THESIS

PLAN B

An Analysis of Common-Pool-Resource in an Institutional Economics Framework: Evidence from Tank Irrigation and Group-Owned Wells in South India

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ABSTRACT

An Analysis of Common-Pool-Resource in an Institutional Economics Framework: Evidence from Tank Irrigation and Group-Owned Wells in South India

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Tanks are man made reservoirs formed by putting crescent shaped earth embankments across the drainage flow to capture and store heavy runoff from concentrated monsoon rainfall. Tank water reaches fields by gravity flow through sluices. Tanks, which were once the largest form of irrigation in South India have declined in importance and are in state of disrepair. This paper synthesizes the disparate strands of thoughts prevailing in the Common Pool Resource literature while analyzing tank and well irrigation in South India. Particular attention is given to the fact that tanks are a part of the village 'public domain' through which social relations are articulated, reproduced and challenged (Mosse,1997).Group Owned Wells are discussed as an alternative, though they do share some common features with other CPR's. Findings suggest that social norms and peer pressure are effective in facilitating cooperation in managing the irrigation wells.

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1 Introduction

1.1 An Overview of Common-Pool-Resource (CPR)

The pervasiveness of common -pool resources (CPR) and recurrent observation of their misuse has caught the attention of analysts all over the world. Common Pool Resources are characterized by the following defining attributes (Ostrom, 1993b):

(1) The difficulty of excluding individuals from benefiting from the good

(2) The subtractability of the benefits consumed by one individual from those available to others

(3) A system that is better managed as a whole and when its appropriable benefits have marginal cost equal to zero up to a point.

Fencing and packaging are the ultimate physical means of excluding potential beneficiaries from a good. However, for these to be effective, fencing and packaging efforts must be backed by a set of property rights that are feasible to defend in an economic and legal sense. It therefore follows that the legal and economic feasibility of excluding or limiting use by potential beneficiaries is derived both from physical attributes of the goods (Situation) and from the institutions (Structure) used in a particular jurisdiction.

As for example in the irrigation context, exclusion cost is non-trivial. In some cases the high cost of exclusion is due to the size of the water delivery facilities and the flow nature of water. In others, legal doctrines or government policies mandate that whoever cultivates land within certain areas is entitled to water regardless of contribution. Also, water is subtractable and the flow of water available at any one time in an irrigation system is scarce in an economic sense. These two features—non-trivial exclusion and subtractability---define a CPR as discussed above.

1.2 Classifying CPR: Appropriation versus Provision

CPR problems can be classified into two broad categories:

1. Appropriation

2. Provision

In appropriation problems, the production relationship between yield from the CPR and the level of inputs required to produce that yield is assumed to be given. The problems to be solved relate to excluding potential beneficiaries and allocating the subtractable flow. This is brought about by various means, including agreement on the level of appropriation, the method for appropriation and the allocation of output.

Provision problems on the other hand are related to creating a resource, maintaining or improving the production capabilities of the resources or avoiding the destruction of the resource. An analysis of provision problem begins by considering an optimal size and productive nature of the resource facility in relation to the cost of providing that facility and the set of beneficiaries to be included. Provision problems focus on the behavioral incentives for appropriators to

a) Alter appropriation activities within an existing CPR that alters the productive capacity of the resource (demand side provision)

b) Contribute resources for the provision or maintenance (supply side provision)

Depending on the specific characteristics of the situation, provision problems may be represented as one-shot games or time-dependent repeated games.

1.3 Situation or Dilemma?

Individuals jointly providing and/or appropriating from CPR's are considered to face a universally tragic situation in which their individual rationality leads to an outcome that is not rational from the perspective of the group. This behavioral result is called a CPR dilemma. However, many CPR situations are not CPR dilemmas. In some CPR's, the quantity demanded of resource units is not sufficiently large that appropriators are motivated to pursue individual strategies that would produce sub-optimal outcomes. Or cooperation emerges even when resource is scarce. When a CPR dilemma does exist, a resolution of the dilemma requires a change in the provision and/or appropriation facilities. One type of solution is for resource users to evolve a set of coordinated strategies related to these.

1.4 Research Objectives

This paper is motivated by the observations on the history of cooperation in the case of Tank Irrigation, a common -pool resource, in South India for centuries until the recent demise of the system. Particular attention is given to the fact that tanks are more than just sources of irrigation water, but a part of the village 'public domain' through which social relations are articulated, reproduced and challenged (Mosse, 1997a). The paper argues for a more historically and politically grounded understanding of resources, rights and entitlements. It is an attempt to bring together the widely disparate strands of thought prevailing in the literature.

The degradation of tanks as a mode of irrigation has brought into prominence group owned wells as an alternative. Group-owned-wells are another example of a common- pool resource. Mathematical models suggest that institutional factors like differential access to credit, group heterogeneity, social norms and even peer pressure are important informal mechanisms of cooperation. A short review is done for some of these models. The results are evaluated in an empirical background and using the concepts from Institutional Economics, Behavioral Regularities and Social Capital.

The following section elaborates, compares, and evaluates the issues using a common Situation-Structure-Performance (SSP) framework (Schmid, 1987). Can the reflections on one mode of irrigation offer insights for the others? Can tanks and group-owned-wells be complementary rather than competing solutions to the irrigation issue in rain-fed, semi-arid region of South India?

The paper is organized as follows. Section 2 starts with a brief review of literature; covering the purely verbal, econometric and the most recent ones in game theoretic terms. Section 3 briefly touches on the specifics of irrigation needs and potential in the Indian context. Tanks as the traditional mode of irrigation are discussed in Section 4. Section 5 deals with group owned wells, which have emerged as an alternative. In section 6 the Situation-Structure-Performance (SSP) framework is used to evaluate the issues. Section 7 is the concluding section and deals with some open, unanswered questions and policy implications.

2 Literature Survey

There are several documented examples of successful local community water management and at the same time there are numerous instances of failure of co-operation, leading sometimes to an anarchical scramble for water. The empirical literature ranges from purely descriptive to game-theoretic and econometric.

The usual game-theoretic models of cooperation among self-interested agents in repeated situations of strategic interdependence provide some useful insights. Ostrom (Ostrom et al 1993b) suggests that adding the behavioral assumption of bounded rationality add more explanatory power to the models. However, in view of their admissibility of multiplicity of equilibria, many of the comparative static questions cannot be satisfactorily answered without recourse to contextual data analysis.

Taking account of these pitfalls, a pioneering study was done by Bardhan (Bardhan, 1993) recently which concentrated on a quantitative analysis of the physical, institutional, and socio-economic determinants of cooperation in tank irrigation communities, based on a large survey conducted in the South Indian state of Tamilnadu. Three alternative variables were chosen as performance indicators of cooperation within the community on matters of irrigation:

a) Quality of maintenance of distributaries and field channels

b) Absence of conflicts in water allocations

c) Extent of violations of water allocation rules

The explanatory variables among others also include number of users and both social and economic variables. The rationale for including the first draws on the studies of Olson (Olson, 1965) and Ostrom (1990). Olson had suggested that it is easier to organize small groups. Weissings and Ostrom's (Ostrom 1990) theoretical model show that in the equilibrium an increase in number of irrigators is associated with an increase in stealing of water.

The results show that co-operative behavior in an irrigation community is by and large significantly related to inequality of land holding, to urban or market connections and (positively) to duration of access to water, monitoring by guards, and in some cases to social homogeneity, small group size, and collective adversarial relation with other villages over water.

