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Rainfall and Tank Storage: Relooking the Tank Performance with Time Tested Tank Storage Pattern Using Tank Cascade Approach in Tamil Nadu

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RAINFALL AND TANK STORAGE: RELOOKING THE TANK PERFORMANCE WITH TIME TESTED TANK STORAGE PATTERN USING TANK CASCADE APPROACH IN TAMIL NADU

Revised Draft Final Report

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EXECUTIVE SUMMARY

Tanks play a vital role in providing irrigation in Tamil Nadu. However, the area under tank irrigation has declined continuously for the past five decades and witnessed poor performance. In order to enhance their performance, substantial investments have been made by the European Union, NABARD and the state government through modernization programs. These initiatives aim to revitalize existing tanks to improve their irrigation capabilities. However, previous modernization efforts and research primarily concentrated on individual tanks, overlooking the potential advantages of cascade-based solutions. The tank cascade approach is critical to study filling behaviour and tank performance as a whole to realize the full benefits of the investment in tank rehabilitation programs. Therefore, the present study specifically focused on examining the tank irrigation using the tank cascade approach, with the following objectives: (i) to study the tank filling pattern during normal rains in the state, (ii) to identify factors affecting the proper tank filling in the cascade systems, (iii) to link the tank filling pattern and tank performance levels, (iv) to identify the list of potential tanks and cascades suitable for modernization and (v) to suggest appropriate (cost-effective) and time tested tank modernization strategies.

For the purpose, the study has examined a total of 315 cascades, covering 2,013 tanks, spread across 15 predominantly tank-irrigated districts[1]. Each cascade comprises of 3 to 40 tanks. These tanks are categorized based on two criteria: (i) the management type, where tanks with an ayacut area of more than 40 hectares are maintained by the Public Works Department (PWD) now Water Resources Department (WRD), while those with less than 40 hectares are managed by the Panchayat Union (PU); and (ii) the location within the cascade (head, middle, or tail). The study has collected both primary and secondary data. The secondary data include tank filling behaviour, extent of encroachments, condition of supply channel, siltation and rainfall for the years 2021 and 2022. Additionally, primary data was gathered from various stakeholders, including members of Water Users Associations (WUAs), WRD officials, and farmers. The study employed frequency analysis, linear regression, the Garret ranking method, and financial feasibility assessment.

The study found that the tank fillings varied from 1 to 3, with PWD tanks having more fillings due to better supply channels and catchment conditions. The PWD tanks also have more number of sluices than PU tanks, given their larger water spread area and storage capacity, ranging from 1 to 7 compared to 1 to 2 in PU tanks. Nonetheless, it is observed that normal rainfall was received during the study period, and more than 90 per cent of the tanks were filled. However, the effective storage capacity is significantly reduced compared to the actual capacity due to silt accumulation and encroachments in the tank water spread area. The tank performance is positively influenced by the location of the tanks in the cascade, number of functioning wells, effective tank storage, and tank

[1]Kancheepuram, Chengalpattu, Thiruvallur, Villupuram, Kallakurchi, Krishnagiri, Pudukottai, Madurai, Ramanathapuram, Virudhunagar, Sivagangai, Tirunelveli, Tenkasi, Thoothukudi and Kanyakumari.

modernization activities in the past five years, whereas rainfall deviation, population density, and defunct of WUA are found to be negatively influencing the tank performance.

The factors that significantly reduce the tank performance in the tank cascade include (i) encroachment in the tank foreshore area, (ii) siltation, (iii) improper functioning of the sluice, and surplus weirs, and iv) dilapidated bunds and distributary channels. Most of the tanks are encroached, which is more in the supply channel than in the tank catchment area and foreshore region. There is no social forestry maintained in most of the tanks except in Kancheepuram district, where tree plantations are carried out under the Tamil Nadu Green Mission. But *Prosopis* and other trees occupied more than 10 per cent of the area across the water spread area, tank bund, and foreshore area, which affect the tanks' performance. In all tanks, the average siltation is around one-third of the storage capacity (30 per cent). Improper functioning of sluices and surplus weirs are also found to be limiting tank water storage, maintenance, and irrigation.

The present study proposed five different tank modernization options viz., (i) desilting of tank and bund strengthening, (ii) supply channel cleaning and removal of encroachments, (iii) sluice repair and management, (iv) repairing of the surplus weir and (v) lining of distributary channel. Before determining which investment options to prioritize, we categorized the tanks based on their performance index *i.e.* high (>75 to 100 per cent), medium (50 to 75 per cent) and low (26 to 50 per cent). It is found that 572 tanks spread across 88 cascades (28 per cent) are identified as "high-potential tanks" for modernization followed by medium-potential tanks (1409 tanks located in 215 cascades accounted for 70 per cent) and the remaining are low-potential tanks (2 per cent). Regarding modernization efforts, Chengalpattu district holds the largest number of high-potential tanks, followed by Madurai, Thiruvannamalai, Villupuram, Tirunelveli, Ramanathapuram, Thoothukudi and Virudhunagar districts. In the case of medium-potential tanks, Tirunelveli district leads with the highest percentage allocated for modernization (26 per cent), followed by Pudukottai (18 per cent), Kanyakumari (14 per cent), Sivagangai (12 per cent), and Ramanathapuram (7 per cent), while the remaining 10 districts have less than five per cent of tanks set aside for this purpose.

The key research question of the present study is: Why are all the tanks in a cascade not getting filled up even during the normal rainfall years? This study covering 2013 tanks in 315 cascades across 15 tank-intensive districts has made a breakthrough in tank irrigation research by examining the tank filling behaviour in the normal rainfall period of 2020-21. It is found that 54.3 per cent of the tanks had 100 per cent filling, 40.7 per cent of tanks had 75 per cent filling, 4.8 per cent of tanks had 50 per cent filling and the rest 0.2 per cent had deficit filling (less than 50 per cent). The effective storage of tanks shows that tanks receive about 87 per cent of the physical filling.

The study on rainfall and tank storage has brought out important observations that would help the policy makers to make appropriate investment options for sustainable management of irrigation tanks in the state. The major conclusions and identified policy options are discussed here.

- The main reasons for the comparatively lesser physical tank filling and low effective storage in normal rainfall periods are siltation in the tank water spread

area, poor condition of the sluice, and encroachment in the supply channel. These issues confirm the need for tank modernization. Accordingly, the type of tank modernization activities/strategies needed in different tank filling typologies also vary. The following tank modernisations are needed.

  - For 100 per cent filling tanks, desilting, and sluice repairing activities are needed to maintain the 100 per cent filling in the future.

  - For 75 per cent filling tanks desilting, supply channel cleaning and sluice repairing activities are needed to keep up the filling up to 100 per cent

  - For 50 per cent filling tanks, supply channel cleaning, and desilting activities are needed to keep up the filling to 75 per cent level and sluice repairing, activities to keep up the filling up to 100 per cent level.

- For the tanks which have less than 50 per cent filling, the study suggests that these tanks may be converted into percolation tanks for groundwater recharge as the issues related to tank filling such as supply channel encroachment, poor water supply, etc., are observed to be seriously embedded with other socio-political issues.

- Among the various tank modernization activities examined for different tank typologies (PU and PWD), the results show that the desilting of tanks and bund strengthening would result in high returns. The IRR is worked out to be 19.50 per cent for high potential tanks and 18.10 per cent for medium potential tanks, whereas the BCR is worked out to be 2.16 and 2.09. The modernisation interventions namely cleaning of supply channel including desilting and removal of encroachment would result in 14.18 per cent and 13.53 per cent IRR for the high potential and medium potential tanks respectively, whereas the BCR is 1.26 and 1.12 for the above tank typologies. The other tank modernisation options including sluice repair and management, repairing of surplus weir and lining of distributor channels are found to be financially feasible for both tank typologies.

- Even though, within the cascade, both PU and PWD tanks perform the same in terms of filling, the less than 50 per cent filling tanks need not be considered for tank modernisation under cascade approach. Tanks located in the tail end of the cascade may have varying levels of filling (50 to 100 per cent) and this can be addressed when the tank modernization focussing on the entire supply channel cleaning is done. Strengthening the WUAs in the tank cascades is considered to be important as a compliment to the physical tank modernization activities.

- The results also confirm that even with lesser fillings, many tanks perform well mainly due to supplementary water from wells in the command area. Hence, augmenting ground water /well development up to the threshold levels in each tank in the tank cascade should be given priority in future tank modernization programs.

- As indicated only 572 tanks out of 2013 tanks (28 per cent) have high potential for tank modernization (i.e. first-category tanks); 70 per cent are categorized as medium-potential tanks and the remaining 2 per cent are categorized as low-potential tanks. Five different potential options for tank modernisation are identified: (i) desilting of tanks and bund strengthening, (ii) supply channel cleaning including desilting and removal of encroachments, (iii) sluice repair and management, (iv) repairing of surplus weir and (v) lining of distributary channel. The total investment for the above modernization activities is estimated to be around Rs. 564.05 crores. The estimated benefits are high in high-potential tanks than in medium and low-potential tanks. The financial feasibility analysis confirms that the identified tank modernisation interventions are found to be financially feasible across tank typologies. Since the study recommends the cascade approach, it is important to include all the tanks for modernization as the modernization options with different priorities.

- Given the scope of modernization of all the potential tanks in the state (like Kakatia mission in Telangana state), the budget estimate (for a 5-year cycle) will be roughly about Rs.564.05 crores[2].

- The study found that wells in the tank command areas found to be very effective for supplemental irrigation which help to save crops, increase returns and so on. Hence, it is suggested that adequate support may be extended to farmers in the tank dominated situations, particularly in the non-system tank commands for construction of wells. However, it should be carefully noted that the number of wells should not exceed threshold level.

- Water Users Associations (WUAs) to manage and maintain tanks are yet to be more active in resource mobilisation, manage and maintain tanks. Considering the importance of various institutions, in relation to tank management, defining the roles of different organizations is crucial at this stage so as to achieve sustainable management of tanks in the country. This will facilitate developing linkages between different organizations involved in natural resource management, tank management in particular, resolve conflicts and promote proper maintenance and management of tanks. There is also a need for comprehensive and accessible database and inventory of resources that would enable better local level planning. Stable and sufficient financial resources are crucial for better long-term planning and sustainable management of natural resources and tanks in particular.

- **Research:** Research system may be encouraged to evolve crop varieties and water management technologies so as to suit to different types of soils, tank typologies. Research on the effect of irrigation and sustainability of yields under various water saving methods and irrigation technologies may be encouraged. Exploratory and in depth socio-economic research is highly warranted to identify the extent of awareness and knowledge about climate change impacts,

[2] This was worked out taking into account the cost of combination of first two modernization options of different tank filling typologies

adaptation, constraints in adoption of various coping and adaptation strategies, transaction costs in technology adoption and identify policy options for various tank typologies.

- **Capacity building**: Though farmers are aware of impact of climate variability, coping and adaptation strategies, still there is lack of awareness among farmers about water management technologies, irrigation scheduling, best agricultural practices etc. Thus, there is a dire need for building capacity of the farming community. Implement proper educational and training programs for farmers with emphasis on major issues on the involvement of users of water on drought problems, floods, and other extreme events. Also, adequate technical support in water management technologies and cultivation of crops, cropping pattern and crop allocation decisions will help them better cope with climate variability.

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DISCLAIMER

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Rainfall and Tank Storage: Relooking the Tank Performance with Time Tested Tank Storage Pattern using Tank Cascade Approach in Tamil Nadu

About NABARD Research Study Series

The NABARD Research Study Series has been initiated to enable wider dissemination of research conducted/sponsored by NABARD on the thrust areas of Agriculture and Rural Development among researchers and stakeholders. The current study titled 'Rainfall and Tank Storage: Relooking the Tank Performance with Time Tested Tank Storage Pattern using Tank Cascade Approach in Tamil Nadu' completed by Centre for Agricultural and Rural Development Studies (CARDS), Tamil Nadu Agricultural University (TNAU) is the forty-second in the series.

