Commons vs. Commons: Managing Scarce Water Resources in Dry Zone Village Tank Systems in Sri Lanka

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COMMONS VS. COMMONS: MANAGING SCARCE WATER RESOURCES IN DRY ZONE VILLAGE TANK SYSTEMS IN SRI LANKA

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EXECUTIVE SUMMARY

The struggle of village tank farmers in the dry zone of Sri Lanka against rising scarcity of water and land resources strongly highlights the interdependence of local resources under diverse regimes of governance. The significant population in the dry zone that lives under the village tank systems represents one of the most vulnerable community groups in the country.

This study attempted to identify technical, institutional, and policy solutions that could provide sustainable answers to the problems faced by the village tank farming community. Physical scarcity is only one aspect of the problem because scarcity is closely influenced by more contentious issues of institutional limitations.

The research was conducted in the Anuradhpaura district of the North Central Province in Sri Lanka. The research design included participatory methods of focus group discussions (FGD) and key informant interviews (KII) to gather primary data. Secondary data were collected from various sources, especially from past researches on village tank systems.

Findings revealed that temporal scarcity of water and associated problems of managing local resources have been the major challenges that have shaped the evolution of local farming systems and water management strategies. The traditional system evolved to overcome this challenge through the development of a set of social customs and local institutions. These customs and institutions had governed the use of lowland as well as upland resources until recently.

However, recent changes such as population growth, government policies, commercialization of local economies, and modernization of agriculture technology have gradually eroded the traditional system. These changes have favored a privately-oriented and resource-intensive commercial farming system. Such changes have contributed to the collapse of control exerted by traditional system of social customs and local institutions over local resources, especially over the upland component of the farming system. This collapse has led to major environmental problems affecting land and water resources in the village tank systems. Hence, what is needed is a holistic approach of integrated resource management that includes technical, institutional, and policy interventions applied over interdependent systems of local resources. However, the implementation of an integrated mangement practices has to be facilitated by a modified system of local institutional arrangements and appropriate policy interventions designed to create an enabling environment.

1.0 INTRODUCTION

Rural farmers operate in integrated systems of water, land, forest, and other natural resources. Hence, the problems of resource scarcity are also similarly interconnected. Resources of such integrated systems usually come under different ownership regimes. One type of ownership regime is common property resources (CPR). While recent literature provide useful insights on the management of CPR, many of these studies seem to be based on selected cases that focused on specific behavioral aspects relating to cooperation and collective action of community groups (Ostrom, 1990; Agrawal, 2001). Only a few such studies appreciated the broad picture of CPR involvement in integrated systems. Hence, many researchers fail to grasp the importance of understanding the close interdependencies that exist between CPR and other regimes of resource governance to cater to the livelihood needs of communities under conditions of resource scarcity. In the final analysis, sustainability of community-managed systems seems to be strongly dependent on the overall outcome of integrated systems rather than on isolated issues of governance addressed by specific resource regimes.

The struggle of village tank farmers in the dry zone of Sri Lanka under conditions of rising water scarcity provides a fine example for such integrated systems. In such systems, diverse resource regimes interact with each other to generate system-wide outcomes. The dry zone faces acute water scarcity during a significant part of the annual cycle. Hence, throughout the last century, successive governments strived to improve the situation of farming communities in the dry zone by investing massive public funds on renovating the ancient network of man-made irrigation reservoirs and by constructing new multipurpose trans-basin diversion projects (Aluwihare and Kikuchi, 1991; Kikuchi et al., 2002). Despite substantial improvements from such efforts, however, a significant population in the village tank systems still lives under conditions of water scarcity not supported by any major irrigation project.

Village tank communities basically depend on local rainfall for their water needs. However, they get significant support from community-managed rainwater harvesting devices, popularly known as village tanks. Village tanks have historically been built to fulfill food security needs of successive generations under water scarcity conditions (Siriweera, 2001). Even today, they make a substantial contribution by helping to control and manipulate the limited local supply of water available during the short season of rainfall in the dry zone.

There are many village tanks scattered throughout the dry zone areas of the country. According to the most reliable estimates, there are over 18,000 village tanks (Panabokke et al., 2004; Ratnatunge, 1979). Recent research has established that rather than occurring randomly, the distribution pattern of village tanks helps to cover rainwater received in well-defined micro catchments through their strategic location in the macro landscape (Panabokke, 1999; Panabokke et al., 2002). Moreover, individual tanks constitute the component units of larger systems of rainwater harvesting units known as 'cascades'. Cascades are clusters of hydrologically interconnected village tanks that help to harvest rainfall received by larger watershed units called meso-catchments (Madduma Bandara, 1985; Panabokke et al., 2002; Tennakoon, 2001).

Village tanks do not reduce the dependency of farmers on local rainfall. Rather, these help manipulate the limited supply of water available from periodic rainfall, hence facilitating the coping mechanism of farmers with water scarcity. Many of the farmers' problems are being aggravated by population growth and looming uncertainties of water supply because of climate change.

To help farmers, government agencies have promoted the extraction of groundwater thorough 'agro-wells' from the shallow regolith aquifer that lies beneath tanks and surrounding valleys (Panabokke, 2008). Agro-wells seem to have become widely popular among farming communities as evidenced by the many wells that have appeared during the last two to three decades (Karunaratne and Pathmarajah, 2002). Although these agro-wells have been popularized through incentives provided by state agencies, such as the Agriculture Development Authority, many farmers subsequently constructed these wells on their own as a private initiative. The construction of these wells has been largely facilitated by the introduction of small, low-cost pumps operated by diesel and kerosene (Kikuchi et al., 2003).

1.1 Research Problem

Both village tanks and agro-wells tap the limited pool of water from the seasonal precipitation (mainly from the north-east monsoon) to small micro catchment drainage basins. Shallow regolith aquifers found in the dry zone village tank areas are annually recharged by the rainfall. They are fed also by the seepage from the tanks continuously throughout (Panabokke and Perera, 2005). Therefore, village tanks (surface water storage) and agro-wells (groundwater storage) are heavily interdependent on each other (Senaratne, 1997).

In addition, there are interdependencies between different tanks in a cascade system also (Tennakoon, 2001). The uppermost micro catchments depend entirely on the local precipitation. The tanks located in the lower reaches of the cascade are also fed by surplus water from up-stream tanks, thereby giving rise to spill-over effects between user communities of village tanks. Overall, a delicate hydrological balance is maintained between surface water and shallow regolith aquifer within the micro catchment as well as between different micro catchments in a given cascade. Therefore, resource management options have to be selected carefully considering the balance between surface and groundwater within the micro catchments as well as the water balance of micro catchments over entire cascades.

The threat of future uncertainties over water supply because of pending changes of climate adds a new dimension to the problem of water scarcity in village tank systems. Recent analysis of agro-meteorological data has shown that although there are no indications of substantial reduction in water availability yet, pattern of rainfall has become erratic over the past several decades (Punyawardena, 2007). This pattern could severely affect communities dependent on rainfall unless appropriate technical and institutional adaptation measures are brought in to effect.

However, focusing on the physical scarcity of water alone seemed to be a narrow way to approach the problems faced by the village tank farming communities. In essence, the issue of the physical scarcity of water is closely interconnected to institutional arrangements dealing with the allocation, distribution, and utilization of limited supply of available water. Village tanks are common property resources (CPR). The use rights for water in commonly-owned village tanks are usually held by well-defined agrarian communities that own or cultivate paddy fields in the command areas of tanks. These communities make decisions on the use of tank water through institutional mechanisms involved with Farmer Organizations (FO).

In contrast, extraction of ground water through agro-wells is a private activity driven by commercial objectives. Despite the fact that ground water aquifer is a 'common pool' resource, access to the resource is determined by ownership rights to land plots in the surface above the aquifer area. As no rules or regulations are in place to govern the tapping of water by individual agro-well owners, groundwater can be considered as a type of unregulated common property.

Three macro-scale processes, namely: rapid growth of population, commercialization of local economies, and 'modernization' of agriculture are rapidly transforming the socio-economic conditions in communities surrounding the village tanks (Panabokke, 2001; Aheeyar, 2001). Increasing population is exacerbating the scarcity of water as well as arable lands. Growing scarcity of land causes the fragmentation of farm units, as well as the encroachment and clearing of surrounding forests even in sensitive areas such as tank catchments. As a cumulative result of such changes, the ownership and tenure patterns of resources associated with the village tank system have undergone significant changes during the recent decades.

Some suggestions have been proposed by researchers and policy makers to arrest the problem of rising water scarcity. These include both technical as well as institutional/policy solutions.

To improve the situation of physical scarcity of water, the Department of Agriculture has introduced and promoted water-conserving technologies and farming system applications. These farming systems included alley cropping (conservation farming), live mulching, organic manure application, zero tillage, and multi-storey home gardening that can increase the efficiency of on-farm water use (Weerakoon and Liyanage, 1987; Dharmasena, 1989). However, such technical solutions have hardly been accepted by farmers as evidenced by low adoption rates. Proposed institutional/ policy solutions were mainly focused on introducing regulations/standards on ground water tapping.

Senaratne (1997) suggested an optimal density criterion to be adopted in constructing agro-wells taking the hydro-geological parameters of micro catchments into consideration. The Department of Agriculture made an attempt to introduce guidelines and controlling regulations for groundwater extraction to avoid the spread of agro-wells in an unsustainable manner (Nagarajah and Gamage, 1998). However, these practices are not practicable solutions unless a sound system of ownership rights and effective monitoring schemes are in place.

Sri Lanka currently possesses no statutory legal framework or effective institutional structure for controlling the usage of groundwater resources. The recent proposal by the National Water Policy 2000 to create water entitlements became hugely unpopular, and as a result, the government has withdrawn the proposal (Water Resource Council and Secretariat, 2000; Gunatilake and Gopalakrishnan, 2002). It should be noted that all these technical solutions and policies were proposed by researchers and policy makers through top-down approaches involving minimum community participation.

In summary, sweeping changes in village tank systems and the resultant increase in scarcity of water and land resources tend to alter traditional patterns of resource tenure. This alteration is driving farmers to adopt more private coping strategies to fulfill their water needs. Since surface and groundwater resources are physically and socially interconnected common pool resources, the sustainability of water management has become a problem. Proposed solutions, namely: water conserving technologies, regulatory measures, and creation of private rights through water entitlements have failed to create any impact for various reasons.

An integrated management that encourages the conjunctive use of surface and groundwater resources is essential to solve the problems in many localities. Otherwise, a crisis situation could potentially develop, leading to conflicts among communities. Past experiences of failed top-down solutions suggest that any solution should ensure enhanced community participation. However, in the village tank systems, two factors make the formulation and implementation of any solution a challenging task: high level of diversity and rapid change in conditions. Village tank systems have diverse physical resource contexts and socio-economic conditions; thus, a uniform solution of integrated management that can perform equally successful in all systems is not a realistic expectation. Further, the rapid, broad sweeping changes of socio-economic conditions can make such a solution obsolete in a short period of time.