2.1 Gap in Literature

There is a considerable amount of literature on the management of the tank and canal system of irrigation in India and on the structure and practices of irrigation bureaucracies. However, economists have only recently started paying attention to issues of local community level co-operation and other institutional arrangements that are the key to substantially improving the existing level of utilization of irrigation potential. Community institutions can have various functions in different irrigation systems. For example, they aim at pooling efforts and resources in constructing and maintaining field channels at the local outlet level, at regulating water allocation and monitoring violations (like the appointment of a watchman/guard), at controlling ground water over exploitation with privately owned pumps in areas with fragile acquifiers. In case of tank irrigation apart from these, community institutions also look after weeding, desilting and stopping encroachments on tank beds. Econometric analysis has shown that socio-economic factors like caste composition and landholding patterns of cultivators in command area affect their ability to organize, but not many studies look at the issue in an analytical framework. What is very important here is to note that tank irrigation is not just a physical relationship. It is symbolic of an underlying social structure. A theory developed in the laboratory of experimental economics might give a useful starting point but cannot be generalized. This will be obvious when the distinguishing features of the village tanks are analyzed.

2.2 Can Social Capital bridge the gap between Game Theory Predictions and Empirical Studies?

Local community level water management is crucial for rural development in the poorest part of the world. While the polar opposite of state and the private markets dominate the limelight in development debates, less attention is paid to the small-group voluntary organizations at the local levels which may avoid the 'failures' usually associated with the two poles and may lessen the severity of some agency problems while achieving more equity. In case of tank irrigation small groups small groups look after this is done by:

1) Desilting

2) Weeding

3) Stopping encroachments on tank beds

4) Regulating water allocations

5) Monitoring

Schmid (1994) in a review of Otsuka and Hayami's book, "Land and Labor Contracts in Agrarian Economies: Theories and Facts", notes that when one observes all of the blood that has been shed over land one suspects that land is not just an ordinary commodity. Land stimulates the emotions, which are both a source of conflict and cooperation, with social capital substituting for tangible and more costly monitoring and incentive inputs. It is important to understand the conditions working for and against the sustainability of cooperation, in situations of economic and social interdependence.

2.3 Cooperation Game Theory

1. Prisoners Dilemma

Since its conception in the 1950's, the prisoner's dilemma has attracted the attention of game theorists. The game encapsulates a particular collective action problem in which individual rationality may generate inefficient outcomes. In the matrix shown below, the payoffs of the game obey T>R>P>S and 2R>T+S. For both players, d is the dominant strategy such that dd is the unique equilibrium of the one-shot game that is Pareto-dominated by cc.

Farmer 2 --→ Farmer 1 |	cooperate(c)	defect(d)
Cooperate(c)	R,R	S,T
defect(d)	T,S	P,P

Game theorists have sought to explain cooperative behavior in the game observed both in the real world and in the laboratory experiments using standard assumptions. Finite iteration of games yields dd as the unique Nash equilibrium in every round using backward induction.

In finitely repeated games, the Folk Theorem shows that cc can be part of some multiple equilibria. This is cooperation arising from a self-interested calculation of the benefits and the losses that may accrue from 'polite' behavior. One way to conceptualize this in the theory of repeated games is that the game is played a finite but indefinite number of times. For example, one could imagine that after each round of play a roulette wheel is spun. If it comes up 0 or 00 (2 chances in 38) the player quits; otherwise the game is played for another round and the wheel is spun another time, and so on. In more general terms, if 1-q is the probability that the game is stopped after each around and q is the probability that the game is continued for at least one more round then, the expected value of the sequence of pay-off's $\{u_1(1),u_2(2),u_3(3),\ldots\}$ for player 1 is $\Sigma^{\infty}_{i=1}\ q^{I-1}\ u_1(I)$ for $q \in (0,1)$, assuming players maximize their expected sum of payoffs. These are variations of the general notion of a super game, where in a particular game called the stage game is played over and over by two players. The problem in repeated game is a profusion of equilibria. Any pair of payoff that is feasible and gives each player more than zero apiece can be sustained in equilibrium. This statement is completely correct in an infinite horizon, undiscounted formulation. For discounting or a finite but indefinite horizon this needs a little amendment. A result where one player is left at a value too close to zero cannot be sustained in equilibrium. Each must have enough stakes in maintaining the equlibrium so a one-stage defection (followed forever by zeros) is not better than carrying through on the agreement. Roughly put, the general result says that any feasible expected payoff can be sustained in an equilibrium as long as each player has expected payoff at least as large as what the player can guarantee for himself even if all the other player gang up on him. Then, no single player, acting alone has an incentive to deviate; the condition necessary for a Nash equilibrium. This result is known as the *folk theorem.*

The case is illustrated with some hypothetical numbers:

Farmer 2---→ Farmer 1 |	Cooperate	Defect
Cooperate	3,3	1,4
Defect	4,1	2,2

The literature on cooperative action has been characterized by a pervasive pessimism on cooperation. The theoretical underpinning of the literature is the classic one-shot prisoner's dilemma in which defection or non-cooperation is the dominant strategy of each player regardless of what the other player chooses. But the constellation of costs and benefits of collective action on common pool resources such as water is often of a kind that is much more favorable to the possibility of cooperation than the prisoner's dilemma game. Take for the example the next case:

2.<u>Chicken or Hawk and Dove Game</u>

Farmer 2---→ Farmer 1 |	Cooperate	Defect
Cooperate	3,3	2,4
Defect	4,2	1,1

The two neighboring farmers are pondering the issue of who will carry out the essential maintenance work on the irrigation ditches which both use. Either the farmer can do it himself or each of them can free ride (which they prefer of course). The literature usually jumps to the extreme case of PD after referring to free riding. But in the case of many vital common pool resource, such as water, the consequences of defection on part of both agents are so bad that either of them would rather do the work himself if the others did not. 'Defect, Defect' is not the dominant strategy. There is no dominant strategy. Of course, in this case, pre-commitment to an aggressive strategy is individually advantageous and the powerful people in the village may resort to this, but at least the necessary maintenance work will get done if the sucker does not rebel.

3.<u>Assurance Game</u>

Farmer 2---→ Farmer 1 |	Cooperate	Defect
Cooperate	2,2	-1,1
Defect	1,-1	0,0

There are cases, however, in which an individual farmer cannot by himself do the whole job and the extra benefits from the part of the work done by him do not fully cover his costs. In this case, each farmer cooperates when the other does and defects when the other defects. This is the assurance game, which captures a widely observed phenomenon in the field studies: nobody wants to be 'suckered', but one tends to be cooperative when the others are, something which PD fails to capture.

Even in the PD game, the earlier pessimism is modified in the repeated game theory literature (Axelrod,1985) where it is shown that the cooperative equlibria can be spontaneously sustained by the long-run interests of foresighted self-interested individuals. The possibility of cooperation will, of course, depend on the future pay-offs not being discounted too heavily or the short run rewards for defection (such as for stealing water) not being too large. The proofs of the relevant theorem in the literature of discounted multi-person repeated games work on the basis of the possibility of administering sufficient punishments over time to outweigh the immediate benefits for the defectors and for these punishments being credible. But therein lies the second order collective action problem, since punishment is costly to the punisher, while benefits are distributed diffusely in the community. The primary task is to devise strategies that punish the player who fail to play his part in punishing the defector –i.e. the rules of what can be called meta punishment.

Elster (discussed in Bardhan, 1993) has raised a question about such meta-punishment rules: do people really punish others when they fail to sanction people who fail to sanction people who fail to sanction a defector? In a large community it is quite likely that sanctions run out of stream at two or three removes from the original violation. But in the small community of irrigators, meta-punishments may not be unreasonable.