Tank irrigation has been a traditional water management system in peninsular plateau states like Andhra Pradesh, Telangana and Tamil Nadu where water supply replenishment is dependent on a cycle of dry seasons alternating with monsoon seasons. Since these states do not have perennial rivers, the tanks form an important source of irrigation. By harnessing the power of rainwater, tank irrigation stands as an integral component of sustainable agriculture as they help farmers enhance crop yields, mitigate drought effects, and contribute to community development.

However, the area under tank irrigation has declined continuously for the past five decades and witnessed poor performance. Various factors like sedimentation(siltation), land encroachment, inadequate maintenance, climate variability affect the efficiency of tanks and result in lesser physical tank filling and low effective storage in normal rainfall periods. These issues confirm the need for tank modernization.

This study covers 2013 tanks in 315 cascades across 15 tank-intensive districts of Tamil Nadu to examine the tank filling behaviour in normal rainfall periods of 2020-21. It identifies the potential advantages of tank cascade approach which is critical to realize the full benefits of the investment in tank rehabilitation programs. The study explores different potential options for tank modernisation and provides important observations for policy makers to ensure sustainable management of irrigation tanks in Tamil Nadu.

Hope this report would make a good reading and help in generating debate on issues of policy relevance. Let us know your feedback.

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1. INTRODUCTION

1.1.Issues

Tanks are one of the important sources of irrigation in Southern India. A major issue in tank irrigation in the state is significant decline in area under tank irrigation. The area under tanks has declined from 8.9 lakh ha during 1971 to 3.6 lakh ha during 2021-22. In the meagre rainfall years, the tanks could store only small volume of water and the chain of tanks except the first tank, receive little supply. These phenomena are more pronounced in non-system tanks than in system tanks resulting in reduction in area irrigated. The issues on tank irrigation management is not a new one and many researchers across the globe have studied several issues over a period of time and contributed to the literature on tank irrigation in India. Most of the studies focused on the role of institutions in tank management, water sharing issues, tank modernisation and its impacts, agricultural production in tank commands, conjunctive use of ground and surface water, impact of climate change on tank irrigation, tank ecosystem services etc.

Several researchers have inquired into the causes for decline of tank irrigation in South India. Rainfall, physical, hydrological, management and institutional factors significantly affect the area under tank irrigation (Palanisami *et al,* 1997; Palanisami and Balasubramanian, 1998; Palanisami and Suresh Kumar, 2004; Palanisami *et al*, 2008). The most dominant of them are lack of incentives among the command area farmers, defunct of traditional tank management institutions and consequent reduction of interest among farmers in tanks (Balasubramanian and Selvaraj, 2003), erratic rainfall, heavy siltation in tank water spread, supply channels, encroachments in foreshore areas and catchments, and lack of adequate attention paid to regular maintenance (Palanisami and Suresh Kumar, 2004).

Poor performance of tanks led to non-availability of water in the tail regions, reduced yield of crops, changes in cropping pattern, reduction in area under rice, water stress under critical stages of crops growth crop failure (Muruganantham and Krishnaveni, 2015, Suresh Kumar el al, 2015). The other effects are non-availability of assured employment opportunities, considerable out-migration of villagers, and rise in agricultural wage rate (Palanisami et al, 2008). Palanisami *et al.,* (2010) examined challenges faced by tank irrigation in the light of climate change scenarios and analysed the potential options for tank performance such as revenue mobilisation through multiple use of tanks, augmenting groundwater resources in the tanks, integrating social forestry, desilting and tank modernisation.

To better manage water scarcity, farmers adopt strategies like increasing heights of tank bunds, construction of farm ponds, water storage, drilling of borewells and desilting of tanks (Palanisami and Suresh Kumar, 2004; International Water Management Institute, 2009; Suresh Kumar, *et al.*, 2015; Vidya, 2017). In addition, farmers adopt different strategies like skipping cultivation, livestock rearing (68 per cent), reducing cultivation area (92 per cent), water purchase (27 per cent), growing less water consuming crops (48 per cent) and growing fodder crops (Palanisami *et al*., 2008).

After the fall of “Kudimaramathu” in the tanks over the years and to address the tank rehabilitation issues, the state government has made huge investments on tank modernisation programmes mainly to provide major repairs and improve tank performance, increase irrigation potentials by construction of new tanks and improve existing structures. The European Economic Community (EEC), now European Union (EU), National Bank for Agriculture and Rural Development (NABARD) and World Bank provided financial assistance for tank rehabilitation in the state. An evaluation of the tank modernization has shown mixed results indicating a) many of the modernized tanks couldn’t improve their performance significantly, b) even in normal rainfall years many tanks have not received inflows into the tanks making tank modernization a redundant activity. Many studies have examined the tank performance linking hydrology and socio economic factors. However, none of the studies focussed the tank cascade approach in studying tank performance.

Hence, in order to address the future of tank irrigation management in the state in particular and in the country in general, as a climate adaptation strategy, this present study was initiated with the following hypotheses:

a) All the tanks in a cascade not get filled equally even during normal rainfall years
b) Tank performance is influenced by various hydrological, and socio-economic factors
c) Tank modernization interventions differ across typologies of tanks and cascades

1.2.Objectives

The overall objective is to study the tank filling behaviour and the tank performance in tank cascades. The specific objectives are:

a) to study the tank filling pattern during normal rains in the state following tank cascade approach
b) to identify factors affecting the tank filling pattern in the cascade systems
c) to link the tank filling pattern and tank performance levels
d) to develop a framework for identifying potential tanks for modernization, and
e) to suggest appropriate (cost effective) and time tested tank modernization strategies.

2. DATA AND METHODOLOGY

2.1. Features of tanks/tank cascade

There are around 41,000 tanks in the state, with varying sizes and types. The tanks are classified into system tanks (which receive supplemental water from major streams or reservoirs in addition to the yield of their own catchment area) and non-system/rainfed tanks which depend on the rainfall in their own catchment area and are not connected to major streams/reservoirs. The tanks are also classified into Panchayat Union[3], PWD[4] and Ex-zamin tanks based upon the management authority. There are about 9,800 ex-zamin tanks, of which more than 60 per cent are concentrated in the undivided Ramanathapuram district. The Ex-zamin tanks are managed by WRD under separate division.

Other than management, location of the tanks in a hydrological boundary may also influence the tank performance. The location of the tanks in a cascade may affect the performance and modernization activities. In ancient times, the tanks were constructed in chains by connecting a series of tanks by channels which enabled water at the highest points to automatically flow to the tanks at the lower points during the rainy season, a concept similar to the modern technique of watershed management. A typical cascade is the one in which all other tanks in that cascade are interconnected with one another through surplus weir/supply channel. Each cascade is called by a group name which is usually the name of the upper most tank in the cascade. Since the cascade tanks are linked to one another, proper storage of water, prevention of runoff, soil erosion, silting up of tanks and channels are achieved.

The major disadvantage with the cascade tanks is that whenever the major breach occurs during the flood, most of the downstream tanks will also get breached due to excess water from previous tanks. However, over years, the cascade of tanks is disintegrated. The encroachment of the supply channel for settlement by the people due to population pressure, for cultivation of crops and development of transport infrastructure have resulted in disappearance of the supply channel that connected upper and lower tanks. Further, poorly maintained structures such as sluices and surplus weirs have also resulted in non- functioning of tanks.

It is expected that the broken cascade had influenced the tank performance as the location of the tanks in a cascade is function of the characteristics of the cascade and in the absence of the functional cascade, such location of the tanks had adverse effect in terms of water supply and overall tank performance. Even though, the concept of tank-cascade is recognized as an interesting methodological approach for taking up any

[3] Panchayat Union (PU) Tanks have a command area of less than 40 ha and are under the control of village communities

[4] Public Works Department (PWD) Tanks have a command area of more than 40 ha, maintained by the Water Resources Department, Govt. of Tamil Nadu

research or development activities, it is still unclear how the tanks in a cascade are distributed?. Why some of the tank of different sizes falls in different location within the cascade? and whether the performance of the upstream tank in a cascade affect the performance of the downstream tanks?

Keeping the above issues in view, an attempt has been made to analyse the pattern of tank filling behaviour and tank performance by selecting tanks in cascade purposively. A sample of 2013 tanks located in 315 tank cascades has been studied. The advantage of such sampling lies in capturing of locational advantage of tanks, i.e. whether a particular tank located in the head/tail reach of the cascade is advantageously placed or not. For example, most of the tanks located in the tail reach of the cascade happened to be PU (i.e. smaller tanks may be located at the end of the tank cascade since the water availability at the tail reach is expected to be less).

Hence, it is decided to study all the tanks in the selected cascade. Information on hydraulic particulars and maps were collected from WRD records and block-level administrative offices. Field visits were made to have discussions with farmers, and water user associations. Out of total tanks surveyed, one third of them are PU tanks and remaining are PWD tanks. PWD offices had tank list and details at region wise, district-wise, division wise and the river basin wise. Pooled data on list of tanks in a district maintained by the panchayat unions was not available. Field visits were made tank cascade wise with the list of tanks available at PWD office and the tanks were grouped into PWD and PU tanks.

2.2. Sampling Design

A total of 15 tank intensive districts (where tank irrigation accounts for more than 1/3 of the irrigated area) are covered for the tank cascade survey. In each district seven per cent of the tanks proportionate to the total number of tanks were selected for conducting field survey. In each district, tanks were selected and surveyed from the tank cascade maps available with the WRD and these selected cascades were used for the survey of tank filling pattern. Total number of tanks in the selected districts is presented in Table 2.1.

Table 2.1.Number of Tanks in tank intensive districts of Tamil Nadu (2020-21)

(Number)

S. No.	District	Number of tanks with Ayacut of 40 hectares or more	Number of tanks with Ayacut of less than 40 hectares	Total Number of Tanks
1	Kancheepuram	292	457	749
2	Chengalpattu	400	730	1130
3	Thiruvallur	548	1319	1867
4	Villupuram	675	684	1359
5	Kallakurichi	313	413	726
6	Krishnagiri	139	1188	1327
7	Pudukottai	660	4791	5451
8	Madurai	293	1995	2288
9	Ramanathapuram	477	1217	1694
10	Virudhunagar	290	707	997
11	Sivagangai	679	4281	4960
12	Tirunelveli	178	974	1152
13	Tenkasi	195	808	1003
14	Thoothukudi	107	546	653
15	Kanyakumari	41	2582	2623
	Total	5287	22692	27979

Source: Season and Crop Report (2020-21), Directorate of Economics and Statistics, Chennai.