What is needed is a flexible strategy of solutions that can be adapted for different local contexts and changing socio-economic conditions. Such a strategy should comprise a flexible combination of interventions that may be adapted to different local contexts. The best way to achieve this is to identify a manageable number of broad scenarios and to develop a set of wide ranging solution strategies that include technical, institutional, and policy interventions to match specific scenarios. The role of policy interventions here is to create an enabling environment for local users to adopt technical and institutional solutions through participatory arrangements. Hence, the key research questions addressed by this study included the following:

- What scope exists under prevailing physical, socio-economic, and institutional contexts for the adoption of participatory institutional solutions for the integrated management of local resources?
- What kind of technical strategies and institutional arrangements should be adopted to achieve the conjunctive use of surface and groundwater resources?
- What type of regulations/legal rights/ policy interventions should be introduced to create an enabling environment for the adoption of technical/institutional solutions and induce necessary cooperation for integrated management?

1.2 Objectives

The general objective of the study is to identify suitable solutions that can provide efficient, equitable, and sustainable answers for problems related to the management of limited surface and groundwater resources in the rainfed dry zone areas of Sri Lanka. Specifically, the study attempted to:

1) Explore the existing situation of
    a) physical scarcity of surface and groundwater resources in the rainfed dry zone areas,
    b) legal, customary, and informal rights for water and enforcement mechanisms in these areas,
    c) institutional arrangements and coping strategies adopted by village communities, and commercialization and market development to understand their implications over integrated management of resources in village tank systems.
2) Identify major scenarios of land and water management that represent diverse contexts of village communities and assess the suitability of different technical and institutional interventions that are feasible under the respective scenarios
3) Examine appropriate policy interventions that can create an enabling environment and induce major stakeholders to adopt potential technical and institutional interventions

2.0 LITERATURE REVIEW

2.1 CPR, Groundwater and Community Management of Water Resources

The study has to deal with two important, recently developed branches of natural resource and environmental economics, namely: common property resource (CPR) management and groundwater resource economics. The CPR school attempts mainly to answer major research questions: why is cooperation successful in certain resource contexts while it fails in others and what conditions (or factors) ensure the successful cooperation among community groups (Agrawal, 2001; Baland and Platteau, 1999; Ostrom, 1990; Wade, 1988). Researchers on CPR attempted to identify factors that affect the success or failure of collective action in CPR, among which the following assume an important place (Agrawal, 2001).

a) resource characteristics (e.g., size, boundaries)
b) group characteristics (e.g., size, boundaries, shared norms, experience/social capital, interdependence, leadership, heterogeneity of endowments)
c) relationship between resource and group characteristics (e.g., overlapping of locations, level of dependence, fairness of allocation)
d) institutional arrangements (rules and customs, enforcement, sanctions, adjudication, accountability) and,
e) external environment (e.g., technology, state).

On the other hand, groundwater, being a renewable, yet depletable stock resource, often non-priced with non-private ownership status, has presented an interesting case of optimal allocation/control of natural resources. Accordingly, many economic studies have dealt with optimization of spatial and temporal allocation of the resource under different scenarios that cover: no control/myopic resource allocation contexts; optimal control scenarios; and competitive, cooperative, and non-cooperative contexts (Allen and Gisser, 1984; Burt, 1966 and 1967; Cummins and Winkelman, 1970; Chemark, Patrick and Brookshire, 2005; Koundouri, 2004; Gisser and Sanchez, 1980). These literature discussed issues such as optimization of the temporal stream of benefits from groundwater maximization of conjunctive benefits from surface/groundwater extraction; conditions for optimal control of conjunctive use; optimum rate of investment on capital resources; and socially optimal spatial and temporal allocation of groundwater and surface water for agriculture and other uses.

The theoretical disposition of the current study lies in the midst of these two broad strands of literature, namely: community management of CPR and optimal control of groundwater. However, a few limitations common to both research schools restrict us from using them in the present study in a straightforward manner. First, since the research uses case studies, insights from the literature on CPR as well as on groundwater economics may be site-specific. This limitation has prevented researchers from appreciating the broad picture of involving CPR and groundwater in interconnected systems of different resource regimes and their interdependencies. Quite often, such resource regimes constitute component parts of integrated systems and provide the livelihood needs of communities. Village tank systems involve such an interconnected system; therefore, it is important to understand interdependencies among different resource regimes. As a result, mainstream approaches adopted for the community management of CPR and optimal control of groundwater may shed some light on specific aspects of the problem, but these provide little practical guide to handle the overall issue.

The study seeks solutions for physical scarcity of resources and socio-economic factors affecting the communities involved. However, it is difficult to find an optimal solution for this problem through quantitative models because of the theoretical and empirical challenges involved. Therefore, this study adopted a more open empirical approach while borrowing freely from CPR and also from groundwater economics schools as per the requirement. A main feature of this approach is the wide application of participatory research tools to assess the rural context. Participatory approach enabled us to explore technical, institutional, and policy aspects from an overall perspective of the problem.

Some insights can be drawn from socio-economic investigations on community management of village tanks and the conjunctive use of surface and groundwater resources. One related study conducted by Balasubramaniam and Selvaraj (2003) in Tamilnadu showed that tank irrigation in many districts has rapidly declined during recent decades because of the disintegration of traditional irrigation institutions. Farmers adopted private tube wells as an individual-coping strategy, but this practice further degraded tanks as the density of private wells increased. The study further suggested that the number of private wells in a given command area negatively affected the collective action of tank management.

Another study conducted in Andhra Pradesh of India on cooperatively managed, group-owned wells suggests that informal mechanisms of cooperation work well in activities such as everyday allocation of water and routine maintenance, which are of repeated nature, entail low risk, require close monitoring, and involve low contributions (Aggrawal, 2000). Alternatively, for larger commitments with higher risks such as investment on new wells, people prefer individual initiatives rather than group actions.

Wade (1995) proposed that the form and operation of water management institutions are conditioned by a few major demographic and ecological variables, namely: population density, irrigation requirement, temperature, and topography. Depending on the variation found in such major parameters, optimal strategy for managing water resources may vary in different local contexts, hence appropriate adjustments in technical arrangements should be made accordingly. Bardhan (2000), examining factors that influence cooperation in canal and tank irrigation in Tamilnadu, found that inequality of land holding size and urban market connections negatively affected the cooperation in irrigation. On the other hand, he found that duration of access to water, close monitoring, social homogeneity, small group size, and proportional cost sharing rules encouraged cooperation. Conversely, based on a study conducted in Karnataka and Rajasthan, Meinzen-dick et al. (2002) suggested that cooperation for canal irrigation would most likely succeed in larger command areas closer to market centres and in places with established social capital based on religious temples, etc.

2.2 Past Studies on Village Tank Systems in Sri Lanka

The village tank systems in Sri Lanka can be considered to be a relatively recent research interest compared to the long history of water management research on major irrigation schemes. However, there have been a significant growth in the literature on village tanks in the last two decades. Of these literatures, majority deal with their physical aspects. Among the major works on small tank systems were those conducted by Madduma Bandara (1985), Panabokke (1999), Panabokke et al. (2001), Somasiri (1979 and 1992), Itakura and Abernethy (1993), Shakthivadivel et al. (1996), Handawala (1994), Ulluwishewa (1995), and Dharmasena (1992 and 1996). These studies have helped to create a systematic knowledge base on the physical aspects of small cascade systems. These efforts were supported by comprehensive mapping exercises by Ratnatunge (1979) and the digital database on small irrigation schemes compiled by the Department of Agrarian Development from the late 1990s. While the physical aspects have been studied at some depth, socio-economic studies seem to be far apart and have limited interconnection with each other. Among such studies were Farmer (1957), Leach (1962 and 1980), Tennakoon (1986), Begum, (1987), and Abeyratne and Perera (1986).

As the large-scale tapping of groundwater for agricultural purposes through ‘agro wells’ is more recent, there are a few major studies on groundwater resources dated from the late 1980s. These include the works of Herbert et al. (1988), Wright (1989), Senaratne (1996), and Panabokke (2005 and 2008). No socio-economic studies that addressed the groundwater utilization under small village tank setting were found in the literature survey. However, the present study borrowed extensively from these studies on physical and as well as socio-economic aspects.

3.0 METHODOLOGY

3.1 Study Area

The study was carried out in Anuradhapura district of the North Central Province. Anurdhapura district is one of the key agricultural districts where village tank cascade systems play a prominent role in the livelihoods of farmers. It also has the most number of agro-wells constructed during the last two to three decades. In addition, the area is a rich source of background information because it is where most studies, especially on the physical aspects of surface and groundwater resources, have been conducted.

Primary data were collected from 16 villages selected from Thirappane, Sivalakulama, Mihinthale, Galenbindunuwewa, Kahatagasdigiliya and Andiyagala Divisional Officer divisions of the district. Potential data collection sites were selected after an extensive field visit in the area and after considering information from a few comprehensive studies done in the area by Panabokke et al. (2001) and Senaratne (1997). This preliminary selection was then short-listed with the help and inputs of local officers. The basic aim of the selection criteria was to capture as much variation of physical, socio-economic, and institutional diversity in the sample. The final list of villages where primary data were collected is shown in Table 1.

Table 1. List of primary data gathering sites (villages)

DO Division	Potential sites matched by criteria
Tirappane	Paindikulama Mahakanumulla Mawathawewa Periyakulama
Sivalakulama	Wembuwewa Dambagollewa Galwaduwagama
Galenbindunuwewa	Mailagaswewa Himbutugollewa
Kahatagasdigiliya	Gangurewa Pattilapuwewa
Mihintale	Siyambalagaswewa Katukeliyawa Pahala Halmillewa
Andiyagala	Upulwehera Maneruwa

3.1.1 Steps and procedure

The research methodology included the following steps.

1. Assessing the contextual environment
2. Identification of institutional and policy scenarios
3. Identification of solution strategies and policy intervention
4. Evaluation of solution strategies

In the initial stage**,** information was collected using both primary and secondary data on the following aspects: situation of physical scarcity of water; implications on rights to water and land; formal/informal institutional arrangements and coping mechanisms adopted by communities; and level of commercialization and market development. All these information collected from the FGDs, KIIs, and secondary data were assessed, and four land and water use scenarios were identified to formulate solution strategies. Assessment was done through a desk exercise using all the background data on physical, social, and institutional aspects and considering the views expressed by farmers and local officers. The outcome of this analysis and other background information were presented to a panel of 11 experts on water resource management. The experts were then engaged in formulating the solution strategies as their views and suggestions on technical, institutional, and policy solutions were considered in the discussion. These solution strategies were further re-evaluated by discussing them with selected members of the farmer community from villages representing specific land and water use scenarios.

3.2 Data and Data Gathering Methods

Both primary and secondary data were collected in the study.

The following methods were used to collect primary data.