Axelrod's work also lays down the path of integrating social capital into economic decision making. The strategy he suggests is 'Tit for Tat'. A person always initially cooperates but would respond to a defection move with his own defection move. The broad conclusions that he draws from the analysis are:

1) Cooperation can get started in a world of unconditional defection (everyone following a policy of always defecting). It can evolve from small clusters of individuals who base their cooperation on reciprocity and have even a small proportion of their interactions with each other. But it cannot emerge if such individuals are too scattered and have a negligible proportion of their interaction with each other.

2) A strategy based on reciprocity can thrive in a world where many different kinds of strategies are being followed (robustness).

3) Cooperation once established, can protect itself from invasion by less cooperative strategies

Axelrod provides 4 suggestions for doing well in an iterated Prisoner's Dilemma:

(1) Don't be envious of the other player

(2) Don't be the first to defect

(3) Reciprocate both cooperation and Defection

(4) Don't be too clever

With both conscious foresight and the ability to shape their environment, human beings can actively promote cooperation. Axelrod suggests five broad ways of doing this:

1) Enlarge the shadow of the future. In other words, arrange the future so that possible future interactions are sufficiently enlarged.

2) Change the payoffs

3) Teach people to care about each other

4) Teach reciprocity

5) Improve recognition abilities.

The theoretical models point to a potentially large number of equilibrium outcomes in which players may use observed past behaviors of others as a guide in their choice. In other words even when costs and benefits of cooperation are otherwise identical, the degrees of trust the players have in each other can play a crucial role. Bardhan points out that when trust matters for the possibility of cooperation, the equilibrium is more negotiation-proof since the reputation loss in a breach of trust will make it difficult for the violators to persuade the others to let bygones be bygones. This ensures that punishments are more credible.

2.4 *Limitations of these studies*

While game theoretic models give important insights into the sustainability of cooperation among self interested people in situations of strategic interdependence in the management of CPR like water, it is important to recognize that these models divert attention from salient issues in real world cooperation.

1.They cannot usually handle the impact of ongoing interaction among agents

2.Group Dynamics is ignored which through deliberation and persuasion may bring about endogenous preference changes and reorientation of values in a community.

3. The language of PD theory as Sen (1987) has pointed out makes it hard to discuss behavior patterns which in adapting to the recognition of mutual interdependence go beyond what Sen calls 'self goal' choice and work towards the enhancement of the respective goals of the members of a group. Such social norms may be particularly useful in a small water community of a village.

4) As Wade (1988) notes in his field study the villagers were not particularly morally motivated, they were more pragmatic, but their self-interest was usually coupled with the moral capacity to recognize the related claim of others. Such social empathy, even sympathy and commitment, if it induces reciprocal behavior, may be instrumentally useful in the general pursuit of self-goals.

3 Origins and Historical Development of Tank and Well Irrigation

Tank irrigation can be traced back two millennia in Tamilnadu. There are references to tanks in the Sangam literature from the early centuries A.D. Stone inscriptions referring to specific tanks are available from the eighth century A.D. 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.

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 the numerous petty chieftains. After doing a historical survey of tanks in India, Meinzen-Dick concluded that, "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 small works like temporary dams. The pattern of irrigation development through the ages has arisen from the condition facing each type of sponsor over time."

The scope of irrigation development increased over time. New works integrated numerous existing tanks and channels through construction of dams and permanent 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 surface water.

During the colonial rule, the Britishers were more directly involved in the collection of revenue and had greater extractive power than their predecessors. 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. The productive capacity was based on the type of soils and irrigation using the following criteria.

Classification of Irrigation Quality for revenue Assessment

	CLASS DEFINITION
1	Perennial source
2	Supply for 8 months and over
3	Supply for 5 months and over but less than 8 months
4	Supply for 3 months and over but less than 5 months
5	All sources giving supple for less than 3 months

Source: Meinzen-Dick, 1984, p16

Most system tanks in South India were designated as irrigation class3. No separate water cess was charged; rather, payment to the government was included in the land revenue. Land irrigated by wells was assessed as dry land unless tanks and channels also irrigated it. Surface irrigation has been estimated to have produced more than 50% of the revenue. 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.

The increase in private wells in 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 high labor cost of raising water, well irrigation was usually reserved for high value crops. For this reason the growth of well irrigation is both historically and socially linked to the development of commercial agriculture. The British government favored well irrigation and assisted farmers who dug wells by not taxing well-irrigated land any more than equivalent lands without well and by furnishing equipment for boring.

When India achieved Independence in 1947, much of the framework of the British administration was retained. Initially, the revenue and Public Works Department (PWD) shared responsibility for tanks but 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 operation and maintenance of tanks. Only the activities below the tank bund--such as distribution of tank water and maintenance of field channels are formally left to local cultivators.

4 Tank Irrigation: Legacy of Colonial Rule

Tanks are natural or man-made water reservoirs, usually bounded on three sides by earthen 'bunds'. They are simply earthen constructs that store surface run-off. Water is distributed to the fields below the tank by gravity flow through a variable number of sluices. The nature of drainage often links individual tanks into local chains and to perennial or temporary water and streams. The broader concept of 'tank system' includes these wider linkages as well as the relationship of tanks to catchment areas, and to groundwater supply. Tanks therefore have a range of functions beyond irrigation, like percolation and ground water recharge, flood control, silt capture etc. Hence, they are affected by changes in a wider resource complex including changes in inland use, cropping patterns etc. Many of the tanks in South India are centuries old and have been historically managed by autonomous local bodies. Their importance can be gauged from the fact that even as late as 1990-91 tanks irrigated 8 million hectares of land in the semi-arid region of South India.

4.1 The Historical Setting

Tank irrigation and settlement expanded in South India between the fourteenth and sixteenth centuries as the southern plain area was integrated into a region-wide warrior polity. Tank irrigation systems did not come into being as autonomous village systems isolated from the state. Tank works were a part of the political process in which rival chiefs extended and maintained domains of control. Rights to control the tanks or to control the flow of water were frequently the objects of royal donation and largesse. For example as early as in 1654,a deed from Rengunatha Chethputhi (king of Ramnad) granted the entire water rights of the Tenar, seasonal river, to Periyatampi, a Cervai caste chief ,to fill tanks of Unjanai area of Sivagangai (Mosse 1997a). History matters (North 1993). Even under the British rule, the former kings continued to treat productive resources(land and water) as political assets to *rule* –i.e. to gift, exchange and redistribute –rather than as property to be managed for profit. A series of litigations over royal successions further diverted resources away from tank maintenance. The idiom of royal grant and entitlements in articulating informal rights over water flow persists even today.

It is also important to note the co-operative water ties between villages. In relation to need, water is always unevenly distributed across the local inter-lined tank systems. Locally specific factors of rainfall, hydrology and cropping produce conditions of surplus and scarcity. In response to this there was an informal market in which water common property is traded (as well as gifted and exchanged) and transferred between villages over large distances (up to 40 miles) through complex networks of channels. These transactions presuppose some social connection that involves relationships of kinship and caste. Leaders with wide-ranging influence act as 'water brokers' arranging purchase of water and its delivery or sale to villages en route. The point to emphasize is that while at one level a tank is an irrigation structure, at another it has long been a public institution expressive of an order that implies relationships of dominance, dependence and caste rank.

The problems arising from CPR's is exacerbated, as it is not just the tank water that is the object of concern but also that fact that tanks and wells are used in conjunction. Tanks and wells are interdependent forms of irrigation depending on a common ultimate source of water: runoff in the catchment area, often channeled through the 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 management system.

