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Tank Cascade Studies during Recent Past

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Various studies have been conducted during the last decade on Village Tank Cascade Systems (VTCS) such as water quality, resources use, tank types, system productivity etc. Abstracts of selected 15 such studies are given below to indicate the interest paid by the research community on VTCS.

1. Cascade tank water quality management: A case study in Thirappane tank cascade system, Sri Lanka

Authors: N.S. Abeysingha S.P. Dissanayake S. Sumanaweera S.S.K. De Silva

Year: 2021

Abstract: Health of the Thirappane VTCS in terms of water quality of *maha* cropping season was tested and the mean status of some drinking water quality parameters such as turbidity, free NH_3, COD, Pb and Cr exceeded the SLS 614. Other than that, maximum values recorded for EC, total alkalinity, total phosphate, COD, TDS, Mg, Cu, Cr, Fe, Mn and Zn of the Thirappane TCS were higher than the stipulated standard values for potable water. Moreover, calculated DWQI of tanks water of TCS was not up to the suitable level to use the water as potable water. However, most of the irrigation water quality parameters tested and IWQI guarantee that the

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VTCS water is suitable for irrigation of any crops which would not deteriorate the yield and the soil properties. This study further concluded that awareness program on the importance of ecosystem components of the VTCS would help to conserve the VTCS and clearly showed the willingness to participate for the rehabilitation work of the ecosystem components by the stakeholders in improving the water quality status. However, the presence of ecosystem features of tank cascade system, annual income of the respondents, satisfaction of the quality of drinking water, and the awareness about the tank cascade system significantly influenced the participatory decisions of the community on the rehabilitation of VTCS.

2. Water productivity in tank cascade systems: A case study in Mahakanumulla cascade, Sri Lanka

Authors: S. Sirimanna, D. V. P. Prasada

Year: 2021

Abstract: This study was conducted to assess the agricultural water productivity and its determinants in the Mahakanumulla tank cascade system located in the dry zone of Sri Lanka. The data collection for the study was carried out in the form of a survey, where 250 farmer households representing 17 tanks within the cascade were surveyed. The productivity assessment was conducted for the upstream and the downstream of the cascade separately. A regression model was used to identify the determinants of the agricultural water productivity in the Mahakanumulla cascade. The average agricultural water productivity in the upstream was 1.48kg/m^3 and in the downstream it was 1.62 48kg/m^3. The extent of command area and climate-related crop losses were the critical determinants of the agricultural water productivity both upstream and downstream. In the upstream, the tank capacity was a determinant of the field water productivity and, in the downstream, degree of wildlife damage remained significant in determining water productivity.

3. Water quality variation in a tank cascade irrigation system: A case study from Malagane cascade, Sri Lanka

Authors: Kushani Mahatantila, Rohana Chandrajith, H.A.H. Jayasena

Year: 2010

Abstract: Tank cascade irrigation system (TCIS) is a water management practice developed in order to match the nature of the rainfall and landscape in the dry zone of Sri Lanka. The series of interconnected tanks in this system serves multiple functions, including irrigation. This study was carried out to investigate the water quality variation in a tank cascade system and

study the role of hydrophytes found in the upper periphery (*Thaulla*). The Malagane Tank in the northwestern intermediate zone of Sri Lanka was selected for the study. Fairly high levels of nutrients and metal concentrations were recorded in the upstream paddy fields and main inflow of the tank. The concentrations of most of the chemical parameters were showed a decreasing trend while passing the *thaulla* area which is one of the most important hydrologic regimes in a tank system. However, the runoff from the either sides of the tank has polluted the lake water particularly during the rainy season. The hydrophytes in the *thaulla* area play a major role in the hydrology of the tank system.

4. A case study on the Retention Tanks in the Walawe Ganga River Basin, Sri Lanka

Authors: Thilakarathne, J.A.S.I and T.M.N. Wijayaratna

Year: 2018

Abstract: Village tanks have been used for irrigation purposes from a longer period of time and its behavior as a cascade system can be considered as an efficient methodology towards a sustainable water management system. Though it's not vividly addressed in recent studies, some tanks are present in a cascade system with a mere intention of retaining water for the downstream tanks and, are being called as retention tanks. Nevertheless, in the present day, those are being used to fulfill human water needs instead of their initial use as retention tanks. Due to this reason, the overall working capacity of village tank cascade systems is being diminished. And in this case study, a methodology is proposed to identify retention tanks using five cascade systems in Walawe Ganga river basin.