3.2.1 Focus group discussions

A total of 20 FGDs with farmer groups, usually composed of 10 to 15 farmers for each group from the selected villages, were conducted. A semi-structured, yet flexible focus guide was used in the discussions. Initially, 16 FGDs were conducted to gather information on selected village sites. The discussions probed into the following: physical profile of resources in the villages; key aspects of farming systems; major issues relating to local management of resources; current development of agro-wells and commercial highland farming activities; formal and informal institutional arrangements and their change; coping mechanisms of water scarcity; cooperation and conflicts among village communities; and experiences in climate change and other village-related matters related that were relevant to the research problem. After analyzing village-level information, four discussions were conducted again with selected members from villages representing the four land and water use scenarios identified. In this round of discussions, in-depth aspects of physical and institutional issues and solution strategies advocated by experts for specific problems were discussed.

3.2.2 Key informant interviews

In addition to FGDs, researchers conducted a series of KIIs and discussions with local officers who were responsible for handling water resources and agricultural development activities in the area. These included all divisional and village level officers involved in the selected villages. The interviews, which sometimes took the form of small group discussions, were conducted in the respective Divisional Offices. These interviews/discussions not only supplemented the information collected from farmers but also helped the researchers recognize the views and perspectives of local officers involved in local resource management in the area.

3.2.3 Collection of secondary data

Secondary data were collected from key institutes, which have either conducted important studies in the past or have undertaken mandatory institutional responsibilities related to the research issues. The major types of secondary data collected included: information on technical aspects of water scarcity; hydrological and water balance information; rainfall and other meteorological data; physiographic information of resources; and studies on socio-economic and institutional aspects.

3.3 Analysis

Given the exploratory nature of data collection from various sources, a stepwise process was adopted to analyze data. The procedure was as follows:

- Initial exploratory analysis of information from various sources to develop broad insights over major issues, vital relationships, essential parameters, and etc.
- Organization of insights on a factual basis for identification and description of scenarios using key parameters
- Categorization of villages under respective scenarios
- Identification of solution strategies for respective land and water use scenarios

No complex statistical or quantitative analysis was involved other than calculation of percentages, averages, etc. and their comparison.

4 THE PHYSICAL SETTING, RESOURCE SCARCITY, AND INSTITUTIONAL CONTEXT

4.1 Rainfall and Surface Water

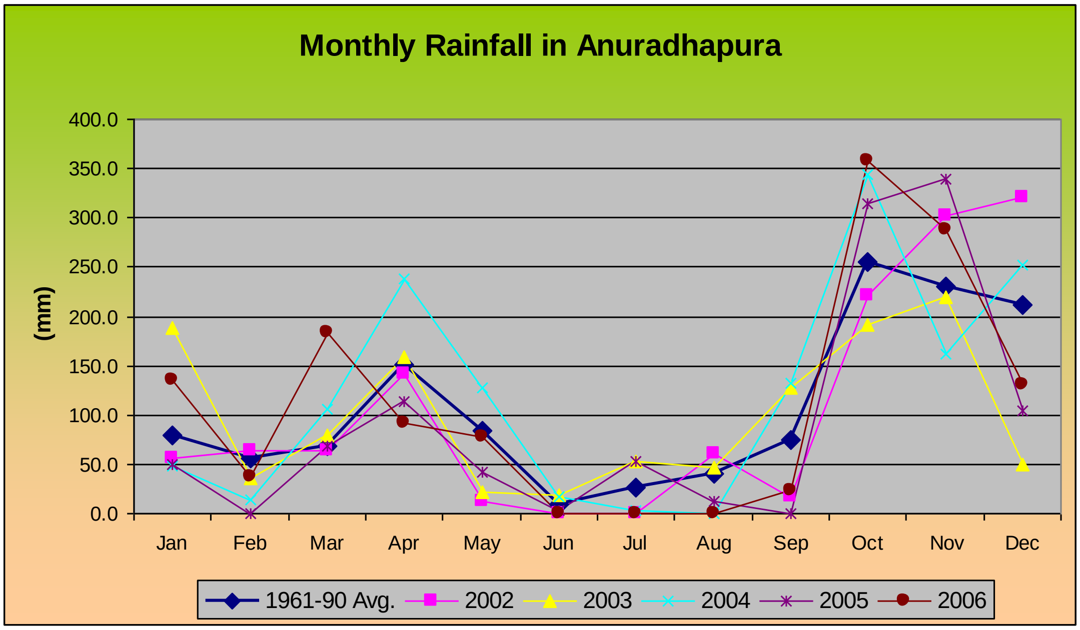
The overall physical setting and institutional background were examined to understand the key aspects of the problem. Table 2 provides a profile of Anuradhapura district's land and water resources.

Table 2. Profile of water and land resources in Anuradhapura district

Parameter	**Sri Lanka**	**Anuradhapura district (%)**
Land area (km^2)	65,610	7,179 (11%)
Inland waters (km^2)	2,905	515 (18%)
Average annual rainfall (mm)	1861	1368
Equivalent water volume (b m^3)	120	9.6 (8%)

Sources: Department of Census and Statistics (2007) and Imbulana et al. (2006)

Anuradhapura ranks among the districts with the lowest water availability in terms of annual rainfall and volume of available water. It receives an average annual rainfall of 1368 mm, which is far below the average annual rainfall of the country. This brings an estimated volume of 9.6 b m^3 of water, which amounts only to 8% of the average annual supply available to the country. More than the total rainfall, distribution of rainfall throughout the year is the more important factor. Figure 1 indicates that the area has a bi-modal rainfall pattern with prominent peak during October to December followed by a minor crest in April. On average, 74% of annual rainfall is received from October to March. Between the four to five months period from May to September, the entire area (though with minor local variations) experiences a lengthy dry spell.



Sources: Department of Meteorology and Department of Census and Statistics (2007)

Figure 1: Rainfall distribution pattern in Anuradhapura

Apparently, communally-owned small village tanks have evolved historically to answer the problem of temporal scarcity of water. As a result, Anuradhapura district has over 2500 small village tanks scattered throughout the district, and some of these date from the earliest era of the country's human settlement (Siriweera, 1994). Because of these man-made water bodies, water-scarce Anuradhapura has the largest area under inland water bodies in the country, accounting for 18% of total inland water area. However, an important observation is that a large proportion of these inland water bodies are seasonal in their nature, having available water only for a limited time during the year (Chakrabarty and Samaranayake, 1983; Thyaparan, 1982)

4.2 Groundwater in Shallow Regolith Aquifer

Since the geology in a small village tank cascade area has a relatively uniform crystalline rock foundation, the potential for groundwater in the area had initially been considered as insignificant (Fernando, 1950). However, subsequent research has confirmed that small village tank areas have two sources of groundwater, namely; weathered overburden named as 'shallow regolith aquifer' and deeper fracture zone aquifer (Herbert et al., 1988; Panabokke, 2005 and 2008). While the former has a more extensive spread at depths ranging from 3-12 m, the latter shows more sporadic distribution at the deeper zone ranging from 40 m and below (Panabokke, 2008). The shallow regolith aquifer provides the foundation for tapping groundwater for agriculture through agro-wells. Extensive surveys on groundwater resources in 50 village tank cascade areas conducted by Senaratne (1996) and Shaktivadivel et al. (1996) have helped to reveal some important information that are relevant for conjunctive management of resources and policy.

- In the undulating landscape (mantled plain) of dry zone with highlands and lowland valleys in sequence, shallow groundwater is mainly confined to lowland valley areas of village tank cascade systems. Therefore, shallow aquifer occurs as isolated pockets, and there is no continuous aquifer that spreads all throughout the plain.
- There is a limited storage capacity within the shallow aquifer, which is annually recharged, mainly during the rainy season from October to late December. Therefore, this limited storage has to sustain through a lengthy period of dry season during which water levels are continuously diminishing. Seepage flow from village tanks is one source that replenishes the fluctuating water level.
- Given the above facts, optimal management of limited groundwater resources in conjunction with the surface water in village tanks is essential. This implies proper siting of wells within cascades; managing sustainable extraction rates and safe yield levels; and maintaining an optimal density of wells within cascades as essential prerequisites for sustainable management of water resources. According to Senaratne's study (1996), the optimum number of agro-wells that could be safely accommodated within 50 cascades was not to exceed 3600.
- Disregard for these scientific facts has led to the construction of many wells, and the number is increasing. These wells are being built without consideration of sustainability issues.

4.3 Projections of Water Scarcity

Limited potential of both surface and groundwater resources has led researchers to rank Anuradhapura district among the areas with highest scarcity of water in the country. Table 3 shows the scarcity projection for the district made by the most objective assessment of water scarcity so far (Amarsinghe et al., 1999). The assessment was made under two scenarios, namely: efficiency of the irrigation remains at the current level (S_1), and irrigation efficiency improves over the project period (S_2). Accordingly, water scarcity has been projected as severe for both seasons by two indicators. However, IWMI indicator predicts that if the irrigation efficiency could be increased, water scarcity during the rainy season could be improved substantially. This again highlights the point that more than the overall supply, temporal variation of water availability is the key issue.

Table 3. Water scarcity projections for Anuradhapura district

Scarcity indicator		Yala (dry season)	Maha (rainy season)
UN indicator	1991	Severe	Severe
	2025 – Scenario 01	Severe	Severe
	2025 – Scenario 02	Severe	Severe
IWMI indicator	2025 – Scenario 01	Severe absolute	Severe absolute
	2025 – Scenario 02	Severe absolute	Little

Source: Amarasinghe et al. (1999)

4.4 Traditional Farming System and Water Management Strategy

The abovementioned physical factors have a strong influence over the farming system and resource management in the area. Farmers in village tank systems have aligned farming system activities with seasonal patterns of rainfall to minimize the uncertainty associated with water supply. Accordingly, the farming system in the dry zone has two cropping seasons, '*Maha*' and '*Yala*', which depend on the rainfall from monsoons. *Maha*, extending from October to March, is the main cultivation season supported by the north-east monsoon, the major source of water for the dry zone. *Yala*, the dry season that extends from April to September, has no major period of RF other than few intermittent rains.

Table 4 highlights the farming system and water management strategy that historically evolved in the village tanks systems. These are summaries of information from farmers and local officers in the FGDs and KIIs, and these are broadly corroborated by other researchers (Abeyratne, 1956; Tennakoon, 1986).

Traditional farming system in the area included both irrigated paddy farming as well as upland cropping activities (Somasiri, 2001; Handawala, 2004). Two major components of upland farming were first, cultivation of seasonal field crops under shifting cultivation ('chena' farming) in the *Maha* season, and second, mixed farming of seasonal and permanent crops in homestead gardens (Abeyratne, 1956; Weerakoon et al., 1987). The upland farming component was purely rainfed. Usually, the mixed-crop *chena* (shifting cultivation) used to be a very important component of the overall farming system. According to some researchers, the importance of various farming system activities varied across different localities (village tank systems) subject to the physical endowment of resources. Some argued that in many villages, highland agricultural activities were predominant over lowland paddy (Tennakoon 1986 and 2001). As expressed by farmers in the FGDs, this system had been in operation about two to three decades ago (around late1970s) with slight adjustments.

