Climate Change, Local Institutions and Adaptation Experience: The Village Tank Farming Community in the Dry Zone of Sri Lanka

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Abstract

Farmers are in a continuous process of, individually and as community groups, adjusting to the observed variability in climate parameters. Climate shocks are considered by farmers in their decision-making as factors affecting risk and uncertainty, and farmers make their choices so as to minimize such risks. The overall outcome of these individual and community efforts is known as 'climate adaptation', which itself is a continuous process. Farmers are traditionally supported by local institutions in this process, which are also currently in a state of transformation. This study examines the climate adaptation responses of the village tank farming community in the dry zone of Sri Lanka in the context of transforming socioeconomic conditions and with the objective of identifying policy implications for adaptation to global climate change. The study was conducted in six Divisional Secretariat areas in the Anuradhapura District of the North Central Province. Both, primary and secondary data was collected in the study. The major sources of primary data included a series of focus group discussions and key informant interviews conducted with village tank farmers and local officers.

The findings reveal that there are two major forms of voluntary adaptation responses by farmers against climate shocks: 1) aligning of farming activities with the recognized seasonal pattern of rainfall; and 2) management of rain water harvested in commonly owned village tanks. Farmers' adaptation responses have been facilitated by local institutions that helped to adopt joint adaptation responses. However, recent socioeconomic dynamics introduced by rapid population increase, spread of commercial opportunities and change in agricultural technology have drastically altered conditions in the village tanks in favor of developing a commercial farming system. As a result, local institutions that traditionally facilitated the climatic adaptation responses are also in a state of transition. Therefore, farmers face problems in adapting to the impending risks and uncertainties of global climate change. The paper emphasizes the need for appropriate policy measures to facilitate the adaptive capacity of farmers.

Introduction

Farmers are in a continuous process of adjusting to various changes taking place in the environment around them. Among others, adjusting to changes in weather and climate parameters is a fundamental condition for their livelihood security. Any observed change in climate parameters, regardless of whether it is a result of natural process or human activity, has the potential to affect farmers' livelihoods in an unforeseen manner. From the point of view of farmers, any change in climate parameters with known or unknown probability can be considered to be climate shocks. Climate shocks enter farmers' decision making processes as matters of risk and uncertainty. Farmers select their choices with the objective of minimizing the risk and uncertainty of outcomes under the influence of climate shocks. Their choices may include individual (private) as well as joint efforts as community groups to minimize adverse effects of climate shocks on their livelihoods. The overall outcome of these individual and community efforts is known as 'climate adaptation', which itself is a continuous process. In the process of climate adaptation farmers accumulate a wealth of experience and knowledge, which helps in further optimizing their choices against climate shocks. Therefore, climate adaptation is an evolutionary process.

In the process of climate adaptation, farmers have created local institutions that help to govern the actions of individuals as well as community groups. In addition, communities have developed facilities that enhance their adaptation efforts over the long run. Usually, these 'adaptation support facilities' also were governed by local institutions. In the developing country context, such local institutions still continue to play an influential role in farmers' decisions on adaptation. However, broad, sweeping forces that transform traditional farming contexts, such as increasing population, rapid commercialization and 'modernization' of technology, have had a tremendous impact on the traditional roles played by such institutions. As a result, the impact of these transformations introduces a complex socioeconomic dimension to the climate adaptation process.

Village tank farmers in the dry zone of Sri Lanka are a fine example of how a community should respond to the challenge of climate adaptation under extensive socioeconomic transformation. Successive governments in Sri Lanka have invested massive public funds in irrigation projects to improve the situation of water scarcity faced by the dry zone farmers (Aluwihare and Kikuchi 1991; Kikuchi et al. 2002). Despite such efforts, a significant population of small village tank farming communities still lives under the constant pressure of water scarcity. Regardless of the support received from village tanks, which are essentially a network of community-managed rainwater harvesting devices, farmers in such communities basically depend on local rainfall for their livelihood needs. Many problems faced by farmers are almost certain of being aggravated in the future given the looming uncertainties of climate change. Compared with their counterparts in major irrigation schemes, village tank farmers are naturally more vulnerable to climate change due to the high dependence of their farming systems on local rainfall. Hence, the small village tank farmers in the dry zone deserve the priority attention of policymakers when the latter are deciding adaptation strategies to face the challenges of global climate change.