Also, tanks and their catchment are not static physical or social systems. Breaches, diversions and new watercourses evoked competing claims to titles that required constant arbitration in inter-village disputes.

In some cases it is the intervention of the state and its assertion of well defined 'property rights' over CPR that is the cause of the demise of the traditional system of resource use. Tanks, which till late 1970's formed the single largest form of irrigation are in a state of disrepair, are silted up, are encroached upon, their sluices damaged, their embankments and weirs broken. The question is why, when property rights are now securely and legally with the state governments? To answer this question, one first needs to look at how this CPR was managed through centuries and escaped the 'tragedy' that other commons are hypothesized to suffer in the absence of secure property rights. What was it that necessitated the redefining of property rights and led to the present scenario? Is it that tanks systems never simply change, they *decay*? Is it that the social, political and economic forces do not underpin, reproduce or extend these systems, they simply erode, dissolve or undermine them (Mosse, 1999)?

4.2 Kudimaramat[1]: *'Village Repairs' and the Colonial Construction of Community Management*

[1] The term *Kudimaramat* is a composite of Tamil kuti—'inhabitant' or 'subject' and the Arabic maramat meaning 'repairs'

The idea of autonomous village irrigation management or maintenance systems has provided a key element in tank development policy in South India for hundreds of years. *Kudimaramat* was the 'village repair or maintenance works'. The hierarchical caste ordering provided a set of rules for the required division of labor.

The water distribution system was not just a set of allocation rules but rather a service *relationship* involving 'Pallar' caste water turners (*nirappaccis*) paid by farmers is grain or cash on a per acre basis. They opened and closed the tank sluice and distributed water in the fields. . The water turner role is an inferior public office whose status is derived from its position within an older pre-colonial caste based social order. Pallar public roles involve them with marginal, and dangerous spaces, for example as gravediggers and woodcutters.

Tanks provided resources like water, trees and fish, which generated economic capital. The present day literature on CPR would classify this as a multiple use CPR, where the stakeholders have differing interests and the distribution of power is asymmetrical. The very factors which are considered to be behind the CPR's today helped the tank system not only survive but be the all important source of irrigation in the semi arid region of South India. First of all, the money from selling fish, wood and other tank resources was always invested in the maintenance work. The question that comes up is how was the monitoring problem of seeing that the resources were actually being channeled into the right place taken care of? The most important reason was that investment in protection, construction or repair of irrigation tanks generated 'symbolic capital' in the form of honor or authority and created domains of influence for political leaders. The caste hierarchy and the associated status symbol is just one way of selectively unhorsing the free riders. In fact it creates joy riders[2] so that the maintenance work is dutifully attended. These leaders also act as water brokers in times of local shortage of water, arranging the purchase (or gift or exchange) of water and its delivery or sale. The crucial success is the accumulation of the 'symbolic capital' in the form of social position, honor and authority necessary to mobilize individual and communal labor and to produce dependent roles to work and irrigate field in a highly concentrated labor period.

These very factors created room for opportunistic behavior. The 'inferior service' label associated with opening and closing of the sluices by the Pallar bargaining position stronger. They were the 'owners' of these services and the social structure gave them a monopolistic position. The power structure began tilting. The economic need for water turner roles has resulted in renegotiation of wages, the redefinition of duties in socially acceptable terms. The changes in payment, roles and obligations involved are part of a wider negotiation of identity and status among low caste involving a shift towards non-hereditary, non-caste specific contractual forms of employment. In Independent India, this power relationship was completely done away with as the modern state acquired property rights. But with this also died the custom of self-maintenance to tanks. As Bardhan points out, a 'difficult transition' is underway in which 'traditional cooperative' institutions are on a decline while participatory alternatives have yet to take root.

Modern Water Users Association

The modern day government tried to reinvent the kudimaramat custom by forming the Water Users Association. However, it failed to achieve the desired

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[2] Schmid applies the term joy rider in the context of high exclusion cost good to describe the people who value the game participation and relationship with others irrespective of the instrumental and substantive

objectives. These development associations are based on the assumption that collective action arises from the association of free and independent appropriators bound by consensus rule. There is an assumption that water users association is going to be narrowly functional bodies sustained solely by the benefits of better water supply. This differs markedly from earlier indigenous tank management where memberships of institutions and rights in resources have to do with social identity, position and status of actors. In the past, where publicly accepted norms and their use often serve to exclude the poorer, low caste, female and tail-end farmers. Field research shows that these water associations become political institutions especially given their role in dealing with tank resources and linkage to external authority and material and political resources. They were more democratic and open to forming excluded groups. An example will illustrate the point. In one of the villages in Tamilnadu, the recently formed tank association provided a major vehicle for both factional and low caste social mobility, as images of community were contested and redefined. In this instance upper caste Mudaliar and low caste Harijan members of the village evoked and manipulated ideals of community in pursuit of separate strategies of social change. Mudaliars sought to found the new water user's association on an old system of privileged 'shares' in the tank clearly indicative of their caste power and social dominance. Harijans perceiving the intent behind the new public service roles and institutions, challenged their own restricted participation , withdrew their support and labor or bargained for new privileges and rights of access to resources. For Harijans, 'community management' of irrigation implied (but concealed) social hierarchy and compromised an ability to negotiate their social position newly acquired in other areas of life.(e.g. in relation to agricultural labor and service relations

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outcomes. These people are a part of status transactions with others.

and other democratic political action). But community management could have other meanings. It was an ideal supported by external sources of power (NGO's tank project staff) which could support Harijan resistance to exclusion, and support their strategies of social mobility, and new access to resources or to protection of exiting rights.

In the case of tank irrigation by South India, the problem of dealing with sanctions when non-cooperative behavior was found was dealt with (Wade,1988). Even when punishment by exclusion is difficult, it is possible to impose fines, as happens in some South Indian irrigation systems. The available sanctions include fines of non-trivial amounts. The field's guards salary is set at less than the daily wage of an agricultural laborer so as to give him strong incentives to collect fines, for they keep all of the small fines and a fixed percentage of the larger ones.

5 Group Owned Wells, Groundwater Contracts and Informal Cooperation

With the demise of the tank irrigation system, groundwater through group owned wells has emerged as a highly valued factor of production throughout South India. Groundwater transactions between farmers who own wells and their neighbors have become quite widespread and are changing the dynamics of agrarian economy. For instance, in many villages of India, social and economic prestige is now more closely related to the depth of the well owned by the farmer rather than by the amount of land he owns. In many semi-arid regions it is now fairly common to observe the supplier of groundwater alone, receiving as much as one-half to one-third share of the total agricultural output. While there is huge literature on land, labor and credit contracts in South India, contracts in groundwater have received limited attention in spite of their growing importance (Aggarwal,1999).

5.1 Review of Literature on Contract Choice

In the theoretical literature on contract choice in agriculture, the insurance-incentive trade off (IIT) model has been used to explain the co-existence of pure fixed payment or pure crop-sharing contracts. The IIT model assumes moral hazard along a single dimension and a risk averse agent and thus explains contract choice as representing a trade-off between providing appropriate incentives and insurance to the agent. This model, despite of its theoretical popularity has received little empirical support so far. Another novel idea and model has been put forward by Aggarwal (Aggarwal 1995) which is called the 'double-sided incentive' (DSI) model. This assumes both parties to be risk neutral and hence abstracts from risk considerations. It explains the existence of a crop-sharing contract as a partnership arrangement in which both parties have incentives to self-monitor.

