



Socio-cultural, Ecological and Managerial Perspectives of a Selected Cascade Tank System in Anuradhapura District, Sri Lanka

Jayasuriya BPW¹, Ranasinghe DMSHK¹ and Maddumabandara CM²

¹Department of Forestry and Environmental Science, University of Sri Jayewardenepura, Sri Lanka

²Department of Geography, University of Peradeniya, Sri Lanka

ABSTRACT

The main objective of the study was to assess the current knowledge and perceptions of the communities on the ecosystem services provided by the water tanks with special reference to a tank cascade system in Anuradhapura District. The findings were used to get an understanding of the present status of management, gaps and provide recommendations using an integrated approach with the relevant stakeholders. An ancient tank cascade system situated in the Kahatagasdigiliya Divisional Secretariat Division in Anuradhapura District of the North Central Province was used for the study. Four tanks constituted the selected cascade system, namely Bambarahela wewa, Kumbuk wewa, Diwul wewa and Hettu wewa and were located in three villages ie. Bambarahela, Diwulwewa and Hettuwewa. The former villages were inhabited by Sinhala Buddhist while the latter was by Muslims. These tanks are under the jurisdiction of the Konwewa Agrarian Development Office. Secondary data as well as primary data were collected on the socio economic, ecological and managerial environment of the tank cascade and related areas. Primary data were gathered using structured questionnaires, key informant interviews. Mixed methods were used to analyse data. According to the findings, majority of the village communities use the tank for farming and related activities, bathing and washing etc. However, none use the tank water for drinking as they have a notion that it is polluted. A statistically significant relationship ($p < 0.05$) was not observed between the occupation and monthly income of the communities with their knowledge of the ecosystem services of the tanks while the education level of households showed a positive relationship ($p < 0.05$). However, there was a lack of knowledge on the full range of ecosystem services of the tanks, tank cascades and this needed to be enhanced. All the respondents were of the view that the tank and associated environment need to be improved and while they were somewhat satisfied with the activities of the farmer organisations and the officials of the Department of Agrarian Services they agreed that this needed improvement to procure the full potential of the tank cascade system. All the respondents were willing to contribute to the improvement and conservation of the tanks. The majority (61%) agreed to pay a fee ranging from a minimum of Rs. 100 to above Rs. 200) annually for tank management. Therefore it could be recommended that in order to promote the ecosystem approach in tank management it is required to enhance the knowledge among the stakeholders and follow an inclusive and integrated approach with the participation of especially farmers and farmer organizations and the officials of the Department of Agrarian Services.

KEYWORDS: Cascade, tank, ecosystem services, management

Corresponding author: D. M. S. H. K. Ranasinghe, Email: hemanthi.ranasinghe@gmail.com

1. INTRODUCTION

Water tanks are not merely structures built to store water but complex man-made ecosystems involving many natural resources and providing a wide variety of functions and services. Different stakeholders actively make use of the resources and functions of a tank ecosystem. The ecological, social and economic elements are closely related and dependent on the existence of the water tank. The central presence of the tank gives the essential structure to the territory as seen clearly in the tank cascade systems (TCS) abundant in the North Central Province of the country. It is essential that the importance of tanks as ecosystems is understood for their effective management. A cascade system is defined as a “connected series of tanks organized within a ‘meso-catchment’ of the dry zone landscape, storing, conveying and utilizing water from an ephemeral rivulet” (Madduma Bandara, 1985; Panabokke, 2003). The building block of TCSs is a tank (a sub system) which makes up this interwoven irrigation network. Tanks, paddy fields, watersheds and canals are integrated and interwoven with the natural environment (naturalized) (Marambe *et al.*, 2012). Water tanks provide different habitats creating a heterogeneous net of interconnected territories. The different ecological, social, and economic elements involved in the ecosystem are closely related and dependent on the existence of the water tank. The central presence of the tank gives the essential structure to the territory (Ariza *et al.*, 2007). The primary function of a village tank was to irrigate dry low-land plains for paddy farming during major cultivation seasons. Water is an essential resource for paddy farming in the dry zone but limited both temporally and spatially although soil, other climatic factors and soil topography are ideal for agriculture. Hence, rural dry zone communities time to time developed TCSs with limited equipment and local knowledge (Geekiyana and Pushpakumara, 2013). Ariza *et al.* (2007), classify uses and functions of water tank ecosystems as economic (i.e., agriculture, livestock, fishing,), ecological (i.e., groundwater