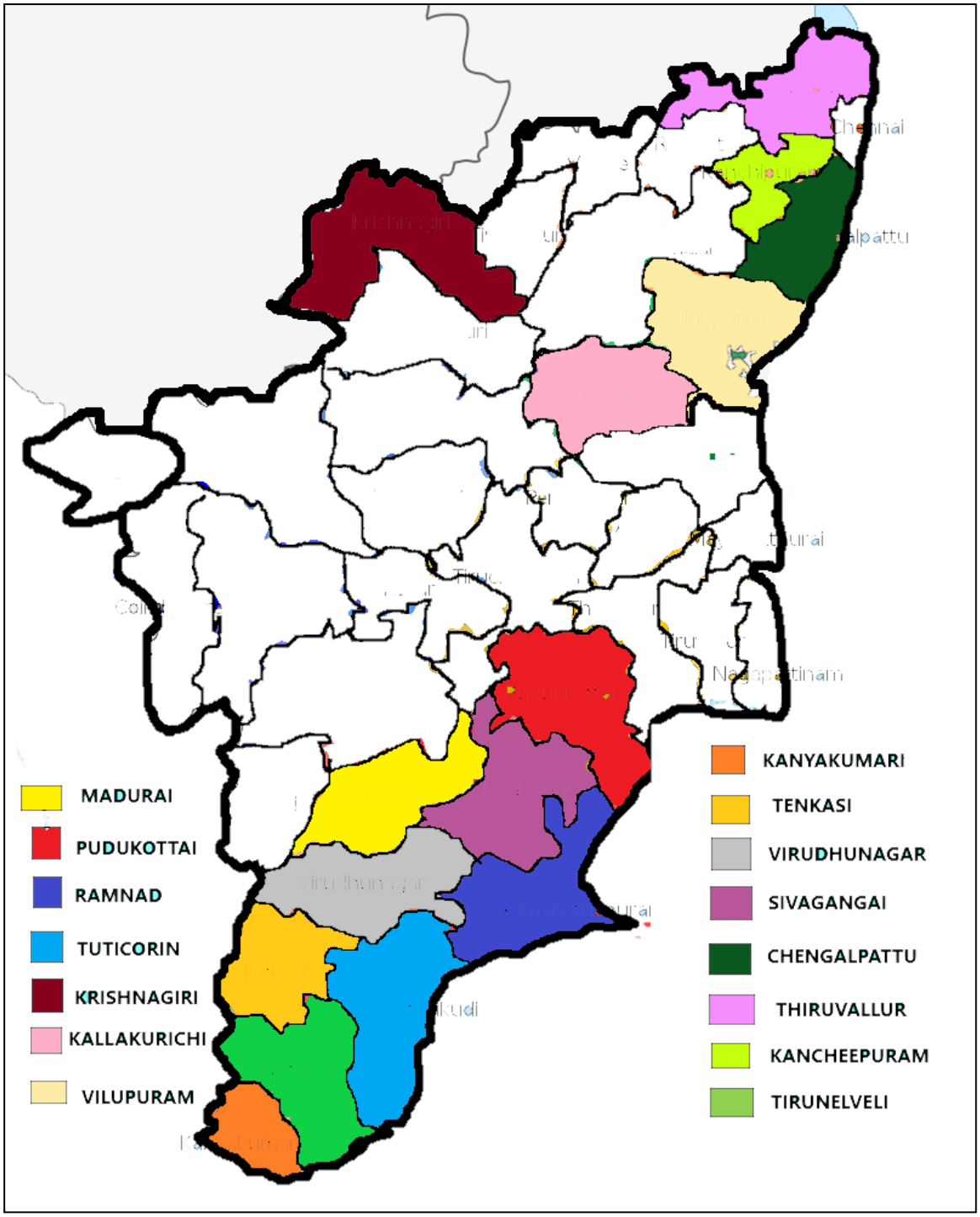


Figure 2.1. Map Showing Sample Districts selected for the Study

2.3. Data collection

The needed information was collected for each tank at different levels. They include:

a) Office level: Location (Latitude and longitude), system or non-system tank, PU or PWD tank, ayacut area (acres), location of the tank in the cascade, actual tank storage capacity (mcft), number of tank filling, rainfall during August-January

months (mm), actual area irrigated and type of rehabilitation works if any (completed) over the past 5 years.

b) Tank level: Percentage of tank filling (per cent of total tank storage capacity filled in this season), percentage of encroachment in tank catchment, condition of the supply channel (functioning or not functioning), percentage of siltation of the tank water spread, condition of the sluice (working or malfunctioning), WUA (active or not existing or not active), percentage of social forestry still present, percentage of *Prosopis juliflora* in the tank water spread, number of wells in the tank command, percentage of area cropped in the tanks during the tank irrigation periods and percentage of area harvested.

A pre tested questionnaire was used for each tank and data collection was done from July to December months, 2022 through personal interviews with the key tank stakeholders such as WUA president, well owners and watermen in the tank cascades. Even though the period of survey falls during the covid-19 period, the research fellows travelled with due care and conducted the survey. The WRD and agricultural department officials dealing with the tank irrigation and tank-based agriculture in the regions were also interviewed regarding their views on tank filling and tank performance.

Tank cascade: Each tank cascade or tank chain indicates the number of tanks falling under the tank cascade given the runoff pattern, soil and the land terrain (slope). Normally, a tank cascade has 10 to 40 tanks depending upon the location and includes both PWD tanks and PU tanks. Tank cascade maps with tank locations available with the WRD department were used in selecting the tank cascades. The selected tank cascades and their types were used to observe the tank filling behaviour using two macro level tank data sets pertaining to the tank irrigation seasons (September 2020 to January 2021; September 2021 to January 2022). The details of the number of tank cascades, tanks covered in Panchayat Union (PU) and Public Works Department (PWD) are presented in Table 2.2. Chengalpattu, Kallakurichi, Kancheepuram, Krishnagiri, Thiruvallur and Villupuram districts are grouped into the northern region.

Districts such as Madurai, Pudukottai, Ramanathapuram, Sivagangai, Tenkasi, Thoothukudi, Tirunelveli, Virudhunagar and Kanyakumari are grouped into southern region. The data pertaining to tanks were collected for the period 2020-21 and 2021-22 and both the years are normal rainfall years. The distribution of selected tanks across districts is presented in Fig.2.2.

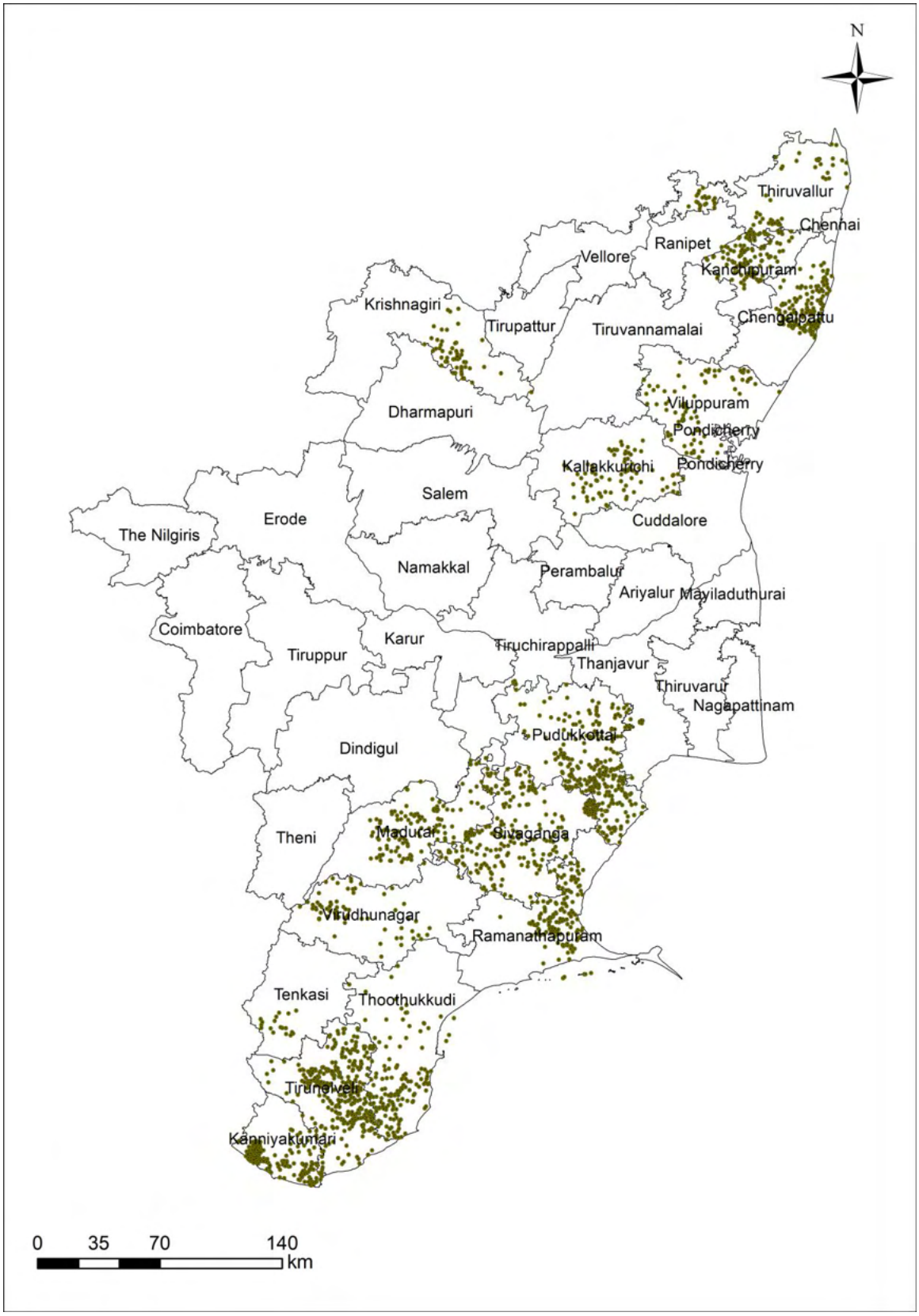


Fig.2.2. Map showing sample Tanks distribution in Tamil Nadu

Table 2.2. Number of Tank Cascades and number of tanks covered in the study

S.No.	District	No. of Cascades	Total Tanks
	Northern districts		
1	Chengalpattu	33	131
2	Kallakurichi	16	62
3	Kancheepuram	14	104
4	Krishnagiri	11	53
5	Thiruvallur	15	90
6	Villupuram	10	89
	Sub total	99	529
	Southern Districts		
7	Madurai	8	119
8	Pudukottai	34	285
9	Ramanathapuram	22	136
10	Sivagangai	37	188
11	Tenkasi	3	18
12	Thoothukudi	5	52
13	Tirunelveli	64	415
14	Virudhunagar	10	66
15	Kanyakumari	33	205
	Sub total	216	1484
	Total	315	2013

2.4.Analysis and tools

2.4.1. Tank performance

Tank performance indicates how effectively the tanks perform in an agricultural year. The tank performance index (TPI) was estimated by following:

$$TPI = \frac{AAIT}{RCA} X\ 100$$

In the tank command area, farmers use wells for supplemental irrigation at times tank water is insufficient to irrigate their crops. Hence, in order to work out the tank performance, area irrigated by wells is also included in addition to the tank irrigated area. Hence, the modified tank performance index (ATPI) was estimated as follows:

$$ATPI\ = \frac{AAIT + AAIW}{RCA} X\ 100$$

Where,

TPI : Tank performance index
ATPI : Adjusted Tank Performance Index
AAIT : Actual Area Irrigated by Tanks in acres
AAIW : Actual Area Irrigated by Wells in acres
RCA : Registered Command Area in acres

2.4.2. Factors influencing tank performance

The tank performance is expected to be influenced by several tank level and supra tank level and socio-economic factors. To understand the factors which influence tank performance, a multiple regression was estimated using tank performance index as the dependent variable. The following model was estimated:

$$TANKPER = a_0 + a_1\,NWELLS + a_2\,RAINFALL + a_3\,NAGLAND + a_4\,POPDENSITY + a_5\,PHYSICAL + a_6\,TLOC + U_i$$

The dependent variable tank performance is expected to be influenced by number of well in the tank command (NWELLS), rainfall in mm (RAINFALL), land under non-agricultural uses in hectares (NAGLAND), population density in number/sq km (POPDENSITY), physical conditions of tank (PHYSICAL) and location of the tank (TLOC). The physical conditions of the tank include encroachments (in tank foreshore area, supply channel and water spread area), level of siltation, condition of tank bund, surplus weir, and sluices condition, activeness of Water User Associations (WUAs) and modernization done in past five years. The location indicates the place of the tank in the particular tank cascade namely head reach, middle reach and tail reach.

The dependence on tank water is an important factor that affects the tank performance. To capture the effect of resource dependence, number of wells are included. Greater the number of wells in the command area of the tank lesser will be the dependence of farmers on tank irrigation. An adverse consequence of this is that there is no incentive for farmers to contribute labour and other costs to tank management and maintenance. Thus, it is expected that the number of wells when exceed the threshold level is expected to influence negatively the tank performance.

Rainfall directly affects tank water storage and irrigation potential. Rainfall is expected to positively influence tank performance. Another important factor which influences tank performance is urbanisation and the demand for land for non-agricultural uses. In the process of urbanisation, conversion of land for non-agricultural purposes takes place at a faster rate reducing tank water spread, catchment area and area under tank irrigation. Thus, non- agricultural use of land due to urbanization can have a negative influence on tank performance. Population density is included in the model to capture the effect of encroachment in catchment area, tank bed and tank water spread area, supply channels all of which can reduce the tank performance. Physical condition of the tank including supply channels, sluices, storage capacity (silt level) etc will influence the tank performance.

The TLOC indicates where the particular tank is located in the tank cascade. Normally it is expected that tanks in the head region of the cascade get more inflows than the tanks in the middle and tail. Since location influences the inflows into the tank, this variable is considered important as future modernization depends upon the tanks which will have some assured storage. Also the present study gives more emphasis on the location of tanks in the cascade and the tank storage.