The double sided incentive problem in the second model follows from the problem alluded to earlier regarding the matching of irrigation deliveries by the water seller with the supply of other inputs such as labor, seeds and fertilizers by the water buyer. While the incentive problem in labor supply is well recognized in the literature, the incentive problem in the supply of irrigation by the seller has not been accorded so much attention. This latter incentive problem arises because of the high transactions cost of specifying, in the contract, the exact timing of the various irrigation applications under all possible contingencies. Given this incompleteness, the person who owns the wells (the water seller here) has the residual rights of control over all aspects of irrigation timing not specified in the contract. Therefore, while a crop sharing contract provides better incentives to the seller for provision of timely irrigation it provides less incentives than a fixed payment contract to the buyer for supply of labor and other inputs. Thus the choice of contracts in this model, amounts to trade off between incentive provision to the buyer and to the seller.

5.2 *Group Owned Wells and CPR's*

Group Owned Wells are not widely representative of common pool resource as is commonly thought to be. There are some differences that need to be noted:

First, ownership rights in terms of each person's share in the total water pumped out are very well defined. Second, the user group is small, group sizes rarely exceed 8 in most villages. Third, group members are neighbors and very often family related. These three conditions, which theory suggests as being quite favorable for emergence of cooperation, are rarely observed in other CPR's.

The study focuses on different activities in which group members interact in the process of use and management of existing group wells. These activities are: everyday allocation of water amongst group members and contributions towards investments in routine maintenance and investments in expansion of the productive capacity of the well. It is assumed that for each of these activities group members enter into various kinds of implicit and explicit agreements and the main thrust of the study lies in examining the transactions costs (such as those of negotiation, monitoring and enforcement) associated with these agreements.

The answers to the following questions are sought:

1) For each of the above-mentioned activities, what are the key characteristics that distinguish groups where collective action is observed from those where it is not?
2) Within the same group, why is collective action observed in certain activities while not in others?

In a recent pioneering study by Aggarwal[3], a mathematical model has been developed which gives insights into how social norms and factors such as guilt, peer pressure shame and empathy interact to create incentives within a group. This represents a big step towards formalizing these subjective notions into standard economic analysis. A variant of this model is presented below:

[3] The analysis is based on primary level survey results done for the villages Aurepalle and Dokur in a south Indian state (Aggarwal 1995,1999). Both villages have been part of ICRISAT's longitudinal village level program.

5.3 The Model

Let G be a group of N farmers. Let $e=(e_1, e_2, \ldots e_N)$, be an N dimensional vector of contributions, in the form of efforts or monetary units, towards some maintenance or expansion activity of a commonly owned well. The production function for this activity is given as f(e),where f(.) is concave and twice continuously differentiable. All group members in proportion to their ownership of common resource share the output from this activity. For simplicity it is assumed that all members have equal ownership shares so that output is divided equally between members. The cost function given by $C(e_i)$ defines the cost that member i faces when he contributes e_i. $C(e_i)$ is assumed to be convex and twice continuously differentiable.

Each member's maximization problem is then given as

$$(1)\ \underset{e_i}{Max}\ \frac{f(e)}{N} - C(e_i)$$

The solution to (1) is given by the following first order condition

$$(2)\ \frac{1}{N}\ \frac{\{\partial f(e)\}}{\partial e_i} - \frac{\partial C(e_i)}{\partial e_i} = 0$$

However, the pareto optimal level is given by

$$(3)\ \underset{e_1, e_2 \ldots e_N}{Max}\ f(e) - \sum_{i=1}^{N} C(e_i)$$

which gives the following first order condition

$$(4)\ \frac{\{\partial f(e)\}}{\partial e_i} - \frac{\partial C(e_i)}{\partial e_i} = 0 \qquad \forall\, i$$

Let e^* be the solution to (4) and e_o be the solution to (2). For N>1,it follows that e^* exceeds e_0. Thus because of free rider problem the contribution by the group falls short of the pareto optimal level.

5.C.1 Presence of Peer Pressure

In the presence of peer pressure, member i's problem in (1) above can be modified as follows

(5)) $$\max_{e_i} \frac{f(e)}{N} - C(e_i) - P_{iG}(e_1, e_2 \ldots e_N)$$

where P_{iG} (.) is the peer pressure function for member i $\in$ G.

In the specification above peer pressure cab be understood as an extra cost that member I faces being part of group G.

However, the peer pressure function is different from the cost function in a number of ways. While the cost function depends only on the effort contribution of the individual, the peer pressure function is social in the sense that it is a function of effort contributions of everyone in the group. Therefore, in deciding upon his actions, each member weighs the benefit from free riding with the peer pressure he would face if he violates the group norm. The outcome depends on the relative weight of these opposing tendencies. If there is no peer pressure, then the free riding equilibrium is observed. The higher is the extent of peer pressure, the smaller is the difference between actual contribution and group norm.

The peer pressure function can be defined in several different ways. In its simplest form the following formulation is considered to fix ideas.

(6a) $P_i = \gamma_i (q - e_i)$

Here γ_I is a non-negative constant, q is the group norm while e_i is the actual amount that individual i contributes. Here, peer pressure is the extent by which the individual falls short of the norm, irrespective of the behavior of others. In other formulations, peer pressure can be modeled in a way where peer pressure depends on the individual's own action as well as expected actions of others in relation to the norm. In that case the interpretation of γ_i will be the intensity of peer pressure felt by individual i.

5.3.1 Explanation

The intensity of peer pressure that an individual faces is likely to differ between the different groups of which he may be a member. It is likely to be higher in-groups formed between friends and family members. One explanation for this tendency is that when partners are friends or relatives, empathy is strong, so shirking results is significant guilt or shame. Also, in groups where members interact not just in sharing of the well but also in other social and economic activities, shame resulting from shirking is likely to be significant particularly in terms of its spillover to other activities.

An individual's decision on how much to contribute in (5) depends amongst other factors, on the expectation about the likely behavior of others. In situations where immediate benefits from defection are large, it makes a significant difference to the outcome, whether individuals cooperate anticipating similar behavior on the part of others or choose instead to defect without waiting for others to do so. In this context, the extent of 'trust' group members have in each other is very important. Trust can be defined here as the expectation by members of the group that others will cooperate. Frequency of past cooperation very often influences the extent of trust that group members have in each other. Thus, a history of past cooperative ventures is likely to be an important determinant of probability of future cooperation.

In a recent survey of literature on informal mechanisms of cooperation in irrigation systems, Bardhan (1993) points out that "water reform in the sense of building and promoting broad based community level institutions of cooperation from below (as opposed to government-mandated water users association) is at least as important as land reforms in rural development." If cooperation is more likely to be observed in certain activities than in others, then in thinking about water reform the relevant questions are regarding which activities should be left to the local people to enforce themselves and which activities need some kind of external intervention. These questions have become particularly relevant in recent years given the interest of many national governments to devolve some of the responsibility for management of natural resources to local groups.

5.4 Evidence on Determinants of Cooperation and Group Dynamics

5.4.1 Allocation of Water

Allocation of water among group members takes place according to some simple norms that have evolved with experience in group management of wells. First, each member's share in the total water pumped out is clearly defined by his ownership share in the well. Thus, or example, when a family subdivides, each of the sons get ownership of a certain fixed proportion of the land and the well owned by their father. Before the season begins they agree on the crops each will grow and the amount of water that will be withdrawn (in terms of number of hours that the pump is operated). Problems in negotiating the allocation of water are substantially reduced because paddy is the main irrigated crop in this area. Paddy has the following desirable properties that reduce conflicts in allocation.