recharge, prevention of soil erosion and floods), and socio-cultural (i.e., domestic, leisure, festivals) and these functions are not independent from one another. Different stakeholders actively use water tank’s resources and functions in different ways. Each group has a different interest on the uses, functions and resources of the tank ecosystem, and therefore interacts in a different way with it. Some of the groups have more power than others to manage and make decision that will affect the transformation of the ecosystem. Some groups influence only the ecosystem transformation without being directly involved in the management (Ariza *et al.*, 2007). It seems to be a common perception among tank users, and other stakeholders, that poor maintenance is a reason for insufficient water availability. Similar studies show that farmers were willing to pay for operation and maintenance costs. This suggests that revenue sources from tanks can be developed, that the obstacle for sufficient funding is not because of farmers’ willingness to pay. Some had stopped paying the fees because of dissatisfactions with the Farmers’ Associations (Nehlin, 2016).

Vidanage *et al.*, 2005 have observed that although the government spends lot of resources to maintain the tanks, the communities around the tanks are not happy and complain about the low quality of the work and its sustainability. The main complaint is that most of the time, rehabilitation work takes place at the tank bunds and the sluice gates, but not in the tank. The communities request is to increase the capacity of the tank to the level what it was 20 -25 years ago.

However, the irrigation engineers of government authorities say that de-siltation is not cost effective and sustainable. The ancient irrigation management system was sustainable with the bottom-up development approach enriched with the active community participation. This traditional community management system was transferred to central government authorities with the centralized bureaucratic administrative system during the colonial period. Although top-

down management system was initiated by the centralized agencies, it was not successful due to limited community participation in the decision-making process and the hindrances in the implementation of top-down decisions. Therefore, the irrigation authorities had to re-launch decentralized management system through the establishment of legally empowered Farmer Organisations (Wijekoon *et al.*, 2016).

The Agrarian Service Act No. 58 of 1979 was amended in 1991, which allowed the Department of Agrarian Services (DAS) to legally register the Farmer Organizations (FOs) which were established by DAS and legally registered in the Department. The main purpose of the amendment was to give the legal recognition and to provide maintenance contracts to FOs (Panabokke *et al.*, 2000). The Act recognizes FO as a formal institution and stipulates the responsibilities including the levying of water fees and confers the authority of the DAS to support the activities of FOs. The above two institutions are working separately, which may lead to duplication and overlapping of their activities. Therefore, interventions are required to integrate and coordinate the functions of these two separate and independent entities. Therefore, it is important to introduce clear coordinated working arrangement to link these two institutions (Wijekoon *et al.*, 2016).

1.1. Objectives of the study

The study was carried out with the following main objectives;

- To assess the people's perception of water tanks

Under this objective, it was enquired whether the villagers conceive tanks as mere water storage structures or as complex ecosystems with many closely related elements. The knowledge and attitudes of different groups of stakeholders as to how they perceive and use water tanks and the associated socio-economic attributes were studied.

- To study the current management of the tank ecosystems considering all the resources, functions and related stakeholders, and the relations among all of them.

Under this, the deficiencies of the current management of small tanks was identified, highlighting the importance of integrated management of the entire tank ecosystem using an exosystemic approach with the participation of the local communities.

2. METHODOLOGY

2.1. Experimental site

The study was based on a small tank cascade system situated in the Kahatagasdigiliya Divisional Secretariat Division in Anuradhapura District of the North Central Province. The study area was located in the Dry Zone in an agro-climatic region with low rainfall and a prolonged dry season. A mean annual rainfall of 1250 mm is received mostly during the North East monsoon from October to January. The protracted dry season causes water scarcity problems for household requirements and agricultural production. The study period was during a significant dry season where the area had not received proper rainfall for over two years.

Four tanks constitute the selected cascade system, namely Bambarahela wewa, Kumbuk wewa, Diwul wewa and Hettu wewa. The three villages belonging to the study area are Bambarahela, Diwulwewa and Hettuwewa. The smallest tank, Bambarahela wewa, and Kumbuk wewa which is a support tank are located in Bambarahela, whereas the other two tanks Diwul wewa and Hettu wewa are located in the villages of Diwulwewa and Hettuwewa respectively. The villages Bambarahela and Diwulwewa which are inhabited by only Sinhala Buddhists, belonging to the 215 Diwulwewa Thulana Grama Niladhari Division (GND), and Hettuwewa which is a Muslim village belongs to the 216 Konwewa

GND. These tanks are under the jurisdiction of the Konwewa Agrarian Development Office. Figure 1 shows the location of the selected cascade tank system.