This paper attempts to examine the climate adaptation process of village tank farmers with the aim of identifying important policy implications that can enhance the adaptation responses to the impending threat of global climate change. Specific objectives of the study include the following:

- Examine the climate adaptation process of the village tank farming community
- Investigate socioeconomic changes involved in the process of climate adaptation and their impact
- Identify important implications for policies on adaptation to global climate change

Method

The Study Area

The study was carried out in the Anuradhapura District of the North Central Province. Primary data was collected from farmers and local officers from six Divisional Secretariat (DS) areas, namely; Thirappane, Sivalakulama, Mihinthale, Galenbindunuwewa, Kahatagasdigiliya and Andiyagala. A profile comparing the water and land resources of the Anuradhapura District is provided in Table 1.

Table 1. A profile of water and land resources in the 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)	1,861	1,368
Equivalent water volume (b m^3)	120	9.6 (8 %)

Source: Department of Census and Statistics (2007)

Data and Methods

Both primary and secondary data were collected in the study and the following methods were used to collect the data.

- Focus Group Discussions (FGDs) were conducted with farmer groups of 10-15 in size, from the selected DS areas. Discussions were held using a semi-structured, yet flexible focus guide. The discussions inquired about the physical profile of the resources in the villages, about the farming systems, local water management, formal and informal institutional arrangements, experience in climate change and adaptation measures to face the changes and variability in climate.

- Key Informant Interviews were conducted with local officers and a few experienced farmers. Local officers included divisional and village level officers. These interviews and discussions, supplemented the information collected from farmers and helped to recognize the views and perspectives of local officers who are involved in local resource management in the area.

- Secondary Data were collected from a number of key institutes, which have either conducted important studies in the past or which undertake mandatory institutional responsibilities relating to the research issues concerned. The major types of secondary data collected include: information on water scarcity; hydrological and water balance studies; rainfall and other meteorological data; physiographic information of resources; and studies on socioeconomic and institutional aspects.

Analysis

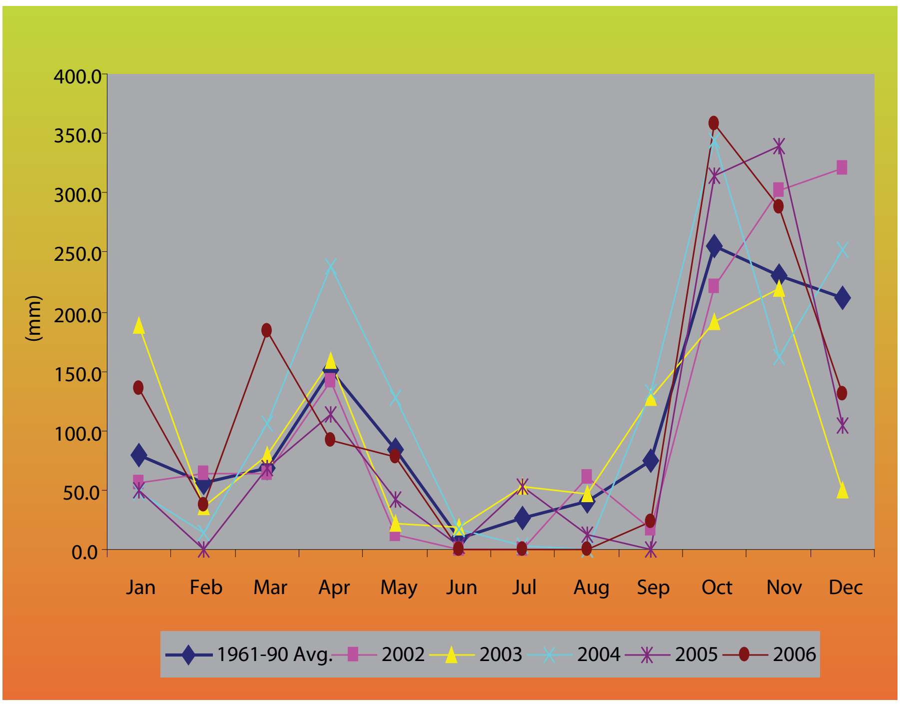
Given the exploratory nature of the data involved, a qualitative analysis of data from various sources was undertaken. This basically involved a comparative assessment of information obtained from different primary and secondary sources. Complex, statistical or quantitative analyses were not made, other than the calculation of percentages and averages, and the comparison of their results.