2.4.3. Effective tank storage

Effective tank storage is the current storage capacity of the tank. The current tank storage capacity is determined by the level of silt deposition, conditions of the sluices, surplus weirs etc. This is estimated as follows:

Effective Tank Storage is calculated using the equation (1)

$T_\varepsilon = \Omega - \sum_{i=1}^{n} \Omega X_i \omega_i$ i=1……n – number of tanks

Where, T_ε refers to effective tank storage; Ω refers to the percentage of tank filling; X_i refers to factors that reduce the tank physical storage expressed in percentage (X_1= Siltation percentage; X_2=Condition of Sluice and surplus weir); ω_i refers weightage given to each factor. (ω_1= ¾ that is siltation is expected to reduce storage capacity approximately by 75 percent; ω_2= ¼ which is sluice repairs is expected to reduce storage capacity approximately by 25 per cent).

A weightage for the tank siltation and sluice condition was worked out as 3/4 and 1/4 respectively and physical tank storage is adjusted for to arrive at the effective tank storage.

2.4.4. Potentiality for Tank Modernization

Using the key factors namely tank filling pattern, condition of the supply channel including encroachment, activeness of WUA, well density, percentage of social forestry, paddy yield variation, multiple uses of tanks, the tank modernization index (TMI) was worked out for the study tanks.

Normalisation of indicators using functional relationship: Obviously the indicators are in different units and scales. The methodology used in UNDP's Human Development Index (HDI) (UNDP, 2006) is followed to normalize them. That is, in order to obtain figures which are free from the units and also to standardize their values, first they are normalized so that they all lie between 0 and 1. Before doing this, it is important to identify the functional relationship between the indicators and tank modernisation index. Two types of functional relationship are possible: potential for tank modernisation increases with increase (decrease) in the value of the indicator. Assume that higher the value of the indicator more is the potential for modernisation.

$$X_{ij} = \frac{X_{ij} - \mathrm{Min}(XL)}{\mathrm{Max}(X_{ij}) - \mathrm{Min}(X_{ij})}$$

It is clear that all these scores will lie between 0 and 1. The value 1 will correspond to that tanks with maximum value and 0 will correspond to the tanks with minimum value. The other formula is also used if the indicator has negative relationship:

$$X_{ij} = \frac{\mathrm{Max}(X_{ij}) - X_{ij}}{\mathrm{Max}(X_{ij}) - \mathrm{Min}(X_{ij})}$$

The a priori between the different indicators and the potentiality of tank modernisation is presented in Table.2.3.

Based on the index value, tanks were grouped into three categories namely high potential (index 0.71-0.87), medium potential tanks (index 0.51-0.70) and less potential for modernization (index 0.30-0.50).

Table.2.3.Indicators used for constructing modernization index

S.No	Indicators	A priori functional relationship between the indicator and tank modernisation
1	Tank filling pattern	+
2	Condition of the Supply channel including encroachment	-
3	Activeness of WUA	+
4	Well density	+
5	Percentage of Social forestry	+
6	Multiple uses of tanks	+
7	Paddy Yield Variation	-

2.4.5. Economics of tank modernization

Different modernization options namely desilting and bund strengthening, supply channel cleaning, sluice repair, surplus weir repair, and bush / prosopis and tree clearance to suit different tank types and locations were identified, cost and benefits for these options were worked out. For estimating cost stream, capital cost for each modernization activity, maintenance cost, and costs of cultivation were included. The maintenance cost is estimated as ten per cent of the capital cost.

For benefit stream estimation, for each of the proposed modernization activity, the expected water saving, expected area increase, additional yield, and income for crop and other multiple uses were considered. Minimum Support Price of Paddy during the study period was taken into account for estimating return from paddy cultivation. Life period of each activity was assumed to be 10 years. It is assumed that the full benefit of modernization is realized once in three years, partial benefits in five years and no benefit in the rest of the years. Using cost and benefits stream, benefit cost ratio (BCR).[5] and internal rate of return (IRR) were worked out[6].

[5]Benefit cost ratio was worked at twelve per cent discount rate.
[6] For e.g in a 10 year period, the full benefits will be for 3 years, partial benefits, 5 years and no benefits 2 years.

3.RESULTS FROM FIELD STUDIES

3.1. Rainfall pattern in the study districts

The data on rainfall and area irrigated by tanks over the years showed that the influence of northeast monsoon rains on the tank-irrigated area in the state is greater than the southwest monsoon rainfall. The correlation coefficient between the area irrigated by tanks and the rainfall is found to be between 0.20 and 0.30.

Table 3.1. Rainfall classification in North and South Tamil Nadu

Classification	North region	South region
Excess	Chengalpattu, Villupuram and Kallakurichi	Madurai, Pudukkottai, Sivagangai, Ramnathapuram, Tenkasi, Thoothukudi, Tirunelveli and Virudhunagar
Normal	Kancheepuram, Krishnagiri and Thiruvallur	Kanyakumari

Note: 20 per cent and above is classified as excess, + 19 % to -19% deviation from normal rainfall is classified as normal and -20% to -50% deviation from normal rainfall is classified as deficit. (Source: Panchayat Union office of the concerned study blocks of each district)

All the districts in southern region have received excess rainfall during 2020-21except Kanyakumari district. But in the northern region, three districts namely Chengalpattu, Kallakurichi and Villupuram received excess rainfall and Kancheepuram, Krishnagiri and Thiruvallur received normal rainfall during 2020-21. Even though the study aims to examine the tank filling behaviour during normal rainfall years, most of the tanks also had excess rainfall during the study periods 2020-21 and 2021-22 which adds strength to the study.

3.2. General Characteristics of tanks/tank cascade

The general features such as the location of the tanks under PU and PWD management, registered command area, actual area irrigated, water spread area, tank physical storage capacity, number of fillings, number of sluices, encroachment in supply channel, encroachment in tank foreshore area, encroachment in tank water spread area, siltation in tank water spread area, percentage of social forestry, Prosophis and other tree plantations are discussed in this section.

The number of tanks ranged from 3 to a maximum of 43 are connected in a cascade. Tanks located in a cascade are classified as head, middle and tail regions based on the distance from the first tank to the last tank in the cascade. Both PWD and PU tanks are located in head, middle and tail end of a cascade. In southern region, more than 45 per cent of the tanks surveyed are maintained by PU. Of the total sample of tanks studied, nearly one third of the sample tanks (529) are in northern region and two third of tanks

(1484) are located in southern region. Tanks maintained by PWD include both system and non-system tanks (Table.3.2 and Table.3.3).

Table 3.2. Location of Tanks in Sample Districts

S.No.	District	No. of cascades	Head		Middle		Tail		Total tanks
			PU	PWD	PU	PWD	PU	PWD	
	Northern Districts								
1	Chengalpattu	33	1	50	2	39	1	38	131
2	Kallakurichi	16	..	20	..	23	..	19	62
3	Kancheepuram	14	5	28	6	32	5	28	104
4	Krishnagiri	11	10	10	7	10	10	6	53
5	Thiruvallur	15	0	31	3	31	0	25	90
6	Villupuram	10	5	23	9	33	4	15	89
	Total	99	22	161	29	166	23	128	529
	Southern Districts								
7	Madurai	8	14	25	17	24	16	23	119
8	Pudukottai	34	2	81	8	114	0	80	285
9	Ramanathapuram	22	14	37	12	33	13	27	136
10	Sivagangai	37	8	45	38	47	14	32	188
11	Tenkasi	3	1	6	4	2	3	2	18
12	Thoothukudi	5	5	15	5	11	3	13	52
13	Tirunelveli	64	98	43	118	30	93	33	415
14	Virudhunagar	10	3	20	3	21	4	15	66
15	Kanyakumari	33	59	7	64	11	59	5	205
	Total	216	204	280	269	293	205	228	1484

Note: Since the PU tanks are spread out throughout the cascade and the details are not readily available during the study period, only the available tank details (which are sufficient to study the tank filling behaviour) have been used to study the performance of the tanks in the cascade.

The basic features of the tanks namely registered command area, actual area irrigated, water spread area, storage capacity, number of fillings, and number of sluices are discussed based on management type (PU and PWD) and location of the tanks in the cascade.

It is observed that the PU tanks across districts of the state are found to be smaller in terms of size, registered command area and actual area irrigated. The registered command area and actual area irrigated by PU tanks in northern region is higher (significant at 1% level) compared to southern districts. The tank performance in terms of proportion of actual area irrigated by tanks to the registered command area is worked out to be 92.53 per cent in northern region and 91.14 per cent in southern region for PU tanks where as it is 89.61 per cent and 92.58 per cent for PWD tanks. (Table.3.4).

Table 3.3. Distributions of Tanks in the Cascade

S.No.	District	No. of Cascades	PU Tanks	PWD Tanks		Total PWD Tanks	Total Tanks
				System Tanks	Non System Tanks		
	Northern Districts						
1	Chengalpattu	33	4	NA	127	127	131
2	Kallakurichi	16	..	..	62	62	62
3	Kancheepuram	15	16	69	19	88	104
4	Krishnagiri	11	27	20	6	26	53
5	Thiruvallur	14	3	12	75	87	90
6	Villupuram	10	18	2	69	71	89
	Total	99	68	103	358	461	529
	Southern Districts						
7	Madurai	8	47	63	9	72	119
8	Pudukottai	36	10	58	217	275	285
9	Ramanathapuram	22	39	61	36	97	136
10	Sivagangai	38	5	60	56	67	188
11	Tenkasi	3	8	10	NA	10	18
12	Thoothukudi	5	13	20	19	39	52
13	Tirunelveli	66	307	106	0	106	415
14	Virudhunagar	10	10	52	4	56	66
15	Kanyakumari	33	182	19	4	23	205
	Total	221	621	449	345	745	1484

The hydrological characteristics indicate that the water spread area is 34.68 ac in northern region and 34.52 acres in southern region for PU tanks whereas it is 120.03 acres and 120.87 acres for PWD tanks. The storage capacity indicates that the average storage capacity is 12.45 mcft in northern region and 4.71 mcft in southern region for PU tanks whereas it is 48.99 mcft and 23.99 mcft for PWD tanks. The number of filling is mainly influenced by rainfall. The number of filling across tank typologies indicate that PU tanks in northern region witnessed 1.62 and tanks in southern region witnessed 1.70 times whereas it is 1.67 and 1.69 for PWD tanks (Table.3.5).

3.3. Tank filling pattern

The number of fillings ranged from 1 to 3 in the sample tanks. The number of filling of PU tanks are low when compared to PWD tanks in both the regions. This might be probably due to rainfall runoff and slope of the terrain and which showed comparatively the better condition of supply channel and catchment area of PWD tanks than PU tanks (Table.3.6).

As tank water spread area and storage capacity, the number of sluices is more in PWD tanks when compared to PU tanks. The average number of sluices is 1.71 in northern region and 1.98 in southern region for PU tanks, whereas it is 3.53 and 3.63 for PWD tanks (Table.3.6). As WUA is not active in most cases, in PU tanks, sluices are mostly operated by farmers themselves.