The tanks did not have a significant reservation surrounding them. The most common plant species found in the existing reservations were

Terminalia arjuna (Kumbuk), *Azadirachta indica* (Neem), *Madhuca longifolia* (Mee), *Vitex leucoxyton* (Nabada), *Gmelina asiatica* (Demata), *Diospyros malabarica* (Thimbiri), *Lannea coromandelica* (Hik), *Pterospermum suberifolium* (Welan), *Cratava adansonii* (Lunuwarana), *Hydnocarpus venenata* (Makulla).

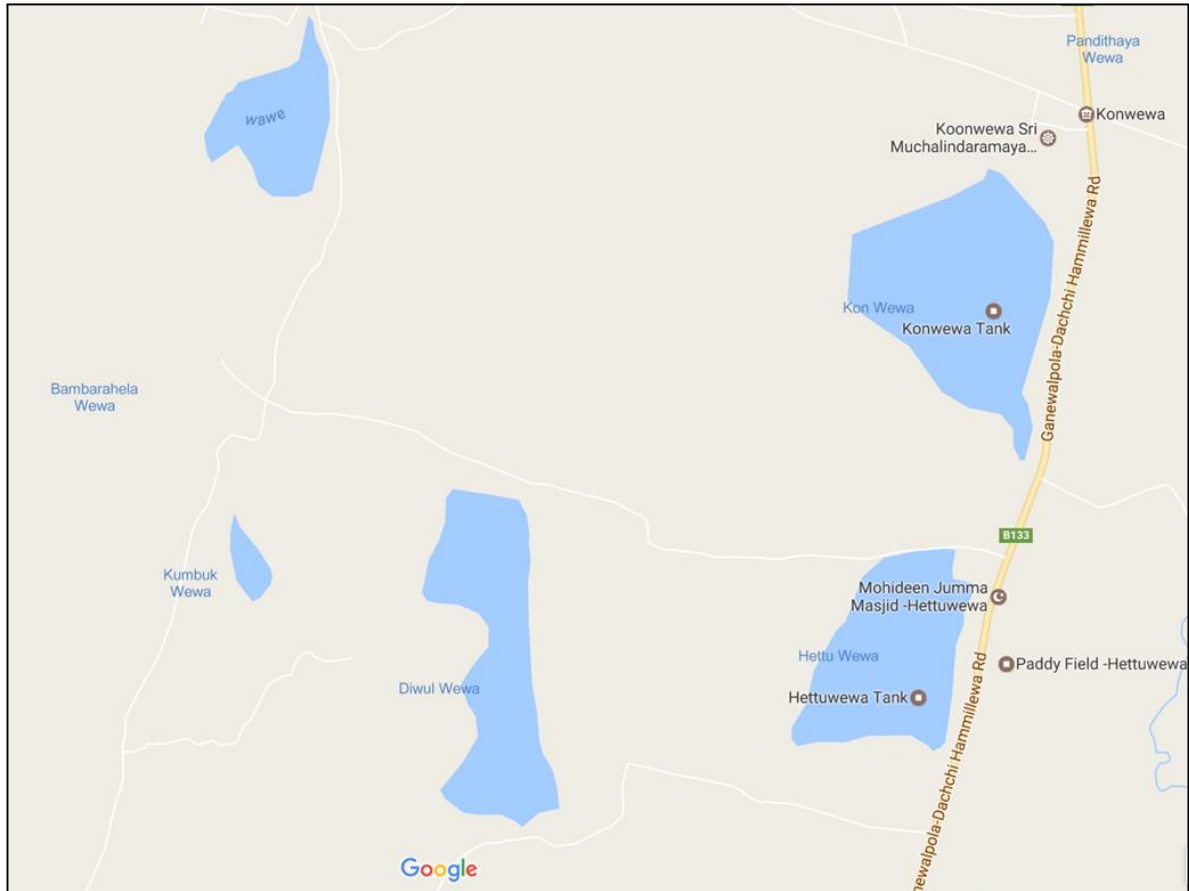


Figure 1: The tanks in the cascade system which was used for the study

2.2. Sampling

Four tanks in a cascade system; Bambarahela wewa, Kumbuk wewa, Diwul wewa and Hettu wewa in the Kahatagasdigiliya Divisional Secretariat in Anuradhapura District were the focus of the study. Secondary data as well as primary data were collected on the socio economic, ecological and managerial environment of the tank cascade and related