Results and Discussion

Climate Shocks and the Scarcity of Water Resources

The key to understanding the climate adaptation strategy of farmers in the area is to examine the pattern of climate variability and resulting outcome of water availability in the area. Figure 1 indicates that Anuradhapura District has a bi-modal rainfall (RF) pattern, with a prominent peak during the October-December period followed by a minor crest in the month of April. On average, 74 % of the annual RF is received during the period from October to March.

Figure 1. Rainfall distribution pattern in Anuradhapura.



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

Accordingly, two major forms of climate shocks can be identified: 1) shocks due to major dry spells that can be recognized in the average pattern of rainfall and; 2) random shocks due to unexpected changes in the average pattern of rainfall. The former can easily be recognized in Figure 1 in the period from May to September, when the entire area (with minor local variations) experiences a lengthy dry spell. This is the major climate shock that determines the situation of water scarcity in the area and farmers have some idea about the probability of this event (Tennakoon 1986). Table 2 provides a projection for the district as regards the severity of the general effect created by this major shock in terms of water scarcity (Amarsinghe et al. 1999). As discussed later, the main strategy of climate adaptation in village tank systems has evolved to face the threat of this climate shock.

Table 2. 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

Notes: Efficiency of the irrigation remains at the current level (S1); Irrigation efficiency improves over the project period (S2)

The second type of climate shocks that can be identified is random in nature and farmers have little idea about the probability of the occurrence of such shocks. Such shocks, therefore, can be considered as extreme deviations from the average pattern. Two visible examples in Figure 1 show that relatively high RF was received in Feb-Mar 2006 during the harvesting period and a low intensity of RF took place during the Oct-Nov period (peak period of the rainy season) in 2003.

Farmers' Adaptation Strategies against Climate Shocks

Farmers have historically adopted two major adaptation strategies to face the major shock of lengthy dry spells, which are observed in the average rainfall pattern of the dry zone. The strategies are: (a) aligning farming activities with the recognized seasonal pattern of rainfall to make the maximum use of water directly available from precipitation; and (b) joint adaptation through the management of rainwater harvested in communally owned village tanks.

Aligning Farming Activities with Recognized Seasonal Rainfall Patterns

Farming under direct rainfall is the least costly option for water supply in the area. However, such a source of water carries some risk due to the uncertainty of RF. Farmers, through their generations of experience, adjusted farming activities to be aligned with the seasonal pattern of rainfall so as to minimize the risk associated with farming under direct rainfall.

Accordingly, two major cropping seasons, *maha* and *yala* have evolved in the farming system of the dry zone. *Maha*, from October to March, is the main cultivation season supported by the north-east monsoon, the major source of water for the dry zone. The *yala* season or the dry season, from April to September, has no major period of rainfall other than a few intermittent rains.

Table 3 highlights the farming system and water management strategy that has historically evolved in the village tank systems. It included both purely rain-fed upland cropping activities and irrigated paddy farming (Somasiri 2001; Handawala 2004). The two major components of upland farming were the cultivation of seasonal field crops under shifting cultivation ('chena' farming) in the *maha* season and mixed farming of seasonal and permanent crops in homestead gardens (Abeyratne 1956; Weerakoon et al. 1987). Lowland paddy cultivation in the *maha* season partially depends on RF during the early stage of crop growth.

According to farmers' experiences, the probability of rainfall varies in different periods of the annual cycle. As a result, farming activities that are aligned with periods of high rainfall probability have become more stable components of the farming system. For instance, farmers consider extensive cultivation of gingelly under inter-monsoon rains with low probability as a high-risk activity and, therefore, the cultivation of gingelly remained a less stable activity in the system. Therefore, data on farming activities, taken from different periods of the annual cycle, indicate farmers perceptions of risk.