First, it has the advantage of being a staple food grain and so is grown by both small and large landlords. Second, its growing season is short enough not to over strain the well capacity. Finally, unlike the case of other irrigated crops such as wheat) where the problem of irrigation timing is critical, in paddy the severity of the timing problem is reduced because of the continuous flooding of the fields.

It is very interesting to note that through the use of simple technology, allocation of water is carried out through rules that require low monitoring and relatively few conflicts. Thus for instance, for most wells, each co-owner has a separate pump from which water is pumped out. The horse power of co-owner's pumps corresponds to their respective share in the ownership of the well. All pumps are turned on and off at the same time and this reflects a roughly conflict-free allocation of water according to ownership shares. Installation of separate pumps is of course costly, hence such an arrangement was only observed in situations where co-owners were relatively rich and do not want to be richer or where the level of trust between members was low.

In instances where only one pump is used to draw water (as is the case with a majority of wells in Dokur), another interesting system is in use to allocate water. The water withdrawn is collected in a reservoir and a wooden plank with grooves is placed at the outlet. The number of grooves corresponds with the number of co owners and the diameter of these grooves correspond to respective share of the co-owners. As water flows through these grooves, it is automatically divided according to ownership shares and flows out through individual channels into the fields of the respective owners.

Unlike state managed systems of irrigation, these locally evolved systems provide much more flexibility with respect to changes in ecological systems. For example, during periods when the recharge rate of water is low, a system of sequential irrigation is used as opposed to the system of simultaneous irrigation described above. Under sequential irrigation, a rotation schedule is followed under which co-owners take turns to irrigate their field. The rotation schedule depends on the recharge rate of the well and irrigation requirements of the crop grown.

A special feature of the system is that everyone has retaliatory strategies that can be credibly imposed against the person who breaks these norms. It is difficult to empirically assess the extent to which retaliatory strategies are actually used. As Kreps (1990) notes, if a threat is really effective we will never see it actually carried out. Therefore, to indirectly examine the effectiveness of these threats as internal enforcement devices, sample respondents were asked whether they had ever resorted to an outside arbitrator (such as village headman or village elders) to resolve problems regarding allocation of water. All of these cases involved members belonging to very different caste categories who did not interact very much with each other. In general, everyday allocation of water was observed to be governed by a set of simple rules which were well enforced and which resulted in very few conflicts in allocation of water.

5.4.2 Routine Maintenance

A major expense in routine maintenance of the well in these villages is to periodically remove silt from the well. This is important in order to maintain the productivity of the well since wells in these villages do not have a stone or concrete lining. In single ownership wells it was observed that silt removing had been undertaken at least once every 5 years.[4]

Unlike the case of allocation of water, no simple widely followed norms were observed in case of maintenance activities. One of the reasons for this could be the limited frequency of these activities as opposed to the case of allocation of water which is an everyday task and hence allows for a lot of learning and experimentation to take place. Disagreements about whether maintenance expenditure was required or whether it was urgent or could wait till the next season., were observed to be very common. In the case of everyday allocation of water, existence of a set of widely accepted norm means that cheating is costly in terms of the peer pressure it induces. However, in case of maintenance activities, the lack of clear rules makes it difficult to define what exactly constitutes cheating. Thus for example, pumping more water than the group norm generally invokes shame and leads to some loss of reputation. However, late payment or non-payment of dues for maintenance activities is tolerated in many instances and does not significantly impair the relation between group members. It is therefore important to include peer pressure in any study.

Existing empirical research has primarily focused on the first question alone. Broadly speaking, it has attempted to explain why collective action is observed in some groups and not in others (Ostrom 1990,Wade 1988). In this study the analysis is carried a step further to see why even within the same group, collective action is observed in certain activities and not in others. The main idea behind looking at different activities

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4 In the survey questionnaire, information was collected on the number of times silt removing had been undertaken by the sample groups over the past 10 years. This was taken as a proxy for the extent of repair and maintenance carried out by sample groups.

within the same group is to get deeper insights on the role of factors such as social norms, peer pressure and reciprocal obligations in reducing transactions costs associated with these activities. Earlier studies have placed a lot of emphasis on the role of these factors in explaining cooperation in traditional rural societies (Bardhan,1993). However, it is not entirely clear from these studies how these factors work and how effective they are in different contexts. The study by Aggarwal (Aggarwal 1993) indicated that while the task of everyday allocation of water is managed very effectively, only a few groups have undertaken any major maintenance activities and fewer still have undertaken any major expansion activity.

5.5 *Credit Market Imperfections and Inefficiency in the Use of Local Commons*

An important factor that limits the capacity of agents to invest in CPR is access to credit. This is particularly so in cases where considerable sunk investment is needed in order to extract from a CPR. The extent of credit available through the formal credit market is generally rationed in most LDC's and is very closely determined by the amount of collateral (e.g. land or livestock) that can be offered. The residual demand is met in part through the informal market where the interest rates are much higher than in the formal markets. This implies that the cost of credit and hence the capacity to use a CPR is likely to differ across agents depending on their ownership of private assets.

In such a situation, the strategic choice of sunk investment as a commitment device in the first stage of the game is used to deter entry or force exit of other agents from the extraction game in the second stage. Since sunk investments are influenced by the cost of credit, heterogeneity amongst agents in terms of their cost of credit becomes an important factor in the analysis.

Under the law in India, landowners have the right to drill wells on their own land and pump out as much water as they desire. Given the huge subsidies on electricity supply, the marginal cost of pumping is very low. However, the fixed costs of drilling a well are very high because wells need to be deep in order to intercept water-bearing fractures in the substrata. The deeper is the well, the lower is the probability that the well will run dry at any particular time. Several studies have shown that the majority of small and marginal landowners have not invested in wells due to poor access to credit (Aggarwal 1996). In many areas, small landowners who invested in wells have been driven out over time as their wells are not deep enough and have become dry due to the rapidly declining levels of water table in this region.

It is important to recognize how the structure of property rights with respect to groundwater has affected the evolution of groundwater transactions. In India, as also in several other developing countries, property rights on groundwater are not well defined. Legally, as long as water remains underground nobody owns it. But once pumped to the surface, it belongs to the owner of the plot to which it is lifted. Thus, access to ground water is the prerogative of the owner of the land above and often entails a large and risky investment in drilling a well and buying the pumping equipment. Given the imperfect nature of rural credit markets, it is only the relatively large landowners that can get access to necessary credit. The situation is further complicated by the fact that the average farm size is very small, around 2 acres, and generally consists of two or more non-contiguous plots. Modern pumping technology, on the other hand, has a built-in indivisibility and has the capacity to pump water at considerably higher rate per unit of time than that required by even the relatively larger sized farms. Under such circumstances, an interesting institutional innovation in recent years has been the evolution of various kinds of informal agreements amongst well-owning farmers and their neighbors to buy and sell water for irrigation.

Agency theory has been used to explain a number of agrarian and other institutions. However, its applications in groundwater transactions is not much heard of. Groundwater as a factor of production has several unique features that makes this an interesting case. First, because of the physical costs of transporting water over huge distances, transactions in groundwater tend to be limited to neighboring farmers. Thus the market structure is quite different from what is observed for land or labor contracts. Second, for many irrigated crops, there are certain stages of plant growth that are highly sensitive to water availability. Any shortfall in water delivery during these stages can result in severe negative consequences on yields. For many of these crops, there is a strong complementarity between the timing of irrigation and the application of other inputs such as seed, fertilizers and pesticides. Matching irrigation deliveries with the specific needs of the crop and the application of other inputs is therefore important. This matching could be particularly problematic when groundwater availability is limited and uncertain, as often happens in semi arid regions. It therefore, is important to see how the choice of contracts helps to alleviate the risk and incentive problems that arise.