5. Exploring the village tank cascade systems (VTCSs) in Vavuniya district, Sri Lanka

Authors: A. Nanthakumaran; H. K. Kadupitiya; S. Devaisy; W. E. P. Athukorale

Year: 2022

Abstract: An attempt was made to identify, validate the village tank cascade systems (VTCSs) and study the water flow from one village tank to another in each VTCS in the eight Agrarian Service Centre (ASC) divisions in the Vavuniya district from October 2017 to December 2018. VTCS contribute a significant share of available water resources for the livelihoods of households in the Vavuniya district. The 1:10,000 topographic map of the Survey Department, satellite images and the digital elevation model were used to identify the cascades and flow direction map for the study area using ArcGIS 10.2.2. Among 756 village tanks in the district, 80 VTCSs

comprising 514 village tanks were identified, and only 69 cascades were validated in the field. In addition, this study identified 111 isolated village tanks without connecting with other village tanks and 131 abandoned village tanks. Further investigation is recommended to explore the possibilities of increasing the cascade areas in the study area by connecting isolated tanks with VTCSs. Initiation taken towards rehabilitation of cascades would enhance the livelihood of farm households in the Vavuniya district and lead to sustainable water resource management.

6. Water management using traditional tank cascade systems: a case study of semi-arid region of Southern India

Authors: Aman Srivastava & Pennan Chinnasamy

Year: 2021

Abstract: Most arid and semi-arid regions of the Southern-Indian peninsula experience frequent drought. To combat this, historically many water recharge structures, such as tank cascade systems, have been constructed. However, in recent years, performance of these tanks, especially for irrigation and groundwater recharge, is limited due to impacts of external factors that are not scientifically understood. This study, for the first time, aimed to explore spatio-temporal variation of water mass balance components and their impact on the Vandiyur tank cascade system (VTCS) in the city of Madurai, India. Study estimated water mass balance components for rural, peri-urban, and urban catchments across VTCS. Catchment-specific algorithms and water budget equation were used to estimate the volume of hydrological parameters. Additionally, land use/land cover maps were developed to understand the significance of using a water balance approach in understanding the behavior of hydrological components governing the water budget of a catchment. Results indicated a rapid increase in the urban area, up to 300%, in peri-urban and urban regions. Urbanization was considered the primary cause of high catchment runoff (40–60% of rainfall). Due to this, seasonal water availability within each tank across catchment was observed inconsistent (0–15%), wherein summer recorded approximately the least tank storage (0–8%). In general, study provided an approach for a practical, water-focused application demonstrating how the principles of mass balance can help to foster robust water accounting, monitoring, and management. It further emphasized the use of a water balance approach in identifying vulnerable catchments for appropriate tank-rehabilitation-based interventions.

7. Modeling for tank cascade system planning and management: Case study of Mamunugama tank cascade system, Kurunegala District

Authors: K D W Nandalal and U. S. Imbulana

Year: 2022

Abstract: The dynamics of tank cascade systems have been studied using simple water balance models. This paper presents the development of a system simulation model for a tank cascade system based on the principles of System Dynamics (SD), a mathematical modeling approach that could be used to study the behavior of dynamic systems. The model was developed for the Mamunugama tank cascade system comprising 06 tanks and 02 anicuts and located in the Kurunegala District, Sri Lanka. Modeling of all the water balance components of the tank cascade system is presented in detail. The model was calibrated using observed water levels at four tanks during the period from October 2020 to September 2021 covering a Maha Season and a Yala Season by comparing them with the model computed tank water levels. The model results provided valuable insights into the water balance components at each tank. The model has the potential to be used as a tool for optimizing the usage of the limited water resources in tank cascade systems for improved agricultural production. It can be used in planning tank rehabilitation, studying the impact of restoring abandoned tanks in addition to planning cultivation seasons in a scientific manner.

8. Tank cascade systems as a sustainable measure of watershed management in South Asia

Authors: Wiebke Bebermeier, Julia Meister, Chandana Rohana Withanachchi, Ingo Middelhaufe andBrigitta Schütt

Year: 2017

Abstract: In the dry zone of Sri Lanka, human-made reservoirs have served for the collection, storage and distribution of rainfall and runoff and provide irrigation water for the cultivation of paddy for 2000 years. This paper introduces the layout and function of four traditional village tank cascade systems in the hinterland of Anuradhapura, located in the North Central Province in Sri Lanka. In contrast to large-scale tanks, these systems are managed and maintained by local villagers. Sedimentological data from two tanks provide information about processes leading to the formation of these deposits and their post-sedimentary, partly human-induced alterations. The presented data support the hypothesis, that the decentralized managed tanks were not affected by severe erosion after the abandonment of the ancient capital Anuradhapura in the 11th century CE, a period that was characterized by socio-economic instability and increased climatic fluctuations. Presented results underline the significance of small-scale tank cascades systems to buffer the effects of climatic fluctuations and point to their potential as a cornerstone in coping with future climate change in the dry zone of Sri Lanka.

