these shallow wells have been abandoned. In the higher depth ranges, wells have been deepened. The picture is the same in the other two villages (see Tables 4 and 5). In all the villages, *the difference between the wet and dry-land wells is quite significant*, which indicates that the water table is falling much faster under the dry-land than under the wet-land. A similar picture has been obtained in other hard-rock regions in Tamil Nadu (Janakarajan and Vaidyanathan, 1996). The average original and current depths of the sample wells however, are the most crucial information clearly pointing to a secular lowering of water table. For instance, in Nesal village, the average original depth of the sample wells in the wet land was 34.8 feet, but for the same set of sample wells, the average current depth is 45.2 feet. *In the dry land, the difference between the average original and the current depths is more than double*. In the other two villages, both in the wet and the dry-land wells, the difference between the average original and the current depths is even more striking and significant.

Table-3: Distribution of the Wells in Nesal by Depth, 1995

Depth Range (feet)	WET		DRY	
	Original Depth	Current Depth	Original Depth	Current Depth

	No. of Wells	%	No. of Wells	%	No. of Wells	%	No. of Wells	%
<20	1	12.5	0	0.0	5	33.4	4	26.7
20-30	3	37.5	1	12.5	6	40.0	0	0.0
30-40	1	12.5	2	25.0	1	6.7	2	13.3
40-50	2	25.0	2	25.0	2	13.3	3	20.0
50-60	0	0.0	1	12.5	1	6.7	2	13.3
60-70	1	12.5	0	0.0	0	0.0	0	0.0
70+	0	0.0	2	25.0	0	0.0	4	26.7
TOTAL	8	100.0	8	100.0	15	100.0	15	100.0
Av. Depth in Feet		34.8		45.2		27.2		56.5

Notes: the four dry-land wells recorded in the <20 feet current depth range are disused.

Source: Survey, 1993-95.

Table- 4: Distribution of the wells in Vinayagapuram by Depth, 1995

Depth Range (feet)	WET				DRY			
	Original Depth		Current Depth		Original Depth		Current Depth	
	No. of Wells	%	No. of Wells	%	No. of Wells	%	No. of Wells	%
<20	6	60.0	0	0.0	8	61.6	0	0.0

20-30	4	40.0	0	0.0	5	38.5	0	0.0
30-40	0	0.0	6	60.0	0	0.0	4	30.8
40-50	0	0.0	4	40.0	0	0.0	5	38.5
50-60	0	0.0	0	0.0	0	0.0	4	30.8
60-70	0	0.0	0	0.0	0	0.0	0	0.0
70+	0	0.0	0	0.0	0	0.0	0	0.0
TOTAL	10	100.0	10	100.0	13	100.0	13	100.0
Av. Depth								
in Feet		17.1		38.9		18.8		45.4

Source: Survey, 1993-95

Table-5: Distribution of the wells in Veerasambanur by Depth, 1995

Depth Range (feet)	WET				DRY			
	Original Depth		Current Depth		Original Depth		Current Depth	
	No. of	%	No. of	%	No. of	%	No. of	%
	Wells		Wells		Wells		Wells	
<20	6	75.0	0	0.0	9	75.0	3	25.0
20-30	2	25.0	1	12.5	2	16.7	1	8.3
30-40	0	0.0	2	25.0	1	8.3	1	8.3
40-50	0	0.0	2	25.0	0	0.0	3	25.0
50-60	0	0.0	3	37.5	0	0.0	3	25.0

60-70	0	0.0	0	0.0	0	0.0	1	8.3
70+	0	0.0	0	0.0	0	0.0	0	0.0
TOTAL	8	0.0	8	0.0	12	100.0	12	100.0
Av. Depth								
in Feet	16.1		42.9		17.6		46.9	

Notes: the three dry land wells recorded in the <20 feet current depth range are disused.

Source: Survey, 1993-95.

The rate at which the water table has fallen is found in table 6. While the water table is deepest in Nesal, the rate at which it has been falling is highest in Veerasambanur, followed by Vinayagapuram.

Nevertheless, the comparison of the original and the current depths of wells dug before 1975, throws up much more striking results. Of the total of 23 sample wells in Nesal, 23 in Vinayagapuram and 20 in Veerasambanur, 18, 16 and 17 respectively were dug before 1975. Of those wells which were dug before 1975 however, 7, 2, and 4 wells have been completely abandoned due to low or non-existent water yields. Table 7 pertains to those wells which were dug before 1975 and those which continue to yield water to this day. The table clearly shows that there has been a competitive deepening of wells, resulting in the secular lowering of the water table. The rate at which groundwater is extracted seems much more than the rate of sub-surface replenishment by way of infiltration.