Table 4. Traditional farming system with water management strategy

Farming system activity	Crops	Seasonality		Water supply		Location	Economic status
		Maha	Yala	Maha	Yala		
Lowland farming	Paddy	All plots in the field	Limited area	Rain-fed + tank water	Tank water	Command area of village tanks. 'Bethma' system adopted in *Yala*	Mainly subsistence with limited sales if there is surplus
Upland farming	Coarse grains, grain legumes, pulses, vegetables, condiments, gingelly	1-5 acres ave. by all HH	Gingelly	Fully rain-fed	Fully Rain-fed	Shifting agriculture in commonly - owned uplands	Mainly subsistence with few cash crops (e.g. mustard)
Permanent crops	Coconut, fruits, multipurpose trees	No seasonality		Rain-fed + retained moisture in soil		Home gardens	Subsistence

In the traditional system, farmers had two major options of water management, namely: farming under direct rainfall and management of rain water harvested in the village tanks. While farming under direct rainfall is more uncertain, it offers a low cost water supply for the area. According to farmers' experience, the levels of uncertainty associated with rainfall that occur at different periods of the annual cycle are not equal. As a result, farming activities that have been aligned with seasons with high probability of rainfall have become more stable components of the farming systems and vice-versa. For instance, farmers consider extensive cultivation of gingelly in the *Yala* season under inter-monsoon rains as a high-risk activity; therefore, it has remained to be a less stable activity in the system. In addition to organizing farming activities according to the overall pattern of rainfall, farmers seemed to have fine-tuned their cultivation practices even within the season, depending on the water availability (Tennakoon 2000 and 2004; Handawala 2004). As explained by Handawala (2004), in such intra-seasonal adjustments, intensity of daily rainfall and distribution of rainy days within the season had more influence in determining cultivation practices than the total rainfall within a season.

The option of managing water harvested in village tanks had helped to minimize and even out the risk of seasonal water scarcity through community cooperation. Compared with the costless supply of direct rainfall, however, this has to be attained at the expense of some transaction cost for participation in decision-making, implementation, monitoring, and periodical maintenance of headwork and canals. Tanks supplement the subsequent late season water needs of relatively water-intensive paddy crop, which usually is established initially with the support of water from direct rainfall. Tanks also allow at least a part of paddy lands to be cultivated during the dry season. Depending on the water availability in tanks, water is allocated to paddy plots according to the system called *'bethma'* (which will be described later).

4.5 Property Rights and Local Institutions

The said system of traditional water management can be considered as a rational outcome of farmers' struggle to overcome the dual challenges of uncertainly over rainfall and the resultant scarcity of water. This has given rise to a unique system of rights over resources and local institutions that involve a complex pattern of private and common property rights. Village tanks assumed the central position in this system. Ownership of tanks was shared by owners and cultivators of paddy lands in the command area of the tank. Ownership of paddy lands, on the other hand, was held privately by individual members of the community. However, it was strongly governed by a system of local customs and institutions that helped to align the private and communal interests according to the overall situation of resource scarcity.

For instance, in the *Maha* season with adequate supply of rainfall, individual farmers were entitled to cultivate their own plots as private lands, subjected to commonly decided schedules of water management. However, during the water scarce *Yala* season, the private rights were suppressed in the common interest of food security for the whole community under the institutional arrangement called *bethma* (the division). In such occasions, community members collectively decided on the total area of paddy land that could be physically supplied by limited water available in the tank and divide this land among all members regardless of the ownership of the respective land plots. In doing so, extent of land allocated for individual farmers were determined in proportion to the individual ownership of land under the tank. In other words, individuals had to make some trade-off in private land rights in exchange for of commonly held rights to water under scarcity.

Operational arrangements in sharing water as well as in rehabilitating and maintaining tanks were also governed by an explicit system of customs and institutional arrangements. There was a village representative appointed by the community members to undertake the implementation and monitoring responsibilities of these arrangements known as *'Wel Vidane'*. *Wel Vidane* was paid for collectively by community members through a share of their harvest. *Wel Vidane* had a strong executive authority over agriculture matters in the village and he implemented the collective decisions of the community members. He could report any disobedience to his orders to the tribunals held by village councils known as (*Gam Sabha*). The village council had the power to impose fines against perpetrators of violations of collective decisions and social customs.

Aside from the village tanks, the watershed area of the tanks as well as other surrounding uplands, were likewise traditionally held under common ownership (Ulluwishewa, 1997). Certain commonly held upland blocks had specifically designated roles in the traditional farming system; some of them being strictly for conservation purposes (Ulluwishewa, 1997; Dharmasena, 2004; Handawala, 2004). Tenure of such common lands was apparently governed by customary laws. Among other uplands, villagers had private tenure rights over homesteads and surrounding home gardens located in the resident area known as '*gangoda'*.

Table 5. Profile of village tanks and paddy land in study villages

DO Division	Village	No. Households	No. Small Tanks	Total Paddy Area (Ac)	Total area of 'Purana Wela' (Ac)	Avg. paddy extent per HH
Tirappane	Paindikulama	244	04	285	76	1.16
	Mahakanumulla	80	01	190	90	2.38
	Mawathawewa	120	08	210	110	1.75
	Periyakulama	120	04	305	139	2.54
Sivalakulama	Wembuwewa	114	04	172	28	1.51
	Dambagollewa	165	04	143	34	0.87
	Galwaduwagama	525	06	269	17	0.51
Galenbindunuwewa	Mailagaswewa	109	09	359 (-60)	122	2.74
	Himbutugollewa	145	05	285	113	1.97
Kahatagasdigiliya	Gangurewa	130	06	337	145	2.59
	Pattilapuwewa	85	01	120	25	1.41
Mihintale	Siyambalagaswewa	65	(01)	10	-	0.15
	Katukeliyawa	40	01	20	-	0.5
	Pahala Halmillewa	100	02	125	22	1.25
Andiyagala	Upulwehera	250	05	127	47	0.51
	Maneruwa	145	03	263	50	1.81

Source: Based on information from FGDs and Farmer Organizations

5.0 CHANGE AND COPING WITH THE CHANGE

5.1 Causes of Change

The village tank system is currently undergoing a transformation that may surpass any transition it has ever experienced for over two millennia. The causes of this transformation are deep rooted and complex. By analyzing the information collected from farmers, officers, as well as secondary sources, four fundamental factors emerged, namely: rapid increase in population; policies of colonial rulers and successive independent governments; speedy commercialization of rural economy; and 'modernization' of farming technologies. These factors have been pointed out as major changing agents by other researchers such as Panabokke (2004), Wanigaratne (2004), and Ulluwishewa (1997). As in the traditional system, these factors also are best understood as agents that change the situation of absolute and relative scarcity of land or water resources in the local areas.

5.1.1 Population

Rapid increase in population is the primary cause or fundamental reason of the current transitional change. While official statistics on changes in village-level population are hardly available, Panabokke (2004) estimated from various sources that population changes in so-called 'traditional villages' (*Purana gam*) could be as high as 7-10 times during the last century. The number of households in the 16 study villages ranged from 40 to 525. High population increases the scarcity of land resources through land fragmentation and land degradation. Paddy lands in command areas of certain tanks are highly fragmented and many individual parcels are less than 0.5 acres (Wanigaratne, 2004).

Table 5 shows the profile of village tanks and paddy lands in the sample of villages in the present study. According to the table, paddy area per household has dropped drastically in certain villages (e.g. Siyambalagaswewa, Galwaduwagama, Katukeliyawa and Upulwehera). Discussions revealed that farming systems in such villages have undergone fundamental changes in favor of upland farming. The natural response of young generation of farmers in such villages was to encroach in surrounding state lands (formerly common property lands) for upland farming, thus leading to rapid degradation of land and water resources.

Farmers have also raised the issue that large populations in villages usually affect the cooperation among community members negatively. This was generally observed by many CPR researchers as well (Agrawal, 2001).

5.1.2 Government policy

Since the era of British rulers, a number of policies and legislations have affected the tenure rights and institutional arrangements in the village tank setting. Abeysinghe (1977) and the Government of Sri Lanka (1991) discussed these substantially. In-depth evaluation of such policies is beyond the scope of this study. Instead, we attempted to summarize the major impacts of a few key policies in Appendix Table 1.

Overall, it can be asserted that these legislations gradually altered the legal and policy framework favoring individually-oriented resource tenure over traditional community-based resource tenure. However, this has been an incomplete process and it has left a legacy of complicated policy environment with mixed signals to resource users.

5.1.3 Commercialization

Liberal economic reforms introduced by the government of Sri Lanka since 1977 progressively connected rural economies to the global markets. The process of commercialization was accelerated recently in the study area by some developments that included: penetration by agri-product manufacturers and middlemen into local areas offering forward contract arrangements, especially for maize and soy; establishment of the major Economic Centre in Dambulla (a regional wholesale market) to collect and forward rural agricultural products into urban markets; entry of private seed manufacturers with contract farming options for products such as chili and vegetable seeds; and emergence of local value-added rice industry with local collectors, medium and large scale millers, and an island-wide distribution network. These improvements enhanced the market access for local producers in an unprecedented manner during the last one to two decades. As a result, market opportunities opened for many crops that have been traditionally cultivated by small village tank farmers in shifting cultivation lands at subsistence scale.

According to the farmers and local officers, the farmers' entry into the commercial stream to facilitate the supply side was a gradual process with three major steps or waves. The first wave was partial commercialization of lowland paddy farming as enabled by the productivity improvements introduced by the green revolution technology package from the 1960s. The second wave was the commercial production of upland field crops (especially chili and onion) during the dry season supported by water supply from agro-wells from the late 1980s. The third wave was the rapid sweep of rain-fed commercial farming of maize during the *Maha* season replacing the traditional shifting cultivation from around 2000. To a certain extent, commercialization has also been facilitated by the production improvement programs launched by agricultural agencies at the provincial and central government levels. The cumulative effect of all these factors has enhanced the emergence of a class of commercial farmers who undertake year-round production of cash crops under agro-wells with speculative market expectations.

5.1.4 Agricultural technology

Adoption of technological innovations had significantly boosted the commercialization of local economies. Technological innovations such as hybrid seeds, fertilizer, pesticides and other chemical inputs, water pumps, tractors, land preparation machinery, mechanical threshers, and others have huge potential to transform the traditional farming system. These innovations have improved productivity and have helped to overcome rising labor wages in the study areas. Adopted in variable degrees in the different study villages, these new technologies have widely altered the traditional farming system with far reaching consequences in more commercialized villages (e.g., Mawathawewa, Mailagaswewa).