9. Evolution of tank cascade studies in Sri Lanka

Author: Muditha Prasannajith Perera

Year: 2017

Abstract: Some of the British agents have wondered due to view of thousands of tanks in low country dry zone of Sri Lanka. The first topographical survey conducted in 1897 and the first systematic study on small tanks within a limited area in 1923 marked the turning point of studying the unique tank system in the country. After this a lot of researchers and professionals both local and foreign, attempted to explore and analyze these systems. Understanding the strategies, water management techniques and issues, anthropological background, ecological settings, organizational behavior of tanks, as well as the current issues and management approaches, were also analyzed within the past period. In addition to the tank based studies, there were a number of studies in relation to "set of tanks" or "combined group of tanks with its catchments as well as command areas". This paper identifies the evolution of these study disciplines, as well as relevant study periods on different perspectives in relation to tank cascades.

10. Resource-use efficiency and environmental sustainability in the village tank cascade systems in the dry zone of Sri Lanka: An assessment using a bio-economic model

Authors: Dasuni Dayananda, Jeevika Weerahewa and Senal A. Weerasooriya

Year: 2023

Abstract: In light of the key findings of the simulation exercises, several conclusions may be drawn. The results demonstrate irrigation water to be the key determinant of the optimal crop mix and, hence, the profitability of farming in the Mahakanumulla VTCS. Therefore, drought conditions lead to severe economic losses in this system, with year-round and seasonal droughts having the most significant impact. Water availability at the mid-stage is the most binding, resulting in a drastic reduction in crop cultivation in this area.

The following policy recommendations are proposed based on the conclusions of this study.

i. Develop drought risk profiles at the national level to capture risk and assess damage. Dry zone VTCSs face drought shocks which lead to drastic profit losses and food insecurity. The introduction of possible alternatives to mitigate profit losses, along with identified damages, is a viable solution.
ii. Introduce buy-back market arrangements to the VTCSs. Resources can be used to maximum potential and profitability restored under extreme climate scenarios by introducing buy-back arrangements for maize and chili.

iii. Discourage tobacco cultivation and introduce alternative crops. Though tobacco generates relatively high profits in cascade systems, it also causes tremendous soil loss and nitrate leaching compared with other alternatives.

11. Socio-cultural, ecological and managerial perspectives of a selected cascade tank system in Anuradhapura District, Sri Lanka

Authors: Jayasuriya BPW, Ranasinghe DMSHK and Maddumabandara CM

Year: 2017

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 analyze 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 organizations 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.

12. Will restoration of ecological functions of tank cascade system contribute to reduce CKDu in Sri Lanka? A review

Authors: Abeysingha,N.S., K. B. Dassanayake and C. S. Weerarathna

Year: 2018

Abstract: People in the dry zone of Sri Lanka where hydraulic civilization once thrived, suffer from occurrence of a chronic kidney disease of unknown etiology (CKDu). The etiology for CKDu is now shown to be multi factorials and but related to water. Ancient people in the dry zone used surface water of tank cascades system and this system was interlinked with the ecosystem and social system of the area. It is hypothesized that the adverse changes that took place to the ecosystem of the tank cascade system and new commercial practices of agriculture in the CKDu prevalent area have also become reasons for the spreading of CKDu. This review assesses the effect of different components of the tank cascade systems in improving the water quality. A number of studies have reported positive effects of improving the surface water quality of the tank by the Wew Ismaththa (closer catchment), Thaulla (upper peripheral gentle sloping land), Kattakaduwa (Interceptor) Iswetiya or Potawetiya (upstream soil ridges), Godawala (small silt trapping pond). The review also identified functions of Thaulla area approximately similar to a constructed wetland. This review highlights the issues and gaps in our understanding the ecological functioning of Globally Important Agricultural Heritage System. It is suggested that reconstruction of ecofriendly structural components of tanks and reestablishment of tank cascade system in the area would help to combat the spreading of CKDu in dry and intermediate zone of the country.