areas. Secondary data was collected from published reports and records while primary data was gathered using questionnaire survey of selected communities in the villages namely Bambarahela, Diwulwewa and Hettuwewa in Kahatagasdigiliya Divisional Secretariat. The total no. of households in the villages were 62, 64 and 162 respectively. 25% of the total households were selected for the questionnaire survey from all three villages. In addition to this,

key informant surveys were conducted. Such key informants interviewed were the Grama Niladhari, monk of the Buddhist Temple, Leader of the Farmer Organization, Senior Citizens, representative of the Department of Agrarian Services. The information collected from the communities provided the following information; The different purposes for which tank water is used; Mode of obtaining water for day to day needs; The knowledge of ecosystem services; awareness of the need to conserve tank ecosystems was also assessed. The knowledge of the role of a cascade tank system; Folklore/rituals associated with the tanks; Willingness to involve in tank management; Willingness to pay a sum annually for tank management; Whether the role of Farmer Organizations in tank management is satisfactory; Awareness of the impact of agrochemicals on tank water. The information thus gathered were supplemented/triangulated by the discussions held with the key informants. In addition to this, observations were made with regards to the ecological perspectives of the tanks.

2.3. Analysis of data

Mixed methods (qualitative and quantitative) were used in the analysis. The major perspectives taken in the analysis were the extent of the use of the tanks, the level of villagers' knowledge and awareness on the ecosystem services provided by the tanks and the views of the stakeholders on the present management status of the tanks including issues and areas for improvement. Descriptive statistics and chi square test were used in analyzing the data collected from the questionnaire survey while qualitative data analysis was used to supplement this.

3. RESULTS AND DISCUSSION

3.1. Local Perception of Tank Ecosystem

In the sample all the respondents in the Bambarahela and Diwiulwewa villages were Sinhala Buddhist while those in Hettuwewa were

Muslim. In all the villages about 82% of the inhabitants had lived in the villages more than 50 years. Apart from the ethnicity, the source of income and the amount, occupations did not vary significantly between the villages. No one used the tanks for drinking water while about 80% of the villagers in the Sinhala Buddhist villages used the tank for other purposes including farming, bathing, washing etc. The inhabitants in the Hettuwewa village which is predominantly Muslim used the tanks less as most of the households had their own wells. The respondents' knowledge of the ecosystem services provided by tanks are shown in Figure 2;

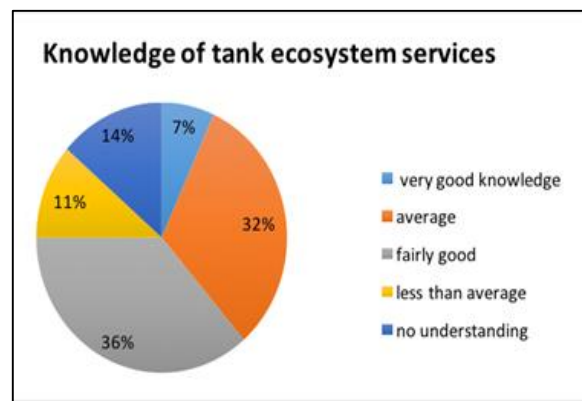


Figure 2: Knowledge of the respondents on the ecosystem services of tanks

As shown in Figure 2, relatively few people were aware of ecosystem functions such as water regulation and retention, water purification, provision of habitats for fauna and flora, flood control, protection and sustenance of the surrounding ecology of the area, recharge of surface water of other water bodies, conservation of traditional knowledge and culture, ensuring livelihood, leisure area, supporting farming, insurance against low rainfall periods, livestock uses, fishing etc. Majority were aware of the function of the tank in the water conservation and use and also the contribution of the tank cascade system in the water purification. Understanding of the other functions were present at varying levels.

The occupation and income did not show significant difference ($p < 0.05$) in the use of the tank. This was due to the fact that while majority were engaged in solely paddy cultivation, most of the others too carry out paddy cultivation along with other jobs. The distal location and most of the households having their own wells deterred the Muslim respondents from using the tank for washing and bathing. None used the tank water for drinking and the reasons given were tank water is polluted and a well in the premises was more useful.