Table 3. 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 in yala	Mainly subsistence with limited sales if a surplus is available
Upland farming	Coarse grains, grain legumes, pulses, vegetables, condiments, gingelly	1-5 ac avg. by all HH	Gingelly	Fully rain-fed	Fully rain-fed	Shifting agriculture in commonly owned uplands	Mainly subsistence with few cash crops
Permanent crops	Coconut, fruits, multi purpose trees	No seasonality		Rain-fed + retained moisture in soil		Home gardens	Mainly subsistence with few cash crops

Joint Adaptation with the Support of Commonly Owned Village Tanks

Small village tanks have historically been constructed to counteract the problem of temporal scarcity of water due to lengthy annual dry spells. From the point of view of climate adaptation, village tanks can be identified as the most important 'adaptation support facility,[1] available to

[1] In the same sense, major irrigation facilities consisting of large storage reservoirs, trans-basin diversion structures and network of distribution canals can also be considered as adaptation support facilities available to farmers in settled irrigation schemes. However, this is a result of planned adaptation supported by the state rather than an outcome of voluntary adaptation by farmers.

farmers. It has been estimated that there are over 12,000 village tanks scattered throughout the dry zone areas of the country (Panabokke 2001). The Anuradhapura District alone has over 2,500. Some of the tanks date from the earliest era of the country's human settlement (Siriweera 1994). An important observation to be made here is that a large proportion of these inland water bodies are seasonal in their nature, in that water is available only for a limited period of time during the year (Chakrabarty and Samaranayake 1983).

Water stored using village tanks, helps to minimize and offset the risk of seasonal water scarcity through the community management of tanks. This can be considered as a historical joint adaptation measure taken by farmers to minimize the risk of temporal water scarcity during the dry spells. Compared with the relatively costless supply of water from direct rainfall, this measure incurs some transaction cost. In the local farming system, tanks seem to fulfill two major functions. First, they support the maha season paddy crop, which is usually established with the northeast monsoon rainfall but requires supplementary irrigation later in the season. Second, they enable at least a part of the paddy lands to be cultivated in the dry season also, depending on the level of water availability in the tanks.

Common ownership of village tanks has facilitated unique arrangements of joint adaptation under high water scarcity conditions. For instance, in the *maha* season when there is adequate RF, individual farmers are entitled to cultivate their plots of paddy as private lands under a common schedule of water management. However, during the water-scarce yala season, the private rights are suppressed in the common interest of food security for the whole community under an institutional arrangement called bethma (the division). On such occasions, community members collectively decide the total area of paddy land that can be physically supplied by the limited water available in the tank, and divide this land among all the members of the community regardless of the ownership of the respective land plots. In other words, individuals have to make a trade off between privately held rights over land and commonly held rights to water under conditions of scarcity. This can be considered a unique social benefit of joint adaptation.

Facing the Random Shocks Caused by Changes in Average Rainfall Pattern

Aligning farming activities with the seasonal patterns of the climate and community management of rainwater harvested in village tanks helps farmers to also buffer random shocks to a certain extent. In addition, farmers seem to fine-tune their cultivation practices even within the season, depending on the water availability. Researchers have made observations that every season farmers adjust their farming activities, responding to the intra-seasonal variability of the climate to a certain extent (Tennakoon 1986). According to Handawala (2004), the intensity of daily rainfall and distribution of rainy days within the season have more influence over the determination of cultivation practices than the total rainfall within a season.

Climate Adaptation and Local Institutions

In essence, adaptation to climate variability is closely interconnected with institutional arrangements dealing with allocation, distribution and utilization of the limited supply of available water. Village tanks are common property resources (CPR). The user rights for water in commonly owned village tanks are usually held by well-defined agrarian communities who own or cultivate paddy fields in the command areas of tanks. They make decisions on the use of tank water through an institutional mechanism that involves Farmer Organizations (FO).

However, three macro-scale processes are rapidly transforming the socioeconomic conditions in the village communities surrounding the tanks, these are: population growth; commercialization of local economies; and 'modernization' of agriculture technology, (Panabokke 2001; Aheeyar 2001; Ulluwishewa 1997). As a cumulative result of such change-agents, ownership and tenure patterns of village resources associated with the village tank system have undergone significant changes during the recent past. In the traditional system, collective actions were taken in several aspects of the farming system and a set of informal, customary practices governed the many aspects of managing local resources (Ulluwishewa 1997). The commercialization of the traditional farming system, however, has rendered many such traditional institutions ineffective. As a result, effective utilization of community-based institutional arrangements for climate adaptation seems to be gradually declining. Instead, private adaptation measures under the commercial farming system are becoming more and more popular.