5.6 *Conjunctive use of Wells and Tanks: Conflict?*

Tanks and Wells are interdependent forms of irrigation depending on a common ultimate source of water: run off in the catchment area, often channeled through the 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 management system. It is also important to note that groundwater irrigation is not simultaneously used with tank water. Well water may be used for nurseries and field preparation before any tank water is released for irrigation, or to bring a standing crop to harvest after the tank water is depleted, or to grow crop in the dry season when there is no tank water. However, as long as there is enough tank water for surface irrigation, well water is not used. It has been noted in literature that this pattern of use of water is inequitable and inefficient because well owners have access to more water.

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 a period of time with investment by both government and groups of cultivators. The facilities are public property, maintained and managed by both a government agency and a cultivator associations. All cultivators have a right to water by virtue of owning the land in that area. The right to tank water is reinforced by paying a wet-land assessment to the government and by participating in the 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'[5] of a tank have rights to both surface and sub-surface water. The former requires ownership of ayacut land plus annual payments to governments and to the ayacut association or its employees. Therefore, as long as tank water is available, it is cheaper for well owners to use this rather than to raise well water for irrigation, since the amount they pay does not vary with the amount of water used. Not only is it that the wealthiest and the most influential cultivators who are most likely to obtain wells and pump sets but ownership of this important instrument of production reinforces their power. The profitability of well ownership is further enhanced by the sale of well water to other cultivators.

Despite problems of unequal access to groundwater, wells provide a crucial supplement to tank irrigation. Water is used more efficiently. Evaporation losses are reduced by storing water in the soil profile rather than in open tanks. Well water is relatively expensive and has a unit marginal cost---both to well owners who must pay for energy to lift water and to other cultivators who pay by the hour--cultivators take particular care in cleaning field channels and ensuring that water reaches the crop. Transmission losses are also lower for well irrigation than for tanks, as wells are distributed throughout the ayacut and are closer to the fields. Well irrigation is more efficient, as it is more responsive to the demands of the individual cultivators and to 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. However, the entire ayacut is not homogeneous with respect to

[5] 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, I use ayacut synonymously with command area.

planting and transplanting dates, variety of paddy and with other crops and for soil moisture retention, so the timing of water issues will not be optimal for all fields. The presence of contiguous well and tank irrigation creates a potential for conflict of interests. Well owners may ask that the association uses its resources (especially its time and government contacts) to get frequent water issues. Cultivators without wells may be unwilling to share the cost of the activities from which they receive little benefits. Well owners have less interest in conservation of tank water for late season use.

The co-operation or non-cooperation of well owners with an ayacut association appears to be an important factor in the efficient management of tanks. 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 co-operation for water acquisition and distribution. When well owners have a secure groundwater supply they may prefer to rely on this rather than on tanks requiring collective action. But when there are no wells or the wells are dependent on recharge from surface water, then collective action is in the interest of all.

6 An Analysis of issues in a Situation-Structure-Performance (SSP) Framework

This section is based on the SSP framework of Institutional Economics. Situation refers to individual (e.g. preferences, values, information processing), community (e.g. number of decision-makers and shared individual characteristics), and goods characteristics. Structure comprises institutional setup and property rights and is chosen. Performance is the outcome for a given situation under a choice of rights and institutions. An integral part of the analysis is 'whose preference counts when choices conflict'? Who has the power to coerce?

Tank Water (the good in SSP framework) is also a high exclusion cost (HEC) good. Exclusion cost refers to the cost of excluding unauthorized users of a good. A high exclusion cost good (HEC) is one where if the good exists for one user it is costly to exclude others. High exclusion cost means that use of an existing good cannot be limited to those who have contributed to its cost of production. (Schmid, 1987). CPR's are an important variant of HEC. Tank water is a high exclusion cost good because once there is water in the tank, it is very difficult to restrict potential users even if they make no contribution to tank maintenance. This problem was aggravated, as there were no written rules or codes. The rules were more in the form of an informal commitment and out of the sense of belongingness to the community. As expected there were free riders but there were other joy riders who more than compensated for them. Schmid (1987) uses the term joy rider in the context of HEC goods to describe people who value the game (ride) participation and relationship with others independently of substantive and instrumental outcome. These people are part of status transaction with others. They pay for the HEC good because they think it is the right thing to do or out of habit.

The caste hierarchy and the associated status symbol is just one way of selectively unhorsing the free riders. In fact it creates joy riders so that the maintenance work is dutifully attended. These leaders also act as water brokers in times of local shortage of water arranging the purchase (or gift or exchange) of water and its delivery or sale. The crucial success is the accumulation of the symbolic capital[6] in the form of social position, honor and authority necessary to mobilize individual and communal labor and to produce dependent roles to work and irrigate field in a highly concentrated labor period. Extending the ideas of Bourdieu, Loesberg argues for the priority of symbolic capital over economic capital in these terms:"In an economy which is defined by the refusal to recognize the objective truth of economic practices, that is the law of naked self and egoistic calculation, even economic capital cannot act unless it succeeds in being recognized through a conversion that can render unrecognizable the true principles of its efficacy. Symbolic capital is this denied capital. Symbolic capital is not merely a symbol for economic capital but the capital that exists when economic interests are denied or negated."

This is in line with the predicted outcome: '*Where large groups of people are involved, high exclusion-cost goods are maintained and produced only under certain conditions that can unhorse the free rider*'. People voluntarily protect CPR when they when they do not make individual calculations of advantage, i.e. when they forgo

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[6] In the "Forms of Capital" Bourdieu expands the notion of capital beyond its economic conception which emphasizes material exchanges, to include non-economic form of capital, specifically cultural and economic capital. He recognizes that all types of capital can be derived from economic capital through varying efforts of transformation.

opportunism in the context of building trust, identification with others, feel an obligation to others, and don't feel good about being opportunistic (Schmid, 1987). Feelings of sympathy for one another in a simple model of exchange reduces transactions cost (thus broadening the market), leads to greater internalization of externalities and voluntary investment in high exclusion cost good (Staatz, 1998).

6.1 *Conjunctive Use of Tanks and Wells: Conflict?*

Tanks and wells are interdependent forms of irrigation depending on a common ultimate source of water: run off in the catchment area, often channeled through the river system. In this respect the 'ground water' (that is underground and the source for both) is an Incompatible Use Good (IUG) between the users of tank water and the user of well water. At times, users have access to both tanks and wells. The ownership of an incompatible-use good influences who can create costs for whom and thus affects the distribution of income. Ownership influences whose interests are realized and whose are forgone.

It is important to recognize how the structure of property rights with respect to groundwater has affected the transactions. In India, as also in several other developing countries, property rights on groundwater are not well defined. Legally, as long as water remains underground nobody owns it. But once pumped to the surface, it belongs to the owner of the plot to which it is lifted. Thus, access to ground water is the prerogative of the owner of the land above and often entails a large and risky investment in drilling a well. What this essentially means is that as long as water remains in the tanks in sufficient quantities, it is a CPR but when it is taken from below the ground, it may be the same water, but it becomes an IUG. Whoever owns the land has the right of drilling water from the well on his tank.