Agricultural technology seems to have a cumulative impact on transforming the traditional system of resource management in village tank systems. Population growth has increased the scarcity of land and water resources, thereby pushing the farmer community towards alternative ways of resource management. While the impact of policies adopted by the government, with mixed incentives for different directions, is quite ambiguous, commercialization and technological innovations together have provided a clear direction for farmers to overcome resource scarcities. These two factors have intensified the production of cash crops to meet the market demand. Overall, the net effect of all key factors seemed to push traditional farming system towards commercial orientation. Sample villages in the study showed different transitory stages of this process of commercialization.

5.2 Transformation of Traditional System of Resource Management

From the resource management perspective, key questions include: how have farmers responded to the said causes of change? What impacts have they experienced? Answers to these questions are best taken from primary sources such as farmers and local officers as well as experts because changes in the village tank systems are so rapid and there are only a few studies on these changes. Analyzing the information from these primary sources, we recognize that farmers have adopted three major strategies to face changes, as follows:

- Intensify the rainfed upland farming component (shifting cultivation) of the traditional farming system
- Augment the water supply by intense extraction of groundwater from shallow regolith aquifer through agro-wells
- Extend the lowland paddy area beyond the original command area *(Purana wela)* and rehabilitate abandoned tanks for paddy production

The farming system component undergoing the highest degree of modification is rainfed upland agriculture, especially shifting cultivation (*chena* farming) in the *Maha* season. This is an economically rational move as the farming under direct rainfall is the lowest cost option for supply of water. Further, the probability of *Maha* season rainfall is relatively high (less uncertain) compared with rainfall in other periods of time. Under the present transformation, traditional characters of this farming activity, namely: subsistence purpose, shifting behavior, extensive nature of farming (low-input, labor intensive), and diversity (multiple cropping) have been drastically altered. Instead, rainfed upland farming is fast being converted into high-input, capital-intensive farming activity of few commercially in-demand crops based on permanent land blocks. This is undertaken in encroached state lands where only a few farmers have secure rights of tenure, either as conditional deeds granted by the state or as temporary permits.

Even though farmers still use the term *chena,* it should be noted that this is not the same shifting cultivation activity in the traditional farming system. As revealed in the FGDs, major changes in this farming system component began around 2000-2002 with forward contracts offered by contract farming companies for maize and soy. This wave of commercial farming has spread faster than the wave of dry season upland commercial farming under agro-wells that started in the late 1980s. It seems that low capital and operational cost requirements for water supply, high assurance of market, support offered by contract farming companies, and loan facilities made available by banks on the guarantee of companies were the major reasons for this situation. As a result, upland farming in *Maha* had become the major source of cash income in majority of the villages.

Agro-wells have enabled farmers to add the shallow groundwater storage to the portfolio of available water resources, thereby augmenting the water supply for farming, especially during the dry season. However, compared with water from direct rainfall or community-managed tanks, this is the most expensive option for water supply. Agro-wells require substantial capital expenditure for construction and pumps as well as regular operational cost for fuel used in pumping. As this cost has to be borne privately by individual farmers, agro-wells can only be availed of by farmers who can afford it, unlike the relatively uniform, freely available water supply from direct rainfall or commonly managed tanks.

The major categories of crops cultivated under agro-wells were chili, onion, and vegetables, which had a ready market in the regional wholesale market in Dambulla. Recently, contract farming has expanded the market opportunities for chili and vegetable seeds. Farming under agro-wells is carried out in upland areas and in fallow paddy fields during the dry *Yala* season (e.g., Upulwehera). However, year-round cultivation of cash crops under agro-wells has also emerged in a few areas.

Table 6. Profile of agro-wells in study villages

Village	No. households	No. agro-wells[1]	No. HH per agro-well	Paddy area/ agro-well
Paindikulama	244	80	3.05	3.56
Mahakanumulla	80	10	8.0	19.0
Mawathawewa	120	>200	0.6	1.0
Periyakulama	120	60	2.0	5.08
Wembuwewa	114	50	2.28	3.44
Dambagollewa	165	50	3.30	2.86
Galwaduwagama	525	78	6.7	3.45
Mailagaswewa	109	100	1.09	3.59
Himbutugollewa	145	70	2.08	4.07
Gangurewa	130	65	2.0	5.18
Pattilapuwewa	85	15	5.67	8.0
Siyambalagaswewa	65	77	0.84	0.13
Katukeliyawa	40	40	1.0	0.50
Pahala Halmillewa	100	23	1.35	5.43
Upulwehera	250	250	1.0	0.51
Maneruwa	145	15	9.67	17.9

Source: Based on information from FGDs. Numbers given are approximate.

Table 6 provides a profile of agro-wells in selected villages. It seems that the popularity of agro-wells farming varied highly among the villages. Even though the number of agro-wells appeared to be increasing in all the villages, the rate of increase was highly variable. In many villages, agro-wells fulfilled a supplementary role in highland farming during the dry season, whereas in a few villages (e.g., Siyambalagaswewa, Katukeliyawa) they were being used for year-round cultivation of commercial crops. With the recent escalation of fuel prices, certain agro-wells have been abandoned, at least temporarily. However, in a few villages where the contract farming has offered lucrative opportunities, farmers have dug even temporary agro-wells.

In addition to expanding the upland component of traditional farming system by intensifying the farming activities and augmenting the water supply from agro-wells, farmers have attempted to expand the lowland paddy area. There are two types of paddy lands in the command area of a given tank, commonly known as *'purana wela'* and *'akkara wela'*. *Purana wela* is the original command area of the tank, and *akkara wela* is composed of grants of one acre plots given under command area expansions in the 1940s and subsequent expansions by farmers (Witharana 2009). Over the years, farmers have further expanded the lowland paddy area by planting in adjacent lands. Table 5 indicates this trend by the fact that *purana wela* is now only a fraction of the total command area in many villages. Time and again, various agencies and projects have also helped farmers expand the paddy area by rehabilitating abandoned tanks and constructing channels, thus connecting water sources outside the village. This is indicated by the fact that some villages have some small tanks with small command areas.

Overall, the transformation of traditional farming system by the adoption of commercial farming under rainfed conditions and agro-well irrigation has significantly increased the income-earning capacity of farmers in the area. This has dramatically improved their living standards. Farmers usually explain this improvement by comparing their past and present asset profiles, such as the number of permanently-built houses and electrified houses as well as the ownership of motor cycles, tractors, vehicles, and others. In general, both younger as well as older generations of farmers were positive about the economic prospects brought about by changes in the farms. However, certain members of the two groups were sharply divided in their opinion over the desirability of the emerging lifestyle. Another important fact is that prosperity brought about by this transformation differed significantly across the villages.

5.3 Problems of Sustainability

From the resource management perspective, improved economic prospects brought about by ongoing transformation should be assessed carefully vis-à-vis resulting environmental impacts. The following broad consensus on the critical environmental impacts was drawn from farmers and experts alike:

- *Accelerated siltation of tanks because of commercial farming in upland catchment areas and paddy farming in land area immediately above the tank (locally known as tawulla).* This process had significantly been accelerated in almost all village tanks because of the recent spread of commercial upland farming. This reduces the water storage capacity, thereby decreasing the irrigation potential of tanks.

- *Disturbance to the local balance of water because of the heavy pumping of groundwater from agro-wells.* This can potentially create overall imbalances in local water availability, thus affecting the water stored in tanks. This also dries out the moisture content of the local ecosystem in general.
- *Development of salinity in lowland paddy lands because of indiscriminate expansion of command areas blocking the path of salinity draining canals.* This decreased the productivity from paddy land because of the increased salinity in the affected area, especially in *purana wela.*
- *Pollution of local water resources and eutrophication of village tanks because of the heavy use of chemical inputs such as fertilizers, pesticides, and weedicides.* There is no clear idea on the repercussions of this process, but farmers have attributed some undesirable effects, both visible and hypothetical, to this damage.

Despite the broad consensus among farmers and experts over the above issues as major environmental problems, there was no consensus on the problems' importance, priority, and potential impacts. Generally, both groups agreed that rapid siltation of tanks was the most severe environmental issue that needed urgent attention. Notably, both groups seemed to appreciate the fact that water in tanks played a more fundamental role in the local environment than just irrigating the command area. Researchers likewise recognized the village tanks as providing environmental and ecological services.

Among others, water tanks help stabilize the surrounding environment by augmenting the water table, ameliorating the harshness of the dry season, and conserving biodiversity by supporting a community of aquatic and terrestrial organisms (Navaratne, 2000; Panabokke et al., 2000; Tennakoon, 2001). One primary purpose of village tanks is to prevent floods during seasons with excessive rainfall (Handawala, 2004). As these services are public goods, their sustainable management under an emerging commercial economy poses a challenging task.

However, opinions over the impact of agro-wells over the village tanks were somewhat divided between the experts and farmers. In contrast to the serious concern of some experts, many farmers as well as some local officers believed that the pumping of water through agro-wells had no significant impact on village tanks. They argued that pumping was usually done during the dry season when tanks provided little support for farming. Therefore, even if the water level of tanks could go down slightly due to pumping of water from agro-wells it is more economically advantageous to use water in upland crops with high cash potential than in water-intensive paddy with limited cash potential. Further, farmers argued that as both tanks and wells are filled annually by October to December rainfall, there would be no issue of long-term sustainability.

The groundwater experts, on the other hand, seemed more concerned about maintaining the fragile balance between surface and groundwater resources, local ecosystems, and the interconnection between shallow and deep aquifers. They have also raised the issue that groundwater potential existed only in limited pockets because of geological properties of the area, and that indiscriminate digging was a wasteful exercise as indicated by many abandoned wells. Some farmers from villages with high density of agro-wells agreed with the experts that indiscriminate digging could be harmful and that wells are being dug even in hydrologically sensitive areas. In general, farmers as well as experts seemed to agree that some control should be exerted over the construction of agro-wells.

5.4 Evolution of Property Rights and institutional Arrangements

The community's responses to broad sweeping changes taking place in the local system have brought far-reaching effects on the property rights and institutional arrangements in the area. Since farmers experienced more major modifications in the upland farming component. More adjustments can also be observed in the tenure of resources associated with this component. As described earlier, in the traditional system, farmers in the upland component had limited individual rights, except for the homesteads. Further, local customs governed mainly the uses of upland. This was low-input, upland farming system that depended on natural fertility of the soil. Under the low productivity system, shifting behavior was an essential practice that necessitated keeping the upland chena area under a common ownership. Even after the British rulers acquired these commonly held lands into crown ownership in 1840, these lands continued to remain as de facto common property until recently. However, deep-rooted socio-economic changes during the last few decades have effectively converted these lands into de facto 'private' ownership within a very short period of time. Legally, majority of such lands are state lands, which have been encroached upon and 'developed' by those who occupy them.