The most prominent private adaptation measure is the utilization of groundwater from shallow regolith aquifers in the area through agro-wells. Agro-wells enabled farmers to tap the shallow groundwater storage in addition to the surface storage in the tanks, thereby further reducing the risk of water scarcity. Despite the fact that the groundwater aquifer is a 'common pool' resource, access to groundwater is determined by the ownership of the land plots above the aquifer. As no rules or regulations are in place to govern the actions of individual agro-well owners, groundwater can be considered a type of unregulated common property.

Groundwater from Agro-wells: Private Adaptation under Commercial Farming

Compared with the historical village tanks, extraction of groundwater through agro-wells is a recently adopted private adaptation measure that became popular during the last two or three decades. It has largely been facilitated by the introduction of small, low-cost pumps operated by diesel and kerosene (Kikuchi et al. 2003). Although, incentives provided by the state agencies, such as the Agriculture Development Authority, have played an important role in popularizing agro-wells, many farmers subsequently invested in wells without any external support (Karunaratne and Pathmarajh 2002; Panabokke and Perera 2005). The major contribution of agro-wells is supplementing of water for cash crops during the dry season, thereby helping to increase farmer income (Nagarajah and Gamage 1998; Karunaratne and Padmarajah 2002).

Extraction of groundwater through privately owned agro-wells is determined mainly by commercial objectives. Compared with water from direct rainfall or community-managed tanks, this is the most expensive option for the supply of water, and the cost is borne privately by individual farmers. The agro-well option requires substantial capital expenditure for the construction of the wells and regular operational costs for the fuel needed to pump the water. As a result, unlike the relatively low cost supply of water more or less uniformly available to all farmers from direct rainfall or commonly managed tanks, agro-wells are an option available only to farmers who can afford it. Therefore, water extracted from agro-wells is utilized only for high-value cash crops (such as chilli and onion) and the level of extraction is largely determined by the price of fuel.

Policy Implications

The unforeseen effects of global climate change introduce a new element of uncertainty to the ongoing process of climate adaptation in the dry zone areas. Although recent analysis of agro-meteorological data in the dry zone has not indicated any substantial change (increase or decrease) in the total availability of RF, there is evidence to indicate that the pattern of rainfall has become erratic over the past several decades (Punyawardena 2007). Many farmers also seem to have observed changes in the established pattern of RF, especially during the past few years. Losses to farmers due to unforeseen changes indicate that familiar strategies of adaptation may not be adequate to face the challenges posed by climate change. Therefore, the adaptive capacity of farmers has to be enhanced further.

Individually or jointly, farmers have to search for an innovative selection of voluntary adaptation measures. One option open to farmers is fine-tuning the available mix of long-term and short-term adaptation measures to face the emerging changes in an optimal manner. Another option is adopting technological innovations such as resilient crop varieties, improved agronomic practices, resource conservation techniques and protective forms of agriculture. Among the market-based instruments for facing the risk of climate shocks are, crop insurance packages, but these are yet to gain wide acceptance among farmers in Sri Lanka.

However, voluntary measures alone may not be sufficient, therefore policy support also has a role to play in helping farmers adapt to climate shocks. Farmers need the support of appropriate policy and institutional interventions that can enhance their adaptive capacity. Among other responses, they need government policy support for:

- coping with the added uncertainty caused by the relatively rapid rate of change that is likely to be involved with global climate change;[2]
- facing disasters that could be caused by an increased frequency of extreme events;
- filling the gaps in the traditional and institutional settings created by ongoing socioeconomic transformation; and
- creating an enabling environment for innovative measures of voluntary adaptation by introducing appropriate policy changes.

For instance, state agencies can reduce the burden of uncertainty by providing climate forecast information so that farmers can anticipate likely changes in the near future. Similarly, the government can enhance the farmers' capacity to face disasters by connecting farmers with the disaster management system that is gradually evolving in the country. Therefore, policymakers also have an important role to play here by introducing suitable interventions to enhance and facilitate the adaptation choices of farmers.

[2] Voluntary adaptation efforts described in the article seem to have evolved over a long period of time as responses to changes that took place at a relatively slow pace. The major difference of global climate change is that it seems to be taking place at a relatively rapid pace.

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