Table: 3.4. Registered command area and Actual area irrigated

(in acres)

S.No.	District	PU Tanks		PWD Tanks				Total PWD Tanks		Total Tanks	
				System Tanks		Non System Tanks					
		Registered command area (acres)	Actual area irrigate (acres)	Registered command area, (acres)	Actual area irrigated (acres)	Registered command area, (acres)	Actual area irrigated, (acres)	Registered command area, (acres)	Actual area irrigated, (acres)	Registered command area, (acres)	Actual area irrigated , (acres)
	Northern Districts										
1	Chengalpattu	90.42	82.00	..	..	299.12	289.60	299.12	289.60	292.74	283.26
2	Kallakurichi	..	..	..	..	194.86	167.73	194.86	167.73	194.86	167.73
3	Kancheepuram	64.49	63.75	492.72	374.04	382.41	357.36	468.90	370.40	406.68	322.76
4	Krishnagiri	46.74	44.59	292.81	278.00	171.53	157.50	264.82	250.19	153.72	145.45
5	Thiruvallur	89.67	83.00	155.43	148.58	312.43	306.40	290.77	284.63	284.07	277.91
6	Villupuram	67.86	58.99	165.99	162.24	229.99	203.73	228.19	202.56	197.22	173.62
Average		71.83	66.47	276.74	240.72	265.06	247.05	291.11	260.85	254.88	228.46
Tank Performance (Percentage of actual area irrigated to registered area)		92.53		86.98		93.21		89.61		89.63	
	Southern Districts										
7	Madurai	53.86	47.26	245.64	233.79	199.80	188.11	239.91	228.08	166.43	156.66
8	Pudukottai	44.41	44.41	124.83	124.83	135.29	135.29	133.07	133.07	129.93	129.93
9	Ramanathapuram	48.15	41.23	278.50	332.89	378.59	248.72	341.44	301.65	257.97	226.97
10	Sivagangai	45.36	41.83	254.10	227.80	234.88	204.83	243.77	215.46	178.06	158.03
11	Tenkasi	70.38	68.13	545.36	522.40	..	..	545.36	522.40	334.26	320.50
12	Thoothukudi	57.17	50.92	630.58	604.85	219.12	196.79	430.13	406.05	336.89	317.27
13	Tirunelveli	43.07	38.94	231.72	219.25	..	..	231.72	219.25	90.57	84.34
14	Virudhunagar	66.49	58.10	246.70	211.77	316.39	252.75	251.67	214.70	223.62	190.97
15	Kanyakumari	21.42	19.62	266.16	243.37	225.47	205.50	259.08	236.78	48.09	43.99
Average		50.04	45.60	313.73	302.33	244.22	204.57	297.35	275.27	196.20	180.96
Tank Performance (Percentage of actual area irrigated to registered area)		91.14		96.37		83.76		92.58		92.23	

Table 3.5. Water Spread Area (in acres) and Tank Storage Capacity (in mcft)

S. No.	District	PU Tanks			PWD Tanks						Total PWD Tanks			Total Tanks		
					System Tanks			Non System Tanks								
		No. of fillings	Water spread area, (acres)	Storage capacity, (mcft)[7]	No. of fillings	Water spread area, (acres)	Storage capacity, (mcft)	No. of fillings	Water spread area, (acres)	Storage capacity, (mcft)	No. of fillings	Water spread area, (acres)	Storage capacity, (mcft)	No. of fillings	Water spread area, (acres)	Storage capacity, (mcft)
Northern Districts																
1	Chengalpattu	1.83	48.92	5.91	..	..	..	1.84	162.13	20.03	1.85	162.13	20.03	1.84	158.67	19.60
2	Kallakurichi	..	..	..	..	..	..	1.85	145.68	20.43	2.17	145.68	20.43	1.85	145.68	20.43
3	Kancheepuram	1.00	44.37	22.74	1.11	43.15	25.76	1.05	68.07	31.80	1.10	48.53	27.06	1.08	47.89	26.39
4	Krishnagiri	1.96	27.79	2.29	1.95	100.07	7.40	1.67	92.02	70.04	1.86	98.21	21.86	1.92	63.00	11.89
5	Thiruvallur	2.00	1.14	8.83	1.71	2.88	8.91	1.56	113.19	13.46	1.59	97.97	12.83	1.60	94.75	12.70
6	Villupuram	1.33	51.19	22.50	2.00	61.49	36.64	1.41	170.79	196.21	1.43	167.67	191.71	1.47	146.00	107.11
Average		1.62	34.68	12.45	1.69	51.90	19.68	1.56	125.31	58.66	1.67	120.03	48.99	1.63	109.33	33.02
Southern Districts																
7	Madurai	1.28	32.12	3.42	1.60	123.31	17.50	1.40	92.78	14.87	1.57	119.50	17.18	1.45	84.99	11.74
8	Pudukottai	2.00	55.45	3.43	1.53	61.44	6.90	1.59	88.08	7.07	1.58	82.46	7.03	5.47	81.49	6.90
9	Ramanathapuram	1.85	40.39	5.34	2.02	278.45	19.55	2.00	257.92	20.39	2.01	270.83	19.86	1.96	204.75	15.70
10	Sivagangai	2.05	33.36	5.13	2.23	93.33	102.70	2.29	96.12	8.67	2.27	94.83	52.19	2.22	75.12	37.56
11	Tenkasi	1.75	0.83	0.62	2.00	0.24	4.15	..	..	..	2.00	0.24	4.15	1.89	0.29	0.01
12	Thoothukudi	1.08	54.56	7.23	1.09	233.11	31.39	1.05	160.70	21.22	1.05	197.83	26.43	1.06	162.02	21.63
13	Tirunelveli	1.76	25.62	6.66	1.80	83.40	12.88	..	..	..	1.05	83.40	12.88	1.74	40.17	8.23
14	Virudhunagar	1.40	57.84	8.56	1.92	151.97	47.57	1.75	237.94	65.37	1.80	158.11	48.84	1.83	142.91	42.74
15	Kanyakumari	2.13	10.47	1.96	2.47	76.19	30.58	3.00	101.58	11.98	1.91	80.61	27.35	2.19	18.34	4.83
Average		1.70	34.52	4.71	1.85	122.38	30.36	1.87	147.87	21.37	1.69	120.87	23.99	2.20	90.01	16.59

[7]mcft refers Million cubic feet

Table 3.6. Number of Fillings and Number of Sluices

S. No.	District	PU Tanks		PWD Tanks				Total PWD Tanks		Total Tanks	
				System Tanks		Non System Tanks					
		No. of fillings	No. of Sluices	No. of fillings	No. of Sluices	No. of fillings	No. of Sluices	No. of fillings	No. of Sluices	No. of fillings	No. of Sluices
Northern Districts											
1	Chengalpattu	1.83	1.75	..	..	1.84	2.27	1.85	2.27	1.84	2.25
2	Kallakurichi	..	..	..	..	1.85	2.32	2.17	2.32	1.85	2.24
3	Kancheepuram	1.00	2.13	1.11	3.28	1.05	2.79	1.10	3.17	1.08	3.01
4	Krishnagiri	1.96	1.56	1.95	2.40	1.67	2.00	1.86	2.31	1.92	1.92
5	Thiruvallur	2.00	1.67	1.71	1.83	1.56	9.83	1.59	8.72	1.60	8.49
6	Villupuram	1.33	1.44	2.00	1.50	1.41	2.43	1.43	2.41	1.47	2.21
Average		1.62	1.71	1.69	2.25	1.56	3.61	1.67	3.53	1.63	3.35
Southern Districts											
7	Madurai	1.28	1.87	1.60	2.98	1.40	3.00	1.57	2.99	1.45	2.55
8	Pudukottai	2.00	2.90	1.53	2.83	1.59	3.50	1.58	3.36	5.47	3.34
9	Ramanathapuram	1.85	2.59	2.02	5.79	2.00	5.00	2.01	5.49	1.96	4.66
10	Sivagangai	2.05	2.02	2.23	4.23	2.29	3.91	2.27	4.06	2.22	3.40
11	Tenkasi	1.75	1.25	2.00	4.40	..	..	2.00	4.40	1.89	3.00
12	Thoothukudi	1.08	2.23	1.09	5.80	1.05	2.47	1.05	4.18	1.06	3.69
13	Tirunelveli	1.76	1.46	1.80	2.52	..	..	1.05	2.52	1.74	1.73
14	Virudhunagar	1.40	2.20	1.92	2.60	1.75	3.25	1.80	2.64	1.83	2.58
15	Kanyakumari	2.13	1.30	2.47	3.21	3.00	2.00	1.91	3.00	2.19	1.49
Average		1.70	1.98	1.85	3.82	1.87	3.30	1.69	3.63	2.20	2.94

3.3.1. Limiting factors of Tank Performance

The tank performance is affected by several hydrological and socio-economic factors. They include encroachment, level of silt deposits, extent of social forestry and tree plantations, number of wells, and location of the tanks in the cascade. These limiting factors are discussed here.

The encroachment is a major factor affecting the water supply to the tank and hence the performance. Encroachment is a common phenomenon and present in catchments, supply channels, and tank foreshore. Urbanisation and industrialisation led to encroachment on catchment and supply channels. In some cases the supply channels are totally disappeared due to encroachment.

The study found that for PU tanks, on an average the encroachment is found to be 6.93 per cent in catchment, 5.86 per cent in tank foreshore and 12.82 per cent in supply channels in northern region, where as it is 6.60 per cent, 4.67 per cent and 7.96 per cent in southern region. Similarly for PWD tanks, the encroachment is found to be 8.36 per cent in catchment, 7.13 per cent in tank foreshore and 12.39 per cent in supply channels in northern region, where as it is 7.20 per cent, 4.96 per cent and 8.32 per cent in southern region (Table.3.7). Irrespective of the regions and PU or PWD tanks, percentage of encroachment is more in supply channels compared to encroachment in tank catchment area and foreshore area.

Siltation is another important factors limiting tank performance. Siltation is also observed in supply channel and the famers indicated that due to encroachment and siltation, rainfall runoff is reduced and water flow is stopped. If the tank in middle region is affected by this, the tail end tank is also affected. Siltation is one of the important factors affecting tank performance. More the siltation less will be the water storage. It is observed that the siltation is ranged from 15 per cent to 41 per cent in PU tanks where as it is 16 per cent to 40 per cent in PWD tanks. On average, the tank silt deposition is 19.37 per cent in northern region and 21.39 per cent in southern region for PU tanks whereas it is 21.39 per cent and 20.29 per cent for PWD tanks (Table.3.8). Depending up on the depth, diameter of the tank, nearly one fifth of the tank storage capacity is physically affected due to siltation.

The social forestry project was launched in Tamil Nadu with the financial assistance from Swedish International Development Authority (SIDA). As one of the components of afforestation of trees outside the forests, initially eighty per cent of social forestry plantations have been done in tank foreshore area. In earlier period, of the total income generated from the social forestry plantations, 60 to 65 per cent was transferred to panchayats for maintenance and management of tanks. Now the social forestry is almost nil in all districts except in Kancheepuram district where tree plantations are carried out under Tamil Nadu Green Mission. But naturally grown prosopis and other trees occupy more than ten per cent of tank water spread area, tank bund and foreshore area. The percentage of area under Prosopis and other trees is found to be around 15 per cent in case of PU tanks and 13.30 to 14.75 per cent in PWD tanks (Table.3.9).