Table-6: Extent of decline in the water table (in feet)

Village	Wet		Dry	
	AOD ^A	ACD ^B	AOD	ACD
Nesal	34.8	45.2	27.2	56.5
	(100) ^c	(129)	(100)	(211)
Vinayagapuram	17.1	38.9	18.8	45.4
	(100)	(229)	(100)	(237)
Veerasambanur	16.1	42.9	17.6	46.9
	(100)	(269)	(100)	(261)

Notes:

(a) AOD refers to the average Original Depth - Average of the sample wells.

(b) COD refers to the Average Current Depth.

(c) Figures in the brackets denote the percentage variation between the average original and the current depths.

Source: Survey, 1993-95.

Table-7: The average original and the current depths of the sample wells which were dug before 1975

Village	Wet			Dry		
	No. of wells	AOD ^A	ACD ^B	No. of wells	AOD	ACD
Nesal	6	32.5	47.3	5	31.8	56.0

		(100) ^c	(146)		(100)	(176)
V'Puram	8	19.5	46.9	6	15.0	47.7
		(100)	(241)		(100)	(318)
V'sambanur	6	14.0	44.5	7	14.3	43.7
		(100)	(318)		(100)	(306)

Notes:

(a) AOD refers to the Average Original Depth - Average of the sample wells;

(b) COD refers to the Average Current Depth;

(c) Figures in the brackets denote the percentage variation between the average original and the current depths.

Source: Survey, 1993-95

5. The Impact of the Secular Lowering of the Water Table on the Agrarian Economy

The impact of the competitive deepening of the wells and the progressive lowering of the water table can be broadly identified under the following three heads: i) the effect on agriculture, ii) costs involved and iii) the institutional implications.

5-1. Effect on agriculture:

The yield of paddy reflects the impact of the falling water table conditions on agriculture. In 1973, it was 2.66 tonnes per hectare, but it includes more than 50 percent of the area cultivated under the traditional varieties whose yield - at 2.5 tonnes - was considerably less than the yield of HYVs - at 3.56 tonnes. In 1993,

however, the area under HYVs was almost one hundred per cent. Therefore, a simple comparison of the yield of the HYV in 1993 (which was 3.88 tonnes) shows that yields have increased by only 8%. The yields of paddy in the three villages may be compared in Table 8. The yield in Nesal is highest (4.2 tonnes) followed by Vinayagapuram (3.1 tonnes) and Veerasambanur (3 tonnes). Such yields corroborate the general irrigation scenario and in particular the steeper decline of the groundwater table in Veerasambanur.⁸ The comparison of the area irrigated by the sample wells when it originally dug and area irrigated in 1993 also indicates a high incidence of wells irrigating a reduced area.

Table-8 Yield of paddy in the Study Villages, 1993-4

(in kilograms per hectare)

Village	Season		
Nesal	4278	samba	3388
Vinayagapuram	3111	navarai	4326
Veerasambanur	3023	sornavari	3953
Weighted av. yield			3881

Source: Survey, 1993-94.

⁸. However, the possibility of errors in our data which might have caused such a big difference in the yield level between Veerasambanur and other villages cannot be ruled out.

The development of non-farm employment in silk weaving is yet another important change, which is the direct off-shoot of distress in agriculture caused by the combination of factors such as the continuous falling of the water table and the persisting drought conditions of the 1980s.⁹ Although the art of silk weaving is considered to be the occupation of a particular group of castes, in recent times many agricultural castes such as **Agamudaya Mudaliars**, **Vanniars** and **Yadavas** have also entered the occupation. From our census, weaving has been reported to be the main occupation of 8%, (63 people in Nesal), 16% (106 people in Vinayagapuram) and 9% (26 people in Veerasambanur). Since 1993, the number of weavers appears to have gone up considerably. Practically none had reported weaving as the main occupation in earlier surveys. Weaving provides the buffer during the times of agrarian crisis (Nagaraj et al., 1996). The agrarian crisis in the state generally and in the study villages in particular, has been caused by the persistent drought conditions of the 1980s.

⁹9. For a detailed discussion of this issue see Jayaraj, 1996.

10. The other major non-farm employment which was virtually non-existent in 1973 is the significant numbers of rice mill **coolies** (Scheduled caste workers) and hulling merchants in Nesal (Agamudaya Mudaliars who commute to Arni every day) and female twisting factory workers in Veerasambanur who commute to Devikapuram town).