This has two implications:

1. The differences in income and power are further exacerbated further. There is considerable sunk or fixed investment needed in drilling a well before it can be put to productive use. Only the wealthiest and the most influential cultivators are likely to obtain wells and pump sets as even access to credit is usually determined and limited by the amount of collateral that can be offered. Ownership of this important instrument of production reinforces their power. The profitability of well ownership is further enhanced by the sale of well water to other cultivators.

2. Also observed is a situation akin to Prisoners Dilemma. The dominant choice for well owners is to extract as much water as possible irrespective of what others do. There is a per unit variable cost associated with using pumps to extract water from wells in the form of electricity costs, fuels etc. Most of the well owners also have access to tank water. It is commonly observed that well owners use the tanks initially when there is enough water and then use wells in times of scarcity (as even if the water table goes down, it can be extracted). Later, they sell water at exorbitant prices to other farmers who do not have wells. This in turn forces the tank users (who are much more in number) to use up as much water as they can. It also pits one well owner against other well owners as they compete in selling water during times of scarcity.

The strategies that are observed here is what is called 'Tit-for-Tat' by Axelrod (Axelrod, 1984). Defection is followed by defection. As emphasized earlier tanks are more than just physical places to store water. Initially, while the well users did make some fortune by defecting, the situation changed from a longer run perspective. The power structure changed. The tank users were generally from the lower strata of the society and they began to rebel and raise their voice more often on any practice they though were unjust and inequitable. Considering the fact that fuel shortages and power cuts are not uncommon, the well owners were highly dependent on these *Pallar* caste water turners (and mostly tank water users) where drawing water from the wells and where manual labor was needed. Theory suggests that in a Multi-Person Prisoner's Dilemma, the success of collective action depends not only on size of the group but also on the ratio of costs and benefits. Cooperative norms act as constraints on narrow self interest.

6.2 Shift in Power Structure

These very factors created room for opportunistic behavior. The 'inferior service' label associated with opening and closing of the sluices made the *Pallar*s bargaining position stronger. They were the 'owners' of these services and the social structure gave them a monopolistic position. The power structure began tilting. The economic need for water turner roles has resulted in re negotiation of wages, the redefinition of duties in socially acceptable terms. The changes in payment, roles and obligations involved are part of a wider negotiation of identity and status among low caste involving a shift towards non-hereditary, non-caste specific contractual forms of employment. In Independent India, this power relationship was completely done away with as the modern state acquired property rights. But with this also died, the custom of self-maintenance to tanks. As Bardhan points out, a 'difficult transtition' in which 'traditional cooperative' institutions are on a decline while participatory alternatives have yet to take root.

However, all was not well with the existing system. Even more difficult was the fact that tank maintenance according to the hierarchical caste ordering had been going on for centuries and it was difficult to break out from it. Even under the British rule, the former kings continued to treat productive resources (land and water) as political assets to *rule* –i.e. to gift, exchange and redistribute –rather than as property to be managed for profit. A series of litigation over royal successions further diverted resources away from tank maintenance. This is an example of path dependency and associated lock-ins described by Douglass North. North says, "The increasing returns characteristics of an institutional matrix that produces lock-ins come from the dependence of the resultant organizations on that institutional framework and the consequent network externalities that arise."(North, 1990). Though North discusses the applications in the context of tangible goods (like the existence of QWERTY key board in spite of no inherent technological superiority), the similar line of reasoning can be extended to the case of the intangibles, like feeling honored, the associated prestige and the like, under consideration. As North says, "History matters". The status symbol associated with tank maintenance persists till date. The idiom of royal grant and entitlements in articulating informal rights over water flow persists even today.

6.2 Behavioral Assumptions

Why would one expect to be motivated by non-economic concerns like acquiring symbolic capital? But this is very much consistent with Margolis's model of multiple self. Margolis develops a model in which individual behavior is in part determined by altruistic motives. He argues that individuals have two types of utility functions, those that favor group oriented preferences, and those that favor selfish preferences. Further, individuals make trade-offs between the two (North, 1990). It seems Margolis interprets group -oriented preferences as the one determined by altruistic motives. However, here even the selfish preference is determined by altruistic motives and that seems to be the root of the problem. Also, internal (e.g. guilt) and external (e.g. shame and ostracism) sanctions associated with norms alter the costs and benefits of cooperating and defecting in prisoner's dilemma.

6.4 Institutional Change Analysis

The difference between informal and formal constraints is one of degree. Formal rules can complement and implement and increase the effectiveness of informal constraints. They may lower information, monitoring, and enforcement costs and hence make informal constraints possible solutions to more complex exchanges. A change in the bargaining strength of parties may lead to an effective demand for a different institutional framework for exchange, but sometimes the informal constraints stand in the way of achieving it. Sometimes, it is possible to supersede the existing informal constraints with new formal rules (North, 1990). The following is a testable hypothesis proposed on the line of North's argument.

As noted earlier, one major cause of degradation of tanks is that due to rising power differences between well owners and tank users. Most of the well owners are also tank users but the majority of tank users do not have access to well water. This creates an asymmetry.

To recapitulate, 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*[7] of a tank have rights to both surface and sub-surface water. The former requires ownership of *ayacut* land plus annual payments to the government (in the form of wet land association tax) 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 no take it, the monitoring and other costs to the organization are very high. The water goes directly past all fields, regardless of whether or not they have wells. The profitability of well ownership is further enhanced by the sale of well water to other cultivators in the *ayacut* during time of scarcity. This has result in increased conflicts. Establishing property rights in vacuum is not a solution. The cooperation or non cooperation of well owners within the *ayacut* association is an important factor in efficient management of tanks.

6.5 An Institutional Innovation

There is no formal statute or deed that says the owner of land is also the owner of land value created by the community (Schmid, 1987). The property right in land-value appreciation is subtle. By virtue of having a well on the plot, the land value of that plot increases if it is sold. As of now, the land tax is a flat rate. *If the well owners are also charged a 'land tax' which is progressive and is revised according to the prevailing 'land*

[7] The term ayacut refers to the area irrigated by a tank or other irrigation source. Sometimes, ayacut is used synonymously with command area.

value' where land value is determined by the amount of 'water sales' during times of water scarcity then the incremental amount of tax can straightaway be put into the tank maintenance fund. As Olson predicted, the free rider is eliminated by centralized public finance.

The following performance can be expected:

1.Water sales can be expected to be minimized unless there is an actual scarcity. This will also prompt the well owners to avoid from drawing excessive water from the tanks.

2.The extra tax will provide for tank maintenance.

3.The amount of 'water sales' is not difficult to monitor as the sales are mostly to neighboring farmers and even they have an interest in reporting correctly.

The potential problems with this is that over time one can expect side-payments from well owners to neighboring farmers to induce them not to report the amount of water sales correctly. As long as the side payment is less than the incremental tax, it benefits both the well owner and the tank user (the individual farmer), however, in the long run this practice will lead to the neglect of tank maintenance.

Crafting institutions is an ongoing process after all.

7 Concluding Observations

After studying the management of tank irrigation at local level, it becomes apparent that tanks cannot be understood in isolation. The irrigation of each farmer's field is part of a complex hydrological system involving not only the tanks and its field channels, but also the rainfall and run-offs in the watershed, the river and channel system that collects and diverts surface water to the tanks. Groundwater and wells are also components of the system because they receive and store percolation water from the tanks and the channels and then provide supplementary irrigation water for crops in the tank *ayacut*. Also, well owners benefit from tank water recharging the water table. Further research is required to see if this affects the well owner's cooperation with respect to the *ayacut* activity. Culture and history are very important in understanding the dynamics of the system.

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