Table 3.7. Percentage of encroachment in tank Catchment area, foreshore area and supply channels

S. No.	District	PU Tanks			PWD Tanks						Total PWD Tanks			Total Tanks		
					System Tanks			Non System Tanks								
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Northern Districts																
1	Chengalpattu	5.00	..	5.00	..	..	..	9.76	13.42	15.14	9.76	13.42	15.14	9.70	13.42	14.81
2	Kallakurichi	..	..	..	..	..	..	0.69	0.52	13.75	0.69	0.52	13.75	0.63	0.47	14.11
3	Kancheepuram	2.50	0.31	9.38	3.75	1.51	12.25	2.11	0.26	10.53	3.40	1.24	11.88	3.26	1.10	11.50
4	Krishnagiri	6.07	7.67	9.64	5.59	9.38	7.00	26.00	8.33	13.75	10.23	9.21	8.42	8.61	8.53	8.94
5	Thiruvallur	..	..	..	2.86	5.00	2.50	7.07	7.38	7.71	6.49	7.08	7.00	6.25	6.80	6.70
6	Villupuram	28.00	27.20	35.42	15.00	10.00	12.50	19.76	11.35	18.36	19.62	11.31	18.16	21.05	13.51	21.16
Average		6.93	5.86	12.82	6.80	6.47	8.56	10.90	6.88	13.21	8.36	7.13	12.39	8.25	7.31	12.87
Southern Districts																
7	Madurai	1.96	1.60	3.62	2.54	1.98	4.21	3.89	2.22	4.44	2.71	2.01	4.24	2.41	1.85	3.99
8	Pudukottai	10.00	13.00	13.00	18.79	11.75	9.34	10.98	8.76	9.13	12.86	9.48	9.18	12.80	9.55	9.25
9	Ramanathapuram	1.03	1.03	2.44	1.39	1.15	1.97	0.56	1.11	3.33	1.08	1.13	2.47	1.07	1.10	2.46
10	Sivagangai	2.92	2.29	18.25	10.55	4.09	16.61	10.10	3.57	13.66	10.33	3.85	15.00	8.62	3.45	16.06
11	Tenkasi	16.00	10.50	10.00	8.83	11.00	15.00	..	..	..	8.83	11.00	15.00	12.09	10.86	12.78
12	Thoothukudi	3.46	2.31	6.54	4.00	5.50	7.50	1.84	0.79	4.47	2.95	3.21	6.03	3.08	2.98	6.15
13	Tirunelveli	5.05	4.38	7.51	5.94	5.68	8.13	..	..	..	5.94	5.68	8.13	5.27	4.69	7.66
14	Virudhunagar	16.50	5.56	7.00	15.69	4.90	7.25	18.75	5.00	8.75	15.91	4.91	7.36	16.00	5.00	7.31
15	Kanyakumari	2.46	1.41	3.27	5.26	4.05	8.33	3.75	0.00	5.00	5.00	3.35	7.50	2.75	1.62	3.48
Average		6.60	4.67	7.96	8.11	5.57	8.71	7.12	3.07	6.97	7.29	4.96	8.32	7.12	4.57	7.68

Note: 1.% of encroachment in tank catchment, 2. % of encroachment in tank foreshore and 3.% of encroachment in supply channel

The extent of social forestry is 20 per cent in northern region and 0.81 per cent in southern region for PU tanks. Similarly, the extent of area covered by other trees is 15.62 per cent and 15.77 per cent respectively for northern and southern regions for PU tanks. The scenario is little different for PWD tanks. The extent of social forestry is 11.68 per cent in northern region and 3.53 per cent in southern region for PWD tanks. Similarly, the extent of area covered by other trees is 13.35 per cent and 14.70 per cent respectively for northern and southern regions for PWD tanks (Table.3.9).

Table 3.8. Percentage of siltation in the tank water spread area

(Per cent)

S.No.	District	PU Tanks	PWD Tanks		Total PWD Tanks	Total Tanks
			System Tanks	Non System Tanks		
Northern Districts						
1	Chengalpattu	15.00	..	18.42	18.42	18.32
2	Kallakurichi	..	..	16.05	16.05	16.05
3	Kancheepuram	18.63	21.36	20.47	21.17	20.78
4	Krishnagiri	20.84	24.94	35.00	27.46	24.08
5	Thiruvallur	17.33	17.90	16.25	16.47	16.50
6	Villupuram	29.41	40.00	28.62	28.79	28.92
Average		19.37	26.05	22.47	21.39	20.76
Southern Districts						
7	Madurai	17.81	17.00	20.44	17.43	17.58
8	Pudukottai	19.30	23.04	21.72	22.00	21.90
9	Ramanathapuram	19.38	17.20	18.31	17.61	18.13
10	Sivagangai	16.41	17.63	17.52	17.57	17.09
11	Tenkasi	25.50	30.29	..	30.29	28.55
12	Thoothukudi	19.54	19.25	18.79	19.03	19.15
13	Tirunelveli	19.08	22.64	..	22.64	20.00
14	Virudhunagar	41.50	22.31	22.75	22.34	25.24
15	Kanyakumari	13.94	14.00	12.50	13.74	13.92
Average		21.39	20.37	18.86	20.29	20.17

Source: Filed survey during 2022

Wells are supplementary source of irrigation in tanks command area. The number of wells is more in system tanks command area when compared to PU and PWD non -system tank command area. The reason might be due to assured source of water for system tanks facilitating continuous recharge compared to other rainfed tanks. The number of wells per acre of command area is worked out to be 0.01 to 0,56 in PU tanks and 0.01 to 0.43 in PWD tanks (Table.3.10). More than ninety per cent of the wells are functioning indicating that water stored in tanks is the major source of ground water recharge in that area.

Table 3.9. Area under Social forestry and under Prosopis tree and other trees (%)

S. No.	District	PU Tanks		PWD Tanks				Total PWD Tanks		Total Tanks	
				System Tanks		Non System Tanks					
		% Social forestry	% area under Prosopis tree and other trees	% Social forestry	% area under Prosopis tree and other trees	% Social forestry	% area under Prosopis tree and other trees	% Social forestry	% area under Prosopis tree and other trees	% Social forestry	% area under Prosopis tree and other trees
Northern Districts											
1	Chengalpattu	..	30.00	..	..	12.50	12.43	12.50	12.43	12.50	12.79
2	Kallakurichi	..	..	..	..	..	12.59	..	12.59	..	12.59
3	Kancheepuram	30.00	6.82	31.17	8.45	..	16.79	31.17	10.30	31.00	9.78
4	Krishnagiri	..	21.67	..	4.29	..	46.25	..	19.55	..	20.29
5	Thiruvallur	..	5.00	..	7.27	8.38	9.73	8.38	9.38	8.38	9.28
6	Villupuram	10.00	18.57	27.50	20.00	16.80	15.69	18.06	15.83	16.23	16.32
Average		20.00	15.62	14.67	10.00	6.28	18.91	11.68	13.35	11.35	13.49
Southern Districts											
7	Madurai	3.91	5.19	9.76	9.39	3.89	4.44	9.01	8.76	7.01	7.32
8	Pudukottai	3.33	18.38	1.49	28.16	1.85	16.20	1.76	18.81	1.78	18.80
9	Ramanathapuram	..	26.47	..	23.33	..	24.71	..	23.83	..	24.58
10	Sivagangai	..	20.28	5.00	16.88	..	17.88	5.00	17.42	5.00	18.17
11	Tenkasi	..	5.00	..	8.40	..	..	..	8.40	..	7.43
12	Thoothukudi	..	7.31	..	14.75	..	8.00	..	11.46	..	10.42
13	Tirunelveli	0.06	12.59	0.96	12.48	..	..	0.96	12.48	0.26	12.56
14	Virudhunagar	..	46.50	26.15	50.79	26.25	15.00	..	26.16	..	29.24
15	Kanyakumari	..	0.20	15.00	..	..	5.00	15.00	5.00	15.00	0.29
Average		0.81	15.77	6.48	18.24	4.57	13.03	3.53	14.70	3.23	14.31

Table 3.10. Total number of wells and Total number of functioning wells

(Number of wells/ac of command area)

S.No	District	PU Tanks		PWD Tanks				Total PWD Tanks		Total Tanks	
				System Tanks		Non System Tanks					
		Total number of wells	No. of Functioning wells	Total number of wells	No. of Functioning wells	Total number of wells	No. of Functioning wells	Total number of wells	No. of Functioning wells	Total number of wells	No. of Functioning wells
Northern Districts											
1	Chengalpattu	0.01	0.01	..	..	0.04	0.04	0.04	0.04	0.04	0.04
2	Kallakurichi	..	..	..	..	0.10	0.10	0.10	0.10	0.10	0.10
3	Kancheepuram	0.20	0.18	0.03	0.02	0.04	0.04	0.03	0.03	0.03	0.03
4	Krishnagiri	0.38	0.38	0.09	0.09	0.22	0.15	0.11	0.10	0.15	0.14
5	Thiruvallur	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
6	Villupuram	0.46	0.46	0.33	0.30	0.18	0.15	0.19	0.15	0.21	0.17
Average		0.18	0.18	0.08	0.07	0.10	0.08	0.08	0.07	0.10	0.08
% functioning wells		98.38		92.93		81.48		89.25		81.50	
Southern Districts											
7	Madurai	0.18	0.17	0.06	0.06	0.08	0.08	0.06	0.06	0.07	0.07
8	Pudukottai	..	..	0.15	0.15	0.06	0.06	0.08	0.08	0.08	0.08
9	Ramanathapuram	..	..	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Sivagangai	0.06	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
11	Tenkasi	0.24	0.24	0.43	0.43	..	..	0.43	0.43	0.42	0.42
12	Thoothukudi	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01
13	Tirunelveli	0.14	0.14	0.06	0.06	..	..	0.06	0.06	0.09	0.09
14	Virudhunagar	0.56	0.56	0.21	0.03	0.05	0.03	0.19	0.19	0.21	0.21
15	Kanyakumari	0.13	0.13	0.03	0.03	0.21	0.21	0.06	0.06	0.08	0.08
Average		0.15	0.15	0.11	0.09	0.05	0.05	0.10	0.10	0.11	0.11
% functioning wells		99.16		81.69		94.29		99.43		99.50	

The location of the tanks in the cascade is important for water supply and in turn tank performance, It is observed that the PWD tanks located in the head regions have more registered command area when compared to the tanks located in the middle and tail regions. However, this is not so in the case of PU tanks.

Table 3.11. Registered Ayacut area and Location of tanks in the cascade

(Acres)

S. No.	District	Head		Middle		Tail		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern Districts								
1	Chengalpattu	81.31	282.07	90.22	291.02	99.92	329.83	90.42	299.11
2	Kallakurichi	..	213.55	..	182.96	..	189.60	..	194.86
3	Kancheepuram	38.27	604.19	79.99	450.77	82.63	354.33	64.49	468.90
4	Krishnagiri	43.90	422.68	35.75	154.66	57.26	185.34	46.74	264.82
5	Thiruvallur	..	326.39	89.67	273.32	..	268.24	89.67	290.77
6	Villupuram	73.72	198.96	51.47	254.19	48.04	206.30	57.21	226.18
	Average	39.53	341.31	57.85	267.82	47.98	255.60	58.09	290.77
	Southern Districts								
7	Madurai	59.58	191.79	49.12	272.02	53.90	258.70	53.86	239.91
8	Pudukottai	51.72	152.31	39.34	125.65	52.90	119.13	44.41	133.07
9	Ramanathapuram	49.86	459.46	55.29	269.55	39.73	267.59	48.15	341.44
10	Sivagangai	37.49	267.25	48.41	256.41	41.30	184.01	45.36	243.77
11	Tenkasi	74.43	559.13	63.00	263.51	78.88	785.89	70.38	545.36
12	Thoothukudi	55.16	377.46	61.61	656.80	53.13	299.10	57.17	430.13
13	Tirunelveli	46.14	244.44	39.09	267.16	44.88	267.16	43.07	231.72
14	Virudhunagar	88.27	316.44	45.06	231.27	66.24	193.89	66.49	251.67
15	Kanyakumari	16.69	212.90	19.16	315.75	28.61	199.06	21.42	259.08
	Average	53.26	309.02	46.67	295.35	51.06	286.06	50.04	297.35

Source: Filed survey during 2022

Table 3.12. Total Storage Capacity in mcft and location of tanks in the cascade

S. No.	District	Head		Middle		Tail		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern Districts								
1	Chengalpattu	7.76	16.75	5.82	26.84	4.23	17.35	5.91	20.03
2	Kallakurichi	..	23.30	..	20.26	..	17.63	..	20.43
3	Kancheepuram	42.81	30.01	6.91	33.06	22.84	17.25	22.74	27.07
4	Krishnagiri	1.91	9.19	4.17	41.61	1.34	10.05	2.29	21.86
5	Thiruvallur	..	11.16	8.83	11.55	..	16.48	8.83	12.83
6	Villupuram	45.23	144.82	117.71	223.76	46.57	193.12	68.72	191.71
	Average	16.29	39.21	23.91	59.51	12.50	45.31	18.51	48.99
	Southern Districts								
7	Madurai	2.57	13.55	3.39	20.19	4.20	17.97	3.42	17.18
8	Pudukottai	3.58	7.81	3.20	7.61	4.34	5.46	3.43	7.03
9	Ramanathapuram	4.76	20.29	6.33	22.07	5.05	16.59	5.34	19.86
10	Sivagangai	4.22	55.87	5.30	25.57	5.23	90.81	5.13	52.19
11	Tenkasi	0.00	0.01	..	..	0.02	..	0.01	0.01
12	Thoothukudi	2.57	21.67	13.98	30.45	3.77	28.54	7.23	26.43
13	Tirunelveli	3.82	14.25	4.15	11.98	12.83	11.86	6.66	12.88
14	Virudhunagar	12.57	31.24	4.99	22.32	8.22	109.45	8.56	48.84
15	Kanyakumari	1.48	11.76	1.95	44.47	2.45	11.50	1.96	27.35
	Average	3.95	19.61	4.81	20.52	5.12	32.46	4.64	23.53

Tank storage capacity is larger in tanks located in northern districts compared to southern districts irrespective of PU am PWD tanks.