13. An analysis of labour use pattern in Thirappane village tank cascade system in Sri Lanka: Determinants and potential effects of off-farm employment

Authors: J. Weerahewa, H. Kanthilanka, R.J. Farquharson, S. Thrikawala, T. Ramilan, and D. Dayananda

Year: 2021

Abstract: Participation in off-farm employment is a strategy adopted by farmers in many developing countries to increase and stabilize their incomes. However, empirical evidence on its effects on management of natural resources is context specific. This study examines the pattern on labor use with special emphasis on determinants and potential effects of participation in off-farm employment by the villagers reside in Thirappane tank cascade system in Sri Lanka. Data gathered from a primary survey conducted among 134 households were used for analysis. The results of probit models revealed that the farmers who possess agricultural assets have a higher probability of joining employment in other-farms and those who are educated and own large farms participate in non-farm sector employment. Community

management of the village tank cascade systems will be challenging owing to the increased interest in off-farm activities by the able.

14. Significance of forest tanks (kuluwew) renovations in the cascade tank systems (ellanga) in dry climatic zone of Sri Lanka: the cases from the cascades in Puttlam district

Author: Sakalasooriya, N.

Year: 2019

Abstract: This study investigates the significant role of Kuluwew (forest tanks) to sustain the forest ecosystems and the Ellanga (Cascades) social-ecological systems of the Dry Climatic Zone (DCZ) of Sri Lanka and points out the neediness of renovating these abandoned tanks. The wew (Tanks) civilization of Sri Lanka is unique and endemic because the tank systems have their own philosophy, science, technology, and arts. Basically, these tanks have been built by the kings of Sri Lanka under the Buddha's thoughts. King Parakramabahu the Great (1153 AD –1186 AD) has concluded the philosophy of irrigation tanks in Sri Lanka as "truly in such a country, not even a drop of water that comes from the rain must flow into the ocean without being made useful to all living beings". Under the concept, the cascade tanks lie on small valleys with low gradient in the DCZ to provide water for all needs of human beings and other living beings in the social and ecological systems. Consequently, there are many types of tanks in the same cascade and they play different roles. The kuluwew are located near to the forest or inside the forest for especial purposes like providing water for wild animals, reduce the silting, filtering the debris, store the rainwater and enrich the groundwater level, supply water to the irrigation tanks by seepage, maintain the food chain providing water, fruits, grass, leaves etc. Unfortunately, after the king's periods, the modern rulers did not pay adequate attention to protect those tanks and now they are malfunctioned. Consequently, lots of wild animals, have been migrated into the villages and it has become a major issue of tank villages in DCZ of Sri Lanka. Wild elephants, monkeys, porcupines, giant squirrels, wild boar, and hundreds of insects and caterpillars are invading the village ecosystems and threaten the whole wellbeing of settlers unprecedently. This study has done 07 case studies in 07 major cascade systems in Puttlama district. There are 159 tanks altogether in these 7 cascade systems and out of the 34 tanks are forest tanks. The main data collecting technique is PRA and resource and hazard maps, seasonal calendar, matrix analysis, transect walks, focus group discussions were the tools. The study has revealed that all the forest tanks have not been renovated for many decades and they are malfunctioned. Consequently, there is a lack of water and edible plants and fruits for the animals in annual dry periods from March to October. Therefore wild animals have been motivated to enter the villages and nearby farmlands. Sometimes some insects, rats and snakes are also coming into the residential and farming areas. The conclusion is that these forest tanks should be renovated

systematically and the wild animal threat may reduce by 80 percent after a full renovation of all the forest tanks and restore the forest ecosystems

15. Aguwewa in cascade systems: Does it serve the purpose?

Authors: D. S. Jayaweera, K.M.S.Thilakarathna, G.N.Paranawithana and B.C.L. Athapattu

Year: 2018

Abstract: The Sri Lankan traditional Irrigation Systems are unique and there are number of tanks which fulfill different specific purposes. Aguwewa is one of those tanks, which is used to prevent siltation, located within the catchment of the larger village tank. A segment of precipitation received in the catchment is retained in Aguwewa before feeding the larger reservoirs. Thereafter major reservoir is fed by seepage or spilling. However, soil erosion is critical and it causes heavy siltation in tanks due to extreme weather conditions, high intensity rain falls, deforestation of catchment, high velocity runoffs. This paper specifically emphasizes on Aguwewa in Cascade Systems and closely examines whether it fulfills its purposes and impacts to the cascade systems within present scenarios. Comprehensive literature review and RS and GIS data were used to investigate the siltation of Aguwewa in Kala Oya basin. Changes of shapes and sizes of tanks and disappearance of “perahana’’ and wind breaking trees were noted by field investigations. It was noted that the traditional irrigation systems are under threat due conversion of Aguwewa into small irrigation tanks of low productivity as a result of the ignorance of the functionality of this type of tanks. Therefore, it is important to investigate and perform mitigations on this age-old method, for revitalizing the functionality of Aguwewa.