“The obverse of this phenomenon, viz., the possibility that weaving provides the buffer in a period of agrarian crisis - points to an important dimension of the agriculture - weaving linkages, viz., the role played by agrarian distress - of agrarian differentiation more generally - in the emergence and growth of silk weaving in and around Arni. Our village survey revealed that the overwhelming proportion of weavers who had some links with agriculture were from the poorer strata of the peasantry. This points to the possibility that agrarian distress would have played a role in the shift to silk weaving made by these households. Our general enquires in the village revealed that this indeed was the case, particularly in the first half of the eighties. While a spell of bad monsoons in the early eighties was the proximate factor behind the distress in agriculture - and hence the shift to weaving - the longer term of process of agrarian differentiation appears to have played a major role here”, (Nagaraj et al., 1996, pp. 67-69).¹⁰

5-2. Cost implications:

The competitive deepening resulting in the progressive lowering of the water table has enormous implications for costs, not only for individual farmers but for society as a whole. First, consider the social costs involved. Future generations are badly affected as there exists a danger of complete loss of access to

groundwater due to over-pumping and to the increasing mismatch between the rate of water extraction and recharge. Moreover, over-pumping may cause underground sea water intrusion in coastal areas, a fate already looming over the southern coastal regions of Tamil Nadu. Most important of all is the rising unit cost of water pumped to the surface. Another major social cost incurred by society is expenditure on energy generation and distribution for agricultural purposes. In the state of Tamil Nadu, the electricity consumed per electrified pump set has gone up from 2501 units in 1980-81 to 3897 units in the year 1992-93 (a rise of 56% over a period of 12 years). This cost is entirely born by the state, in other words by tax payers.

The cost incurred by an individual well owner is ever rising in real terms. The investment in well-digging, in the construction of pump set sheds, the installation of pump sets, pipelines, further improvements to the wells such as deepening, installing vertical and horizontal bores and so on, all increase. In recent times, considerable investment is going into the laying of pipelines, a technique which the farmers are forced to adopt to preserve wastage from seeping and evaporation. In Vinayagapuram, twelve farmers had invested in pipelines. Elsewhere, hose pipes are mostly used for water conveyance. This is a phenomenon of the nineties. Although we have not investigated the costs of the various components of well irrigation as incurred by an individual well owner, research elsewhere in Tamil Nadu shows that it exceeds the per unit area of surface irrigation by major and medium irrigation schemes (Janakarajan, 1996). According to the Report of

the Working Group on Major and Medium Irrigation Programme for the Eight Plan, Government of India (1989), the amount spent per acre of irrigation potential created during the Seventh Plan (1985-1990) is Rs. 14,700 (Rs. 36,240 per hectare), whereas according to the study on wells conducted in the Vaigai basin, it is Rs. 32,600 per acre or Rs. 80,000 per hectare of net area irrigated. *Private well irrigation is about two and a quarter times more costly per unit area than is surface irrigation.* If we also add the costs incurred on failed wells the multiple would increase. According to Nagaraj et al. (1994), the probability of well failure is 0.4 in the hard rock zones such as those of our study region.

5-3. Institutional implications

The process of differentiation is the most important institutional implication. Available evidence suggests that differentiation is intensified by competitive well-deepening and the secular lowering of the water table. As more and more resource-poor well-owners are excluded from the race of competitive deepening, a few emerge to monopolise the precious groundwater. The conditions of such resource-poor well-owners is precarious. The process of differentiation is accelerated by competition for water in at least two ways. First, a significant number of producers have lost access to land through debt due to their expenditure on wells. We have recorded a good number of cases of those who have lost their land - either fully or in major part - due to heavy investments in wells. Second, many of those who failed in the race of competitive deepening resort to the purchase of water at high rates. They also enter into complex contracts mediated

by both price and non-price means. The nexus between water sellers and water purchasers and the manner in which the water market is interlocked with the labour and product markets is documented in Janakarajan, 1992. Apart from charging a price for the water supplied, there are two other measures used to extract surplus; i) by commanding underpaid and unpaid labour services of water purchasers and ii) by compelling water purchasers to lease-out their parcels of land in favour of water sellers on arbitrary terms (the case of 'reverse tenancy'). Some have been forced to sell tiny parcels of land. The incidence of reverse tenancy and forced sale is significant in Vinayagapuram and Veerasambanur.

The consequences of the secular lowering of the water table and of the competitive deepening for a given well owner depend at least partly on the emergence of non-farm employment mediated by agrarian distress. The escalating cost of wells, however, was the most striking proximate impact. The process of differentiation is accelerated due to the ever rising investment in wells.

6. Summary and Conclusion

This paper traces the development of an agro-ecological crisis in the agrarian economies of three villages over two decades. Though 1973 (the year of the first survey) has been kept as a reference period for the sake of comparison, we have traced the events as far back as possible. The present status of the traditional irrigation institutions (tanks and springs) is discouraging, as they are in disuse or decay in all the villages. It is the complex interaction of several technical,

socio-economic and institutional factors which is responsible for the disintegration of the traditional irrigation institutions. The introduction of the HYV technology and the concomitant spread of well irrigation are the two crucial factors contributing to the decay of traditional irrigation sources.

The massive spread of mechanised private lift irrigation over the past two decades was to a great extent facilitated by the electrification of the villages, and though it contributed significantly to agricultural production, has had adverse impacts on the lowering of the water table. As a consequence, there have been an escalating investments in wells, increasing social costs and depressed returns to agriculture. The combined effect of all these events has accelerated differentiation in these villages.

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