3.4 Tank filling behaviour and tank performance

This section deals with linking tank filling behaviour and tank performance. More specifically, it discusses why several tanks not filled up even during normal rains as experienced during 2020-21 and 2021-22.

3.4.1 Tank filling behaviour

The tank filling was worked out by taking average of percentage of filling based on the discussions with officials from WRD, PU, WUA and farmers. This was further verified with field visits. As the study period is the normal year, more than 65 per cent of tanks surveyed had full tank filling and the average filling percentage ranged from 87 to 100 per cent. On an average, the PU tanks in northern districts have registered 94.21 per cent filling and PU tanks in southern districts registered 91.82 per cent filling. Similarly, the PWD tanks in northern districts have registered 88.39 per cent filling and PWD tanks in southern districts registered 91.44 per cent filling (Table.3.13). Highest filling percentage is experienced by tanks located in head reach compared to middle and tail reach of the cascade irrespective of PU and PWD tanks.

Table 3.13. Tank filling percentage during 2020-2021

S. No.	District	Head		Middle		Tail		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern Districts								
1	Chengalpattu	100.00	93.80	100.00	91.66	100.00	92.23	100.00	92.67
2	Kallakurichi	..	83.75	..	84.13	..	85.79	..	84.52
3	Kancheepuram	98.00	93.21	95.00	88.75	87.50	87.68	93.75	89.82
4	Krishnagiri	90.50	88.00	87.86	92.50	98.00	91.67	92.59	90.58
5	Thiruvallur	..	80.65	100.00	88.55	..	82.40	100.00	83.97
6	Villupuram	90.00	93.70	86.67	87.42	73.75	84.33	84.72	88.80
	Average	94.63	88.85	93.90	88.84	89.81	87.35	94.21	88.39
	Southern Districts								
7	Madurai	95.00	99.00	98.53	98.54	100.00	95.86	97.98	97.85
8	Pudukottai	88.33	91.35	100.00	91.06	100.00	89.51	96.50	90.70
9	Ramanathapuram	97.50	97.57	93.75	98.18	93.85	92.59	95.13	96.39
10	Sivagangai	78.13	85.11	80.39	86.28	79.64	82.17	79.92	84.84
11	Tenkasi	80.00	81.67	82.50	77.50	83.33	77.50	82.50	80.00
12	Thoothukudi	93.00	94.67	94.00	93.18	93.33	96.92	93.46	95.00
13	Tirunelveli	84.03	88.26	85.42	83.33	89.35	89.70	86.17	87.31
14	Virudhunagar	100.00	98.00	93.33	94.76	100.00	90.60	98.00	94.80
15	Kanyakumari	96.86	98.57	97.81	95.45	95.51	94.00	96.76	96.09
	Average	90.32	92.69	91.75	90.92	92.78	89.87	91.82	91.44

Source: Field survey conducted during 2022

The effective tank storage at full tank filling level is 89.68 per cent and 85.08 per cent for PU and PWD tanks respectively in northern districts, where as it is 87.63 per cent and 85.92 per cent respectively for PU and PWD tanks in southern districts. The effective tank storage is smaller in half tank filling compared to 3/4th tank filling and full tank filling irrespective of the typologies. There is significant difference (at one per cent level) in effective tank storage among PU and PWD tanks at full tank filling 3/4th tank filling.

Table 3.14. Effective tank storage under different tank filling pattern

(Per cent))

S. No.	District	Effective tank storage at full tank filling		Effective tank storage at 3/4th tank filling		Effective tank storage at half tank filling	
		PU	PWD	PU	PWD	PU	PWD
1	Chengalpattu	91.75	85.85	..	81.28	..	63.00
2	Kallakurichi	..	88.55	..	82.05	..	64.05
3	Kancheepuram	90.21	82.89	81.90	80.24	..	64.54
4	Krishnagiri	89.12	84.63	81.02	76.49	..	52.50
5	Thiruvallur	90.47	88.69	..	81.65	..	63.70
6	Villupuram	86.88	79.91	79.72	75.29	51.25	57.97
	Average	89.68	85.08	80.88	79.50	51.25	59.80
7	Madurai	90.38	86.79	80.84	82.22	59.50	..
8	Pudukottai	88.51	83.68	..	79.12	64.25	61.62
9	Ramanathapuram	89.55	86.58	79.66	81.91	..	..
10	Sivagangai	81.67	88.39	82.27	81.08	..	61.69
11	Tenkasi	93.40	..	75.15	75.01	..	..
12	Thoothukudi	88.65	86.22	81.19	79.94	..	63.00
13	Tirunelveli	89.26	82.65	80.69	78.70	63.25	62.91
14	Virudhunagar	75.25	83.54	85.05	78.42	..	..
15	Kanyakumari	92.00	89.50	84.33	83.81	..	..
	Average	87.63	85.92	81.15	80.02	62.08	62.30

The analysis of filling behaviour of tanks revealed that 71.39 per cent of PU tanks and 45.55 per cent of PWD tanks have witnessed 100 per cent filling in northern districts. Similarly, 42.13 per cent of PU tanks have witnessed 75 per cent filling followed by 16.67 per cent witnessed 50 per cent of filling. Around 47 per cent of PWD tanks in northern districts have registered 75 per cent of filling followed by 6.75 per cent of tanks witnessed 50 per cent of filling (Table.3.15). PWD tanks had 50 per cent filling except in case of Villupuram. There were no tanks reported in the category of less than 50 per cent filling in northern region. The location wise number of PU and PWD tanks based on the tank filling categories are furnished in the following tables (Table 3.17, 3.18 and 3.19).

Around 62 per cent of PU tanks and 60.35 per cent of PWD tanks in southern districts have witnessed 100 per cent filling. Similarly, 39.38 per cent of PU tanks have witnessed 75 per cent filling followed by 6.30 per cent witnessed 50 per cent of filling. Around 37 per cent of PWD tanks in southern districts have registered 75 per cent of filling followed by 5.31 per cent of tanks witnessed 50 per cent of filling (Table.3.15).

Table 3.15. Filling behaviour of the tanks

(Percentage of tanks)

S. No.	District	100%		75%		50%		25%		Total No. of Tanks	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern Districts										
1	Chengalpattu	100.00	62.20	0.00	36.22	0.00	1.57	0.00	0.00	4	127
2	Kallakurichi	..	20.97	..	77.42	0.00	1.61	0.00	0.00	0	62
3	Kancheepuram	62.50	54.55	37.50	39.77	0.00	5.68	0.00	0.00	16	88
4	Krishnagiri	55.56	53.85	44.44	38.46	0.00	7.69	0.00	0.00	27	26
5	Thiruvallur	100.00	31.03	0.00	56.32	0.00	12.64	0.00	0.00	3	87
6	Villupuram	38.89	50.70	44.44	38.03	16.67	11.27	0.00	0.00	18	71
	Average	71.39	45.55	42.13	47.70	16.67	6.75	0.00	0.00	68	461
	Southern Districts										
7	Madurai	93.62	90.28	4.26	9.72	2.13	0.00	0.00	0.00	47	72
8	Pudukottai	90.00	62.55	0.00	29.45	10.00	8.00	0.00	0.00	10	275
9	Ramanathapuram	79.49	82.47	20.51	17.53	0.00	0.00	0.00	0.00	39	97
10	Sivagangai	5.00	25.78	90.00	71.09	5.00	3.13	0.00	0.00	60	128
11	Tenkasi	25.00	20.00	75.00	80.00	0.00	0.00	0.00	0.00	8	10
12	Thoothukudi	61.54	66.67	38.46	30.77	0.00	2.56	0.00	0.00	13	39
13	Tirunelveli	33.66	39.62	57.61	51.89	8.09	7.55	0.65	0.94	309	106
14	Virudhunagar	90.00	73.21	10.00	26.79	0.00	0.00	0.00	0.00	10	56
15	Kanyakumari	80.77	82.61	19.23	17.39	0.00	0.00	0.00	0.00	182	23
	Average	62.12	60.35	39.38	37.18	6.30	5.31	0.65	0.94	678	806

The per cent of tank filling is significantly influenced by the location of the tank in the cascade. Hence, an analysis of tank filling was done based on the location of the tank in the cascade and presented through tables 3.16 to 3.18. The analysis of tank filling behaviour based on the location of the tanks in the cascade revealed that tank filling significantly varies across regions. As one expects, more number of tanks located in the head and middle reach have witnessed 100 per cent filling followed by tanks located in tail reach (Table.3.17). Contrary to this, more number of tanks located in tail reach have witnessed 50 per cent filling and less than 50 per cent tank filling. This is commonly observed both in southern and northern districts.

Table 3.16. Number of Tanks with Full Tank Filling (100%)

(Number)

S. No.	District	Head		Middle		Tail		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern Districts								
1	Chengalpattu	1	34	2	22	1	23	4	79
2	Kallakurichi	0	5	0	4	0	4	0	13
3	Kancheepuram	4	17	5	17	1	14	10	48
4	Krishnagiri	5	5	2	6	8	3	15	14
5	Thiruvallur	0	6	3	14	0	7	3	27
6	Villupuram	2	13	4	18	1	5	7	36
Total number of tanks		12	80	16	81	11	56	39	217
	Southern Districts								
7	Madurai	12	24	16	22	16	19	44	65
8	Pudukottai	2	62	6	58	1	52	9	172
9	Ramanathapuram	12	32	9	30	10	18	31	80
10	Sivagangai	0	11	3	15	0	7	3	33
11	Tenkasi		2	2				2	2
12	Thoothukudi	3	9	3	8	2	9	8	26
13	Tirunelveli	30	19	37	10	37	13	104	42
14	Virudhunagar	3	18	2	16	4	7	9	41
15	Kanyakumari	47	6	55	9	45	4	147	19
Sum		109	183	133	168	115	129	357	480

Table 3.17. Number of tanks with 75 % Tank Filling

S. No.	District	Head		Middle		Tail		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern Districts								
1	Chengalpattu	0	16	0	16	0	14	0	46
2	Kallakurichi	0	14	0	19	0	15	0	48
3	Kancheepuram	1	11	1	12	4	12	6	35
4	Krishnagiri	5	3	5	4	2	3	12	10
5	Thiruvallur	0	19	0	15	0	15	0	49
6	Villupuram	3	10	4	10	1	7	8	27
Sum		9	73	10	76	7	66	26	215
	Southern Districts								
7	Madurai	1	1	1	2	0	4	2	7
8	Pudukottai	0	29	0	30	0	22	0	81
9	Ramanathapuram	2	5	3	3	3	9	8	17
10	Sivagangai	7	33	34	31	13	23	54	91
11	Tenkasi	1	4	2	2	3	2	6	8
12	Thoothukudi	2	6	2	2	1	4	5	12
13	Tirunelveli	57	21	70	15	51	19	178	55
14	Virudhunagar	0	2	1	5	0	8	1	15
15	Kanyakumari	12	1	9	2	14	1	35	4
Sum		82	102	122	92	85	92	289	290

Table 3.18. Number of tanks with 50 % Tank Filling

S. No.	District	Head		Middle		Tail		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern Districts								
1	Chengalpattu	0	0	0	1	0	1	0	2
2	Kallakurichi	0	1	0	0	0	0	0	1
3	Kancheepuram	0	0	0	3	0	2	0	5
4	Krishnagiri	0	2	0	0	0	0	0	2
5	Thiruvallur	0	6	0	2	0	3	0	11
6	Villupuram	0	0	1	5	2	3	3	8
Sum		0	9	1	11	2	9	3	29
	Southern Districts								
7	Madurai	1	0	0	0	0	0	1	0
8	Pudukottai	1	6	0	8	0	8	1	22
9	Ramanathapuram	0	0	0	0	0	0	0	0
10	Sivagangai	1	1	1	1	1	2	3	4
11	Tenkasi	0	0	0	0	0	0	0	0
12	Thoothukudi	0	0	0	1	0	0	0	1
13	Tirunelveli*	11	3	11	5	5	1	27	9
14	Virudhunagar	0	0	0	0	0	0	0	0
15	Kanyakumari	0	0	0	0	0	0	0	0
Average		14	10	12	15	6	11	31	36