The highest education level of the respondents is shown in Figure 3.

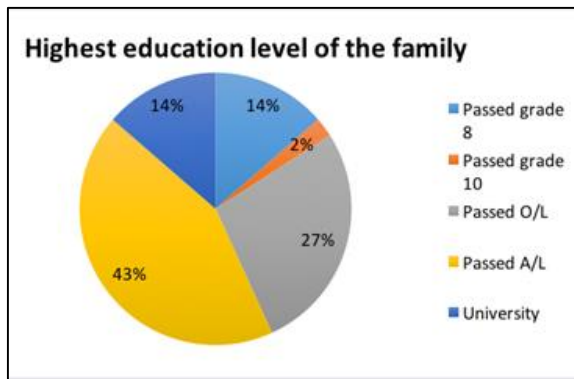


Figure 3: The respondents’ knowledge of tank ecosystem services

There was a significant positive correlation ($p < 0.05$) between the education level and the knowledge of tank ecosystem services. Further, there was a significant positive relationship between the knowledge of tank ecosystem services and the willingness to pay to conserve the tank. This did not show a significance with the income level.

All respondents who were engaged in paddy cultivation use agrochemicals and a great majority (93%) were aware of the harmful impact of these chemical pollutants on tank ecosystems i.e., water pollution and environmental damage. However none of them were prepared to forego the agrochemicals as they were of the view that without them the yield

will be drastically declined. These findings are in agreement with those of Ariza *et al.*, 2007, Geekiyanage and Pushpakumara, 2013.

3.2. Current status of management of the tank cascade system and way forward

The details of the tanks in the selected cascade system is shown in Table 1.

Table 1. Details of the tanks in the selected cascade system

Tank	Length of the tank bund (m)	Capacity (Acre feet)	Total command (Acres)	No. of dependent farmer families	Last repaired in
Bambarahela wewa	320	150	55	45	2010
Kumbuk wewa	450	150	60	40	2015
Diwul wewa	660	200	148	85	2015
Hettu wewa	1240	500	102	160	2013

It was clearly seen that the tanks were not properly maintained. However this could also be due to the low functioning of the tanks due to lack of rainfall over a considerably long period, and the situation could be different when the tank system is functioning optimally. The tank bund and other infrastructure were not in good condition. There was no buffer zone around the tanks, and people had cultivated in lands adjacent to the tank bund.

In each village there is a Farmer Organization which is involved in the management of the tanks along with the Agrarian Development Office (ADO) in the area.

All the respondents in questionnaire survey, focus group discussions and key informant surveys were unanimous in agreeing that the current management of the tanks were not effective. As the tanks comes under the

jurisdiction of the Department of Agrarian Services they are responsible for the management of the tanks and the villagers especially through farmer organisations participate in it. All the respondents raised the following issues pertaining to the tank cascade system; Reduced water availability and problems with water allocation, Silt accumulation leading to less capacity of tanks, desilting not being done regularly, Poor maintenance affecting the performance of the tanks, Less participation in tank management, Water contaminated with agrochemicals, Water plants and vegetation in the tanks. All the respondents brought the fact that there was no buffer zone around the tanks. Encroachments and illegal cultivation near the tanks are common and problem. Legal action has been taken against some cases, while in some other cases there was undue political influence against the action taken.

All the respondents were willing to contribute for the improvement and conservation of the tanks. When asked if they would like to pay a fee (ranging from a minimum of Rs. 100 to above Rs. 200) annually for tank management, a considerable majority (61%) gave positive responses. Others mentioned that a fee is already being collected for using tank water for cultivation, and the funds allocated by the government are sufficient for the management of the tanks, if efficiently utilized. It is interesting to note that even those who were not dependent on the tank for their livelihood were willing to contribute with money or labour for maintenance of the tanks. This indicates that all villagers consider the tanks as an asset to the village. These findings were in agreement with Vidanage *et al.*, 2005, Nehlin, 2016 and Geekiyana and Pushpakumara, 2013).

4. CONCLUSIONS

From the results it can be concluded that despite the sub optimal condition in which the tanks in the cascade system are operating due to the lack of maintenance and extended dry period in which

the study was done, the majority of the people in the villages have close associations and dependence on the tanks for multitude of reasons such as farming and related, washing, bathing. None of them use the tank water for drinking and this is influenced by the fact that they perceive it as polluted and also some have wells. Since majority of the villagers have been living in the present location more than 50 years they have a close association with the tank and also have a good to average knowledge on the tank ecosystem services.