The change described above has strong implications over the resource management of the entire village tank systems. Even under the de facto common property status after the Crown Land Encroachment Ordinance, informal customs continued to prevail over the tenure of uplands to a large extent, making an overall balance among resources under different regimes, including village tanks (Ulluwishewa, 1997). According to Leach (1956), all aspects of resource tenure found in the village tank systems were effectively 'traditionalized' (Leach, 1956). According to farmers and local officers, a set of informal, customary rules governed many aspects of local resource use by village communities a few decades ago. These rules controlled many activities pertaining to tenure of local resources including catchment conservation, regular maintenance and periodical renovation of tanks, utilization of community held uplands for agriculture, and others.

Gradual conversion of uplands into de facto private property has left a wide gap in the local resource management because of the erosion of local customs and rules. As the population increases and as farming systems rapidly commercialize around upland farming activities, tenure patterns that uphold the private rights of individual farmers are becoming stronger. Many villages have over 200 households, and some even have more than 500 households. Besides the growing number of households, households are also expanding their activities over wider spaces of land and other physical resources. As a result, even though all these households have some kinship relations, the feasibility of organized collective action among large community groups is ever diminishing. So is the effectiveness of customary rules for governing the behaviors of community members. This situation has rendered traditional institutions ineffective.

As a result, community management and collective action have become largely restricted to village tanks, the only existing common property resource under the stewardship of Farmer Organizations. Decisions regarding the use of tank water are usually taken up in '*Kanna Resweem'* (seasonal meetings), which are participated in by members of the Farmer Organizations and local officers from the Agrarian Development Department (ADD). In seasonal meetings, farmers collectively decide on: (a) how to use the water available in tanks subject to pending uncertainties of rainfall, (b) dates of water issue (starting date, periodic issues, and last issue), (c) the calendar of cropping activities (time schedule for land preparation, broadcasting, water supply, and harvesting), (d) clearing, maintaining, and repairing of tank bund, channels etc., and (e) other matters concerning the use of water including fisheries and aquaculture. Government officers are involved as facilitators and guarantors rather than representatives of any state ownership claim. However, minutes taken by the village-level officers (usually by the Agrarian Research and Production Assistants of ADD) showed that the government officers have some official status if a conflict arises subsequently over a decision taken in the meeting. In addition to the allocation of water for irrigation and fisheries, rights for other minor uses of tank water such as for domestic water, animal husbandry, etc. are usually governed by social customs rather than by any formal institutional mechanism.

While Farmer Organizations involve some level of collective action, the system appeared weaker than it used to be, as observed by farmers who have experienced the traditional system. The strength of the Farmer Organizations is highly variable in different villages. In villages where lowland paddy farming is still prominent, participation for collective action and compliance with the decisions of Farmer Organizations appeared to be satisfactory. In other villages, especially where commercial cash crops under agro-wells are produced year-round, the Farmer Organizations is rather weak. Only a few active members run the organization, and the only bond that keeps the farmers at least nominally in the organization is government incentives such as fertilizer subsidies.

Overall, ownership and tenure patterns of village resources associated with the tank system have undergone significant and cumulative changes during the last few decades. A major outcome of this transformation had been the gradual erosion of communal tenure patterns in favour of private ownership and tenure (Ulluwishewa, 1997). This has dramatically altered the traditional CPR management system that survived over two millennia, leading to the inevitable erosion of social customs that upheld the cooperation and collective action among village communities (Ulluwishewa, 1997).

6 SCOPE FOR INTEGRATED MANGEMENT OF RESOURCES: POLICY IMPLICATIONS AND RECOMMENDATION

6.1 Policy Implications

Ongoing changes taking place in village tank systems have given rise to a complex problem of land and water resource management. This problem encompasses adverse physical impacts over village resources because of the disintegration of local institutions; intensification of resource use under unmanaged conditions (e.g., spread of intensive commercial farming into sensitive areas of upland watersheds); creation of various production externalities (e.g., siltation of tanks, chemical pollution); ill-defined access and use rights for interconnected village resources (e.g., haphazard expansion of groundwater utilization, encroachment of sensitive upland areas); and decline of cooperation among community members. Given that these issues are closely interconnected, addressing any one of them in a partial manner is unlikely to create desired results. Therefore, the village tank systems demand a holistic approach to prevent further losses of economic and social welfare, which seem quite likely unless emerging issues are duly addressed.

However, any solution strategy should be based on objective assessment of ground conditions and expectations of local communities. In the first place, the traditional system that was based predominantly on the concepts of common property resources, local customs, and collective actions has altered drastically over the last decades. Despite the high resilience and sustainability displayed by the traditional resource management system, it could only support a low productivity farming system with limited cash income potential.

The causal factors that have transformed the traditional system are broad sweeping, powerful forces of social change. The production system being evolved as a result of these factors has the potential for high level productivity and high income than the system it is replacing. Given the circumstances, it seems that the ongoing transformation is irreversible, and there is no reverting back to the past system, however environmental-friendly it may be. Instead, we need to identify the strengths, weaknesses, and gaps in the emerging system so that we can make it more sustainable than the present. Therefore, any technical/ institutional interventions or policies should aim at finding a sustainable path of transformation rather than preserving or re-establishing the old order.

6.1.1 Scale and Magnitude of the Problem

It is useful to get some idea about the scale and magnitude of the problem before discussing ways to overcome it. All available accounts indicate that the complex resource management problem described in the preceding sections is actually a macro issue that affects livelihoods of thousands of farmers scattered throughout dry and intermediate zones of Sri Lanka. According to Witharana (2004), there are around 12,000 functioning tanks in the country, which service a command area of over 168,000 ha. These tanks help around 320,000 farm families. Our observations in the sample villages as well as the findings of other researchers indicate that local communities in a majority of tank villages are currently experiencing at least few issues related to the problem at variable levels of intensity (Dharmasena, 2001 and 2004).

In fact, the magnitude of certain issues seem to be well recognized by policy makers as evident by the significant public expenditure on village tanks, especially for raising the bunds of tanks under siltation. More than lack of recognition, the poor perception of the problem and the addressing of symptoms rather than of causes are the matters of concern here. Many such efforts have been made under the pretext of enhancing water supply for rice production without much concern for overall resource management problem or its causes. Even statistics on village tanks reflect this by covering only paddy production with hardly any information on highland uses where the actual roots of the problem lie. Paddy farming is only one component of the local system, and village tanks play a far greater role in the livelihood of farmers and the local ecosystem beyond paddy (Tennakoon, 2001). Karunaratne (2008), based on a study conducted in 10 village tanks in Hambantota district, concluded that tank rehabilitation was not economically justifiable on the ground of benefits of paddy production alone unless other multiple uses such as fish, domestic water, livestock, local industries (e.g., brick making) as well as recreation values were also considered.

6.1.2 Emerging Scenarios of Resource Use and Feasible Outcomes

An emerging commercial system seems to be overriding the many physical and socio-economic differences among village tanks systems, by compelling village communities to adopt a few land and water use practices. Village communities adopt these options based on strategic advantages available in their specific local contexts. For instance, communities in lower reaches of cascades may tend to retain prominent lowland paddy farming component as higher availability of water resources and broad lowland valleys provide comparative resource advantage for them over others for lowland paddy in commercial scale (Dharmasena, 2009). Table 7 presents the major land and water use scenarios that may be addressed by integrated management solutions.

Table 7. Major land and water use scenarios

Scenario	Villages in the study sample	Key characteristics	Major resource management issues
Dominantly paddy farming with limited upland farming activities	Mahakanumulla, Periyakulama	Relatively high per capita and total paddy extent; Village tanks with high water capacity; Significant paddy cultivation in both seasons; Active Farmer Organizations; High number of HH per agro-well (low density)	Siltation of village tank; Salinity build-up in paddy fields
Dominantly rainfed commercial upland farming with limited paddy and agro-well farming	Paindikulama, Himbutugollewa, Dambagollewa, Wembuwewa, Galwaduwagama, Gangurewa, Pattilapuwewa, Pahala Halmillewa	Large area under upland commercial farming in *Maha*; Paddy mainly in *Maha*; Paddy area is highly fragmented; High to medium number of HH per agro-well (low to medium density)	Siltation of village tanks; Pollution of water resources; Salinity build-up in paddy fields
Dominant Agro-well farming	Katukeliyawa, Siyambalagaswewa, Upulwehera	Dominant agro-well farming (some cases year round); Very limited paddy farming or rain-fed upland farming activities; Farmer Organizations are relatively weak	Siltation of village tanks; Disturbance to water balance because of heavy agro-well pumping; Pollution of water resources; Salinity build-up in paddy fields
All commercial (Rainfed upland + Agro-well + Paddy)	Mawathawewa, Mailagaswewa	All three farming components developed into commercial scale; High level of resource use intensity; High potential for all types of resource degradation	Siltation of village tanks; Disturbance to water balance because of heavy agro-well pumping; Pollution of water resources; Salinity build-up in paddy fields

It seems that the system of dominant upland, rainfed, commercial farming component with limited paddy, and agro-well farming activities is the most common scenario to be addressed by technical, institutional, and policy solutions. Although a few villages have evolved a fully commercialized system based on all major farming system components, this system cannot be considered as a logical final scenario for all villages. Similarly dominant agro-well faming component with year-round cultivation also seems to be rational in certain circumstances only.

It is difficult to make an objective assessment of likely outcomes from the unimpeded continuation of the above land and water use scenarios because of limited data. However, information from certain studies helps us to project some ideas about the key features of a 'dominant scenario' of feasible outcomes, unless major resource management issues (Table 7) would be countered by appropriate technical, institutional, and policy measures. From the policy makers' point of view, this can be considered as a 'do nothing' or 'without-the-project' case for making policy decisions. Accordingly, the feasible scenario of outcomes seem to be centered on accelerated siltation of tanks, resultant loss of storage capacity, and associated changes in system hydrology (water balance) and local habitats.

Dharmasena (2001 and 2004) described that accelerated process of siltation does not only reduce water storage capacity but also modifies the tank bed geometry. This leads to shallower water bodies resulting in further water losses because of increased evaporation. Somasiri (1991 and 2001) assessed that runoff water from the catchment is an important source of water supply for tanks. Growing activities of commercial upland farming in the catchment area have disturbed the runoff flow by blocking and altering the natural streams that fed into tanks. These effects could significantly affect the water balance of the system, creating repercussions over the farming system as well as in local habitats. For instance, reduced water availability in tanks because of capacity losses, evaporation, and stream flow disturbances would decrease the cropping intensity of paddy, especially during the dry season. Similarly, continuous soil loss from upland areas may reduce the fertility, thereby causing productivity and income losses in commercial farming activities.

Overall, these effects would produce a net increase in water and land scarcity, thereby reducing the productive capacity of tanks and interconnected resources. Additionally, other effects such as haphazard expansion of groundwater utilization, increased pollution of tank and local environment, and building up of salinity because of unplanned command area expansions would create a cumulative negative effect over the welfare of local communities. The communities would experience economic, social, health, and environmental losses. Therefore, stakes that are at risk because of the changes taking place in village tank systems appears to be quite significant.