The most common services they are aware are water storage, water purification, provision of irrigation water for farming and for livestock etc. The occupation, income did not show significant difference in the use of use of the tank. This was due to the fact that while majority were engaged in paddy cultivation, most of the others too carry out paddy cultivation along with other jobs. However, there was a significant relationship between the educational level and the knowledge of the ecosystem services of the tanks. From the sample about 43% had passed A/L and 36% had a fairly good understanding of the tank ecosystem services).

All respondents who were engaged in paddy cultivation use agrochemicals and a great majority (93%) are aware of the harmful impact of these chemical pollutants on tank ecosystems i.e., water pollution and environmental damage. However none of them were prepared to forego the agrochemicals as they were of the view that without them the yield will be drastically declined. With regards to the management of the tank cascade system, almost all were of the view that it is very much sub optimal in the present system due to prolonged drought and lack of proper maintenance. While it was the belief that the Department of Agrarian Service who are the custodians of these tanks need to step up the maintenance especially desilting the tank core with the participation of the villagers. About 61% of the respondents were willing to make a payment of Rs. 100-200 annually towards tank management.

REFERENCES

ARIZA P, GALÁN E, SERRANO T & REYES-GARCIA V. Water Tanks as Ecosystems: Local Ecosystemic Perception for Integral Management of Water Tanks in Tamil Nadu, South India. *Water Tanks as Ecosystems*. 2007; 303 -327.

BANDARAGODA D J. (n.d.) Status of Institutional Reforms for Integrated Water Resources Management in Asia: Indications from Policy Reviews in Five Countries. International Water Management Institute.

BEGUM S. Minor Tank Water Management in the Dry Zone of Sri Lanka. Colombo 7: Agrarian Research and Training Institute. 1987.

CASCADE IRRIGATION SYSTEMS FOR RURAL SUSTAINABILITY: Experience of Plan Sri Lanka's Cascade Systems Development Project in North Central Province of Sri Lanka 2004-2010. Plan Sri Lanka. 2012.

GEEKIYANAGE N & PUSHPAKUMARA DKNG. Ecology of ancient Tank Cascade Systems in island Sri Lanka. *Journal of Marine and Island Cultures*. 2013; 93-101.

JAYANESA HAH & SELKER JS. Thousand Years of Hydraulic Civilization Some Sociotechnical Aspects of Water Management. Understanding the Role of Politics in Water Management. 2004; 225-262.

JAYASENA HA. Water Management in Ancient Tank Cascade Systems (TCS) in Sri Lanka: Evidence for Systematic Tank Distribution. *Journal of Geological Society of Sri Lanka*. 2011; 27-33.

MADDUMA BANDARA CM. Village Tank Cascade Systems of Sri Lanka: A Traditional Technology of Water and Drought Management. *TIK* 6. 1985; 328-336.

MENDIS DLO. (n.d.). Ecosystem based Indigenous Water Management

NEHLIN M. Management of Local Irrigation Systems and Stakeholder Perceptions in Southern Tamil Nadu, India. 2016.

PANABOKKE CR. Village Cascade Systems in the Rajarata. 2003.

PANABOKKE CR, TENNAKOON MUA & ARIYABANDU RdeS. (n.d.). Small Tank Systems in Sri Lanka: Issues and Considerations. 1-6.

VIDANAGE S, PERERA S & KALLESOE MF. The Value of Traditional Water Schemes. IUCN Water, Nature and Economics Technical Paper No.6. 2005.

WIJEKOON WM, GUNAWARDENA ER & AHEEYAR MM. Institutional Reforms in Minor (Village Tank) Irrigation Sector of Sri Lanka Towards Sustainable Development. ICSBE 2016. Peradeniya: University of Peradeniya. 2016;1-9.

WITHANACHCHI S, KÖPKE S, WITHANACHCHI CR, PATHIRANAGE R & PLOEGER A. Water Resource Management in Dry Zonal Paddy Cultivation in Mahaweli River Basin, Sri Lanka: An Analysis of Spatial and Temporal Climate Change Impacts and Traditional Knowledge. *Climate*. 2014; 329-354.