6.2 Towards an Integrated Resource Management (IRM) System: Some Recommendations

Complex problems call for complex solutions. Given the number of resource issues involved and their complex interrelationships, land and water resource management in village tank systems demand a holistic approach with multiple strategies to address respective issues. It entails innovative interventions in the spheres of technical improvements, institutional arrangements, and policy reforms. Among others, there are three major areas to be addressed by the proposed interventions, namely:

- Restoring and maintaining physical conditions of degraded resources through enhanced resource management practices;
- Filling institutional gaps created by the collapse of the traditional system of local resource management through institutional innovations, and;
- Introducing enabling policies that can enhance the effectiveness of technical and institutional interventions.

In other words, problems in village tanks require an integrated resource management approach. It is highly unlikely that a uniform solution strategy, which can address the requirements of all village tank contexts, would be developed. Instead, what we attempt here is to identify the broad scope of interventions and outline potential strategies that can fill current gaps in resource management and help in redirecting the ongoing transformation along a sustainable path.

6.2.1 Aims and objectives of IRM

There are three major broad objectives for integrated management systems, namely: efficiency, equity, and sustainability of local resources. It is always a tough task for policy makers to balance these objectives in selecting feasible alternative actions to address resource issues. In village tank systems, this may seem quite challenging as the act of balancing involves choices between a low productive, yet relatively environmentally benign traditional system and an economically more attractive, yet high demanding system over local resources.

The existing system seems to be in a transitory stage between a traditional system based on community cooperation and an emerging commercial system based on private initiative. This is best exemplified by the sharing of water in village tanks through community management while shifting rapidly towards commercial farming under forward contract arrangements. We believe that it is an impossible task for outside policy makers or researchers to select and decide on the final activities that could balance competing objectives in a given specific local condition. Hence, we propose that we leave the responsibility of making the final selection among available options to community members through a participatory process. Policy makers would instead focus on creating a conducive environment that could enhance the success of the villagers' selections.

6.2.2 Restoring and maintaining the physical conditions of the resource system through enhanced resource management practice

Restoring and maintaining the physical conditions of resources from their degraded state is the essence of the proposed system of integrated resource management. The system has to be attained through the adoption of enhanced resource management practices. Appropriate management practices should be selected based on what effective technical means are available to restore key resources that have faced the threats of degradation. In the past, the traditional system has managed to overcome these problems through the adoption of low-resource intensive technologies. The emerging system that is replacing the traditional system is a highly resource-intensive system, which creates pressures on natural systems. Hence, management practices to overcome the problems created by emerging activities involving intensive resource use should be selected based on their technical merits.

One may find it tempting to propose market-based instruments such as payment for ecosystems (PES) to be applied here given the rapid drive towards a market economy and the involvement of various production externalities. However, we observed some conditions that might constrain this approach in the area. First, both acting and affected parties are the same, and they comprise poor marginal farmers. Second, the situation of property rights is quite ambiguous. Finally, given political sensitivities, the chances for introducing a payment scheme seem quite low.

Therefore, we recommend a participatory land use planning and management approach as an ideal intervention for restoring and maintaining the physical conditions of resources. This move could create the necessary conditions for the application of improved practices of land and water management. The essence of participatory land use planning should be a system of zoning local resources based on their suitability for different production and conservation activities. The key elements of the participatory land use planning and management system should include the following:

Identify and establish zones of production and conservation through participation of farmers in every village. It is necessary to identify a zonal arrangement, especially for upland areas, for production and conservation purposes. This has to be undertaken through a participatory process that involves members of the farming community as well as local officers (local representatives of government agencies involved in land and water resources).

Demarcate each zone physically. All zones thus identified should be physically demarcated using appropriate means of boundary marking acceptable to all stakeholders involved. This is particularly important as lack of visibly demarcated boundaries for already existing zones such as 'tank reservation' create difficulties when officers make recommendations on alienation of state lands and inquire about complaints on encroachments.

Establish norms of production for each zone. Zones may include areas for:

- Production activities with no restrictions applied;
- Conservation purposes with no production activities allowed, and;
- Production activities permissible subject to appropriate conservation measures are in place (e.g., bunds and terraces, conservation hedges).

Norms of standards for each zone have to be identified and declared with penalties for violation and non-compliance. All types of norms/ standards should be identified through a participatory process. Norms/standards should be flexible enough to be revised later based on practical experience of success/failure through a similar participatory process.

Implement standards for agro-well construction. Standards applicable for construction and utilization of agro-wells should be declared for each zone. Here, experiences of farmers as well as standards/guidelines introduced by government agencies may also be considered. These may include density of agro-wells permissible in a given zone, distance between wells, size/depth of wells, capacity of pumps to be used, etc.

Researchers have described elaborate local arrangements of land use planning and management that existed in the past until the early 20th century (Ulluwishewa, 1997; Dharmasena, 2004). While the broad principles and certain local arrangements may still be applicable, broad revisions may be necessary to accommodate and tackle new resource management issues that have arisen because of the rapid changes taking place in the systems. Moreover, traditional arrangements for monitoring and ensuring compliance have also collapsed. The essence of the participatory land use planning and management process is to reestablish the control over indiscriminate activities currently taking place, especially in upland areas. Given the current realities of social change, such a control cannot be achieved unless a formal process that has the backing of state agencies is also in place.

There is some limited experience of participatory resource management in the same areas under the Sri Lanka-Australia Natural Resource Management Project (SLARNMP) that concluded recently. This project has tried to draw community support for the community forestry initiative of the Forest Department in dry and intermediate zone areas. In these zones, 50 community groups around local forest patches have worked with local authorities to develop village resource profiles, including village tanks, and to draft five-year resource development plans with annual operational milestones through a participatory process. In addition, some cascade development programs have been supported by NGOs and donor-funded projects. Lessons from these programs may be useful in designing integrated resource management programs in village tanks.

The focal point of the participatory process should be Farmer Organizations. Despite their current weaknesses, the Farmer Organization is the only legitimate local institution that can assume the responsibility of filling the gap created by the disintegration of the traditional system. It derives its legitimacy from three major factors. First, the current paddy farmers in tank command areas are also the ones responsible for the harmful activities in upland areas. Second, Farmer Organizations already enjoy some legal status under the *Agrarian Development Act 2000.* Third, they have experience in managing the activities of village tanks and lowland paddy farms for over two decades. The major drawback of Farmer Organizations is that currently, they do not have any control over farming activities in upland areas. Ways of strengthening the position of Farmer Organizations to meet this challenge will be discussed under institutional innovations and policy reforms in the forthcoming sections.

Many sustainable farming system practices have been researched and introduced during the last few decades. Table 8 summarizes such practices. In the current realities and context of the village tank system, the essence of enhanced management practices is to control the damage from externalities of commercial upland farming systems to local water resources, i.e., village tanks, local water balance, and habitats. Proposed solutions include actions to be adopted by individual farmers (e.g., conservation farming, IPM, organic manure); measures to be implemented with community participation (e.g., catchments conservation measures; partial desiltation); and collectively synchronized individual operations of farmers (e.g., salinity control measures). The effectiveness of these solutions to resource management issues has been proven to a certain degree by researches by the Department of Agriculture. However, higher acceptance of these innovations must be promoted Measures to promote adoption are discussed under the forthcoming section on policy reforms.

Table 8. Scope of technical solutions

Environmental/resource management issue	**Scope of main technical solutions**	**Remarks**
Siltation of tanks	– *Conservation farming* for upland commercial farming and protection of tank catchments – *Partial desiltation* for rehabilitation of tanks – Introduction of catchment management measures	Many of the available technical options have been experimented, field tested, and introduced to farmers under certain projects. Adoption failures observed for reasons other than technical ineffectiveness.
Disturbances to the water balance because of agro-wells	– Implementation and monitoring of technical standards and guidelines for conjunctive management	Guidelines and standards based on research outputs have been developed. No participatory assessments have been done. Applied in recommendation of incentives for agro-wells, but no effective implementation at present.
Pollution of water sources	– Promotion of *organic manure* and suitable techniques of *organic farming* – Promotion of *Integrated Pest Management* (IPM)	Many of the technical options have been experimented, field tested, and introduced to farmers under certain projects. Adoption failures observed for reasons other than technical ineffectiveness.
Building up of salinity	– Field implementation of salinity control and drainage measures	Practices have to be designed to match local conditions. Practices of traditional system may be invigorated.

6.2.3 Institutional innovations

Institutional innovations define institutional arrangements that may ensure the successful implementation of the enhanced management practices for restoring the physical conditions of resources. Innovations proposed here cover prospective arrangements to fill major gaps that exist in the current institutional setting. The gaps are most crucial in the governance of land resources for upland farming activities including lands in sensitive areas such as tank catchments. Traditionally, these resources have been governed by a system of local customs and institutional arrangements that restrained individuals from engaging in unsustainable practices. The local system further ensured the participation of village members when communal efforts were necessary, and it maintained vigilance over the actions of individuals when it clashed with community interest.

However, as village tank systems are fast being converted into intensive commercialized systems, this traditional system of local institutions and customs is gradually being rendered ineffective. This has left a large gap in governing the activities of individuals. This gap can create external cost over others as well as over local habitats, thereby creating highly unsustainable outcomes. Inasmuch as evolving technical and socio-economic conditions are fundamentally different from past conditions, it is no longer feasible to revive the traditional system of social customs and local institutions. Therefore, suitable institutional arrangements that can address the governance issues of the emerging setup must be introduced. The following institutional arrangements are proposed to address these gaps.

Extend the scope of activities and powers of Farmer Organizations to monitor zonal activities identified under proposed participatory land use planning system in lowland as well as in upland areas. Presently, the Farmer Organization is the only local institution involved in managing village resources. However, the scope of its resource management activities is restricted to sharing of tank water for irrigation and undertaking of minor rehabilitation activities. Further, it has no control over the harmful activities of commercial upland farming threatening the village tanks, even those activities in the tank reservation (the immediate catchment area of tanks), once effectively controlled by local customs. And to think that the village tanks are the only significant asset under the purview of Farmer Organizations. Hence the gap created by the collapse of traditional control over upland activities has to be restored in a manner that can be quickly monitored and implemented effectively. Despite its present weaknesses, however, the Farmer Organization is the only institutional arrangement that can fill this void.

Establish a local mechanism for arbitration of minor conflicts and violations of agreed upon local arrangements of participatory land use planning. Even the local officers of ADD do not have any significant powers to intervene in upland farming activities. The only authorities on highland areas are Divisional Secretaries and Land Officers who perform administrative tasks of land alienation that involve a time-consuming and long procedure. If the selected land use management options are to be effective, a mechanism for arbitrating minor conflicts and compliance issues is essential. Therefore, it is necessary to establish a village level arrangement represented by local officers and Farmer Organizations. It should provide speedy resolution for conflicts and violations in a way that was done by tribunals of village councils in the past.

Implement institutional criteria for alienation of state lands according to technical guidelines set by zonal arrangements of land use. We observed that land alienation is being decided upon based on certain criteria, which gives limited attention to scientific principles of land use planning. Decisions should be based on sound criteria of land use planning. The best way to achieve this is to streamline the land alienation process according to criteria based on norms/standards set by zonal arrangements of land use planning in specific localities.

6.2.4 Enabling policies and legal reforms

The role of polices is to put in place measures to create an enabling environment for the successful implementation of proposed management practices and institutional institutions. Policies must also provide incentives to induce expected responses from individuals as well as from collective groups.

There are two major needs to be fulfilled by policy measures here. First, necessary legislative and policy framework for monitoring and controlling degradation of resources taking place in village tank systems should be enacted. The current legal framework and existing procedures for management of village resources, especially ‘state’ land, are purely administrative. These framework and procedures provide no incentive for the evolution of a sustainable system of integrated resource management that can fulfill the gap created by the decline of social customs and local institutions. Therefore, sustainable policy and legal reforms should be introduced to create an enabling environment for the successful implementation of proposed management and institutional innovations.

Second, agencies responsible for promoting sustainable resource management strategies should take necessary measures to promote them in the village tank areas. As presented in Table 8, many conservation-oriented land and water use management practices introduced by government agencies had little acceptance by local communities. This could be attributed to poor design of built-in incentives for farmers to adopt them; lack of enabling environment for adoption; and poor awareness of farmers on potential benefits of such practices or lack of effective programs by respective agencies to promote the activities among farmers. One positive observation regarding the recent changes in the village tank systems is that farmers are receptive to technological innovations when these serve their purposes. Therefore, relevant government agencies should exert sufficient efforts to promote appropriate resource management practices with the full participation of community members. Accordingly, the following policy interventions are proposed to create an enabling environment for enhanced resource management practices and new institutional arrangements:

Establish necessary rules for the effective implementation of enhanced management practices and institutional innovations and a provision for their legal sanctioning. There are two major roles to be played by legal and policy reforms. Firstly, they should provide legal recognition for integrated resource management initiatives in villages, especially for participatory land use planning and zonal arrangements, to ensure the respect of and compliance from relevant stakeholders. A number of legislations provide for the creation of 'special areas' of management when critical threats for human life or the environment are detected. For instance, the *Soil Conservation Act of 1952* provides for the declaration of 'soil conservation areas' to provide legal coverage for the prevention of harmful activities and promotion of beneficial activities regarding soil erosion. Such provisions in many legal enactments are currently in a defunct state. Such arrangements can be used to provide special protection at least for certain critical, sensitive areas such as tank catchments. This would provide the necessary clout for effective implementation of zonal arrangements, especially for ones demarcated for conservation purposes.

Second, policy reforms are necessary to strengthen the position and capacity of Farmer Organizations to monitor and control the negative externalities that affect local resources, especially in upland areas. Despite being the only community organization involved in local resource management, Farmer Organizations are only a shadow of past local arrangements for community cooperation in villages. With changing socio-economic conditions where a privately-oriented commercial farming system is fast emerging, Farmer Organizations are no longer in a position to exercise the authority in the manner that local customs or traditional leadership controlled village resources in the past. Therefore, the position of Farmer Organizations should be strengthened with necessary legal backing. Legal clout is important in exercising their responsibilities of monitoring upland activities to conserve tank catchments, and in effectively implementing standards on agro-wells, etc. This may require amendment of the current provisions in the *Agrarian Development Act of 2000.*

Define the role of government as the final arbitrator using existing legal provisions or enactment of suitable amendments. Some arbitration mechanism is necessary to address the issues of non-compliance or violation of arrangements, norms, standards, etc. Given the declining social cohesion among village communities, local arbitration by village level officers and Farmer Organizations alone may not be adequate to resolve major cases of conflicts. Currently, there are no effective procedures available for the resolution of conflicts over local resources other than state land alienation/acquisition processes and the judiciary, both involving costly and lengthy procedures. Given the government has some stake over both types, uplands (Divisional Secretaries, Land Commissioner) as well as lowlands (Agrarian Development Department), an arbitration procedure with the involvement of respective agencies, is necessary. This can be set up at the DO division level with appropriate powers and a mechanism for speedy resolution of conflicts. One major role expected from this body is the control of indiscriminate encroachments into environmentally sensitive areas such as the immediate catchments areas of water tanks.

Deliver facilitative role by government agencies through complimentary action for local arrangements of integrated resource management. The above policy interventions mainly involve the administrative branches of government such as Divisional Secretariat, Land Commissioner's Office, etc. Within the framework laid down by these legal and institutional arrangements, technical branches of government such as central and provincial agencies of agriculture, irrigation, and land have to fulfill the important role of facilitating community efforts. Among others, their contributions may be most useful in areas of introducing conservation farming practices, creating awareness on sustainable resource management practices, offering technical services such as soil and water testing, undertaking research and development, and providing training for community members. These technical branches must coordinate regularly with Farmer Organizations in delivering their services.

7 CONCLUSIONS

Throughout history, temporal scarcity of water with its associated problems of managing local resources has been the major challenge faced by village tank communities in the dry zone of Sri Lanka. Local farming systems and water management strategies that have evolved to overcome this challenge had a strong system of CPR, which was governed by local institutions and social customs.

However, recent changes introduced by population growth, government policies, commercialization of local economies, and modernization of agriculture technology have forced the traditional system into a path of transformation that radically altered the technical and institutional conditions in the system. The emerging system is favoring a privately-oriented, intensive commercial farming system over community-oriented, low intensive traditional system in the past. This has led to the collapse of governance over local resources, especially the upland component of the farming system. The uplands have become the major source of environmental problems affecting local water and land resources.

Environmental problems have to be addressed through a holistic approach of integrated resource management that includes technical, institutional, and policy solutions applied over interdependent system of local resources. In restoring and maintaining the physical conditions of resources, participatory planning and management has a major role to play. Implementation of sustainable management practices has to be facilitated by the modified system of local institutional arrangements spearheaded by

Farmer Organizations. To achieve this, institutional capacity of Farmer Organizations must be strengthened through appropriate policy measures.

7.1 Areas for Further Research

The current study focused on problems of land and water resource management faced by village tanks communities with the aim of examining broad policy options available to address them. Despite the limited sample size used for primary data collection, the study was able to understand the problem from a holistic perspective rather than from micro-issue examination. Analysis has been enriched by studies undertaken by other researchers who examined different micro issues that have contributed to the complex overall problem described in this research. The strength of the current study is its focus on institutional aspects as a major cause of overall resource management problem as well as a key to finding solutions for it. The policy implications and recommendations are directed at addressing the problem through a holistic approach. Hence, it identifies areas that may need further research so as to refine the policy implications and recommendations made here. Some important areas include:

- Review numerous legislations and policies available on management of land and water resources in Sri Lanka with a view of adapting suitable provisions to address emerging land and water management problems in village tanks systems;
- Undertake studies on various sustainable resource management approaches to improve their adoption rate for integrated resource management;
- Experiment on different innovative institutional models that can be used for integrated resource management in village tanks under major scenarios of land and water use, and;
- Review lessons from different participatory resource management programs in Sri Lanka and elsewhere to ensure and to improve the success rate of the proposed integrated management practices.

7.2 Strategy for Dissemination of the Current Research

As the major focus of the study are the institutional and policy aspects of the research problem, the major target group comprises policy making and resource management agencies of the government. Accordingly, the research's message and recommendations will be disseminated through the following activities:

- Research report and a policy brief based on the research will be sent to the heads of major stakeholder agencies such as the Department of Agrarian Development, the Department of Agriculture, the Ministry of Public Administration, the Department of Irrigation, the Hector Kobbekaduwa Agrarian Research and Training Institute, and the Land Commissioner's Department.
- Similarly, publications will be sent to key researchers who have been involved or are currently involved in undertaking research on village tank systems for their knowledge and feedbacks for future research.
- A more accessible report with detailed executive summaries in the national languages of Sinhala and Tamil will be prepared for the wider target group of middle and junior management of the above target institutions.

- Authors have already developed contacts with important persons from some relevant agencies as a result of expert consultation meetings conducted during the study. These contacts will be asked to promote the ideas generated by the study in their respective organizations as well as among fellow research groups.
- Authors have already contacted the Department of Agrarian Development to organize a presentation of the findings and recommendations to its senior and middle management staff in Colombo. This type of seminar will also be used to promote the messages, especially, the recommendations discussed here.

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APPENDICES

Appendix 1: Key legislations and policies that affected the tenure and institutions in village tanks

Policy/Legislation	**General Scope**	**Key impacts over village tank systems**
Abolition of ancient *'Rajakariya'* system – British rulers in 1832	Abolished the state system of sanctioning compulsory labor on public works by Sinhalese Monarchy	Negatively affected the rehabilitation and maintenance work of tank using common labor
Crown Land Encroachment Ordinance (CLEO) – British rulers in 1840	Acquired all lands for which ownership cannot be proved with a title or deed as crown lands	All uplands under common ownership were taken under the crown ownership
Introduction of *Wel Vidane* system – British rulers in 1857	Introduced an institutional arrangement for tank management	Rectified and filled some gaps left by earlier British legislation
Land Development Ordinance – British rulers in 1935	Provided for alienation of crown land to individuals and colonization schemes	Provided the legal framework for transfer of state land for private tenure under temporary permits and conditional deeds
Paddy Lands Act – Government of Sri Lanka in 1958	Re-defined the relationship between landlords and tenants in land lease arrangements of paddy lands	Affected the tenure relationship between land owners and tenant cultivators in tank command areas
Agrarian Services Act of 1978 and Agrarian Development of Act of 2002 - Government of Sri Lanka	Provided for the establishment of Farmer Organizations and government involvement in village tank management	Effectively replaced the former institutional arrangements of village tanks management

Appendix 2: Panel of experts

Name of the expert	Institution	Area of expertise
Dr. C. R. Panabokke	IWMI	Soil and Water
Dr. P.B. Dharmasena	Consultant, Formerly of Department of Agriculture	Soil and Water
Mr. M.I.M. Aheeyar	Hector Kobbekaduwa Agrarian Research and Training Institute	Water Management
Mr. D.B. Keerthiratne	Consultant. Formerly of Department of Agriculture	Soil and Water
Mr. K.A.U.S. Imbulana	Ministry of Agriculture, Irrigation and Mahaweli Development	Water Policy
Mr. S. Niyangoda	Lanka Jalani	Water Policy
Mr. Prabath Vitharana	Agrarian Development Department	Irrigation Management
Mr. Ranjith Rathnayake	Lanka Jalani	Water Policy
Mr. Nijamudeen	Department of Agriculture	Soil and Water
Mr. R. Ariyaratne	IWMI	Water Management
Ms. Anoja Seneviratne	Water Resources Board	Groundwater