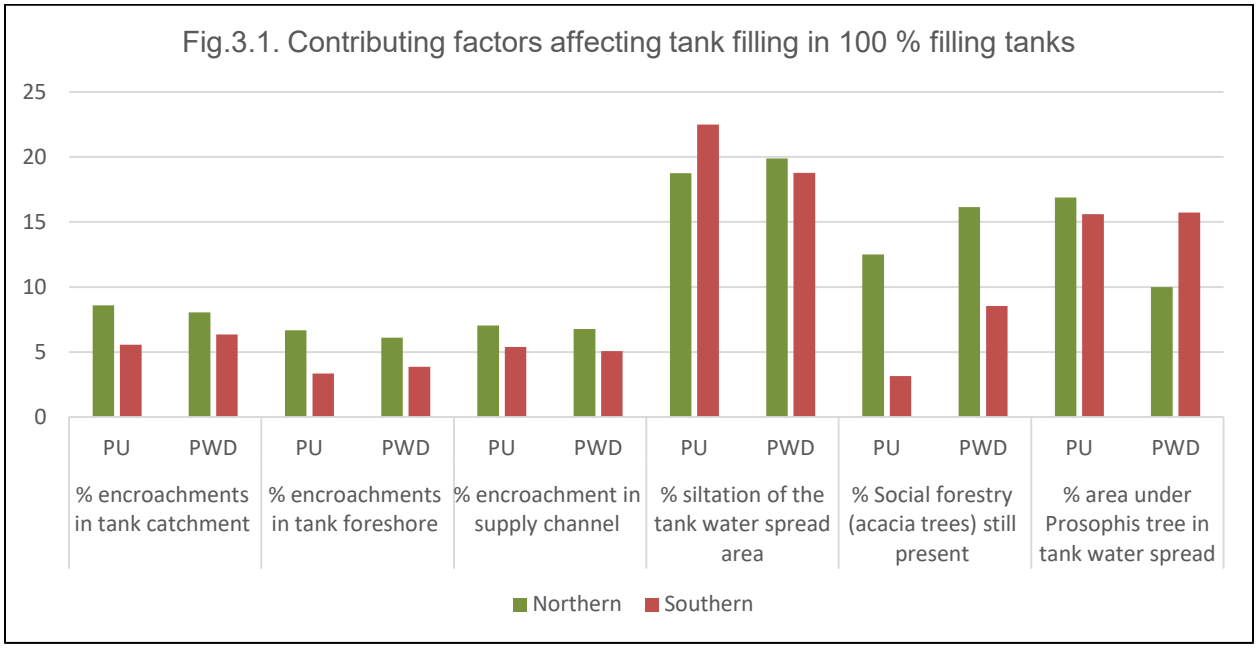
*: Two PU tanks and one PWD tank in Tirunelveli district have less than 50 % filling

The tank filling is expected to be influenced by encroachment in the supply channel, catchment, tank foreshores, silt deposits, extent of area covered by trees etc. The analysis of tank filling shows that there exists inverse relationship between tank filling and encroachment, siltation, and area under trees irrespective of typologies. For instance, for the tanks which have 100 per cent filling, the encroachment in catchment is 8.60 per cent and 5.57 per cent respectively for northern and southern districts with respect to PU tanks where as it is 14.67 per cent and 5.48 per cent for tanks which have 75 per cent filling and 15.50 per cent and 14.51 per cent for tanks which have 50 per cent filling.

Similarly, the encroachment in catchment is 8.04 per cent and 6.36 per cent respectively for northern and southern districts with respect to PWD tanks which have 100 per cent filling, where as it is 8.25 per cent and 9.42 per cent for the PWD tanks which have 50 per cent filling and .20.25 per cent and 12.98 for tanks which have only 50 per cent filling (Table.3.19). Similar scenario is visualised for other key factors such as encroachment in supply channels, encroachment in tank foreshore, per cent of siltation, per cent of social forestry and percentage of area under prosopis trees. Hence, the future tank modernisation programmes may give priorities for these factors.

Table.3.19. Tank filling and extent of encroachment, siltation, social forestry and area under trees

District	% encroachments in tank catchment		% encroachments in tank foreshore		% encroachment in supply channel		% siltation of the tank water spread area		% Social forestry (acacia trees) still present		% area under Prosophis tree in tank water spread	
	PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD
100 % filling												
Northern	8.60	8.04	6.67	6.11	7.04	6.76	18.76	19.89	12.50	16.15	16.87	9.99
Southern	5.57	6.36	3.35	3.87	5.39	5.06	22.49	18.78	3.14	8.53	15.61	15.72
75 % filling												
Northern	14.67	8.25	17.67	8.05	19.010	14.42	22.52	21.21	20.00	16.13	13.10	16.80
Southern	5.48	9.42	4.04	5.56	9.46	10.47	17.88	20.16	1.29	4.84	16.58	17.37
50 % filling												
Northern	15.50	20.25	50.00	9.50	70.00	34.85	65.00	29.14	5.00	15.83	32.50	18.88
Southern	14.51	12.98	9.09	8.23	24.74	32.27	16.91	21.99	25.00	4.58	14.24	16.77



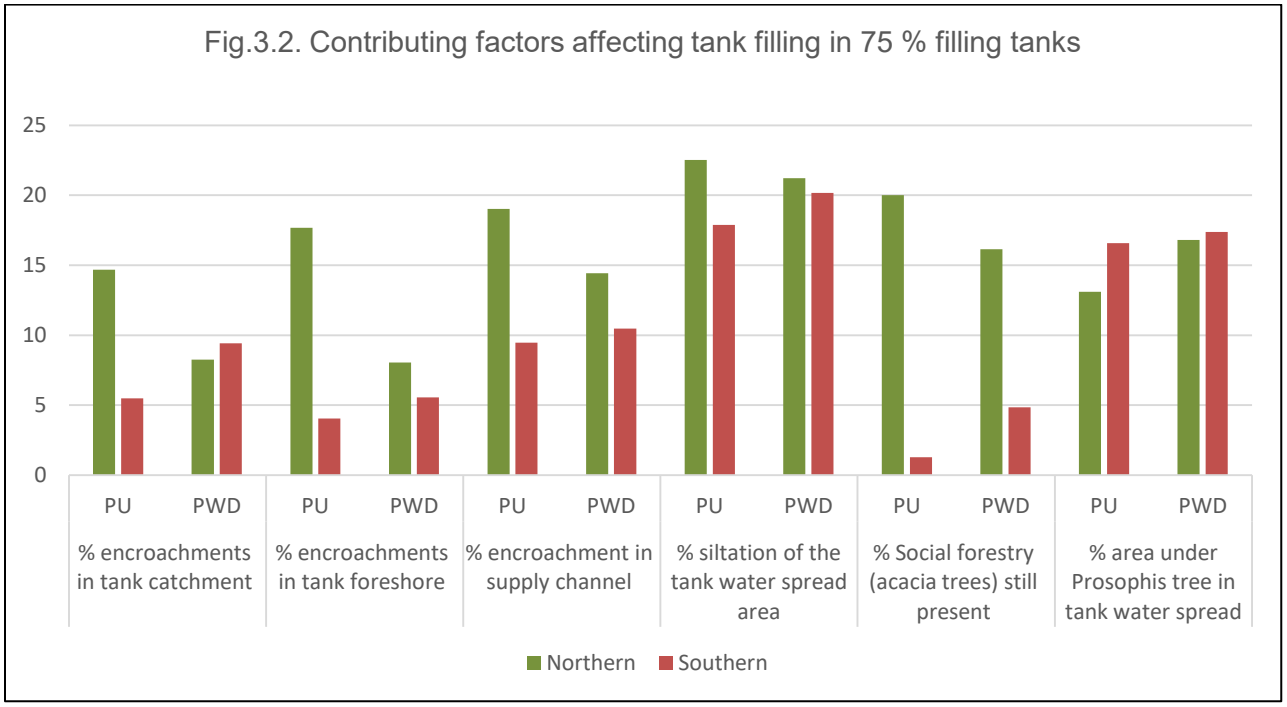


Fig.3.2. Contributing factors affecting tank filling in 75 % filling tanks
25
20
15
10
5
0
PU
PWD
% encroachments in tank catchment
% encroachments in tank foreshore
% encroachment in supply channel
% siltation of the tank water spread area
% Social forestry (acacia trees) still present
% area under Prosophis tree in tank water spread
Northern
Southern

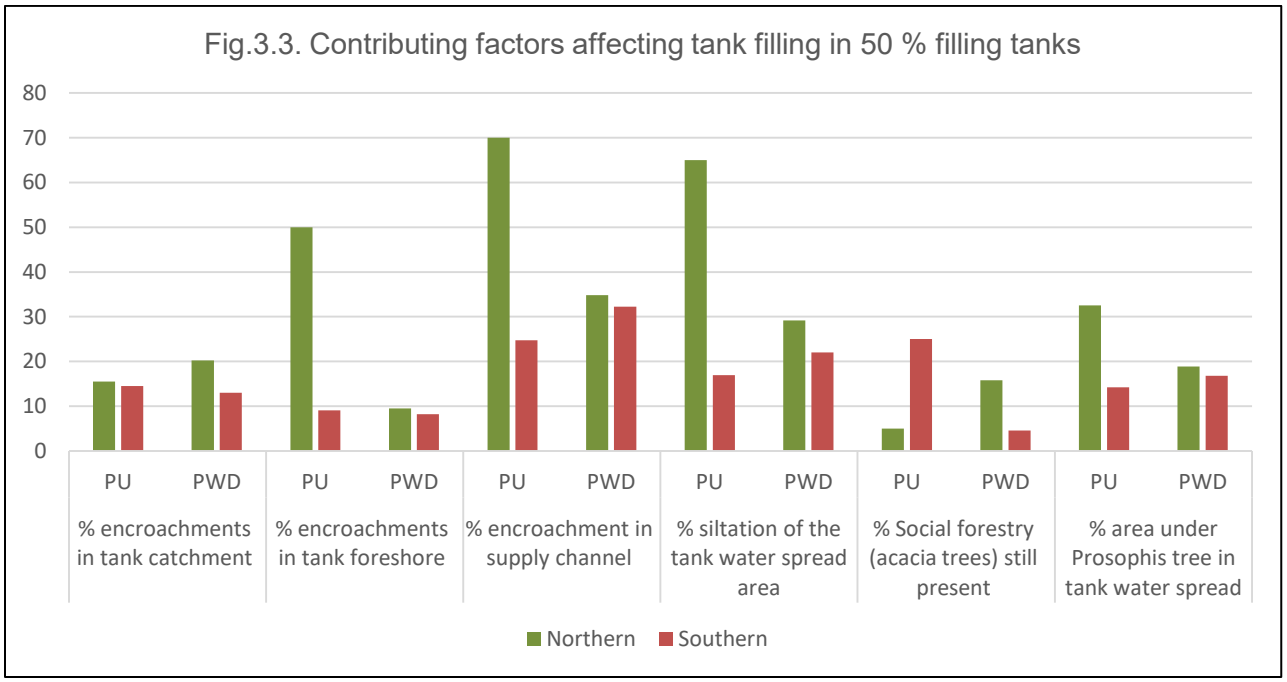


Fig.3.3. Contributing factors affecting tank filling in 50 % filling tanks
80
70
60
50
40
30
20
10
0
PU
PWD
% encroachments in tank catchment
% encroachments in tank foreshore
% encroachment in supply channel
% siltation of the tank water spread area
% Social forestry (acacia trees) still present
% area under Prosophis tree in tank water spread
Northern
Southern

Tank performance is generally measured as the ratio of actual area irrigated by the tank to the total command area. The analysis of tank performance indicates that both PU and PWD tanks in almost all the districts have registered more than 80 per cent except for PU tanks in Villupuram district. Similarly, the tanks located across regions viz., head, middle and tail regions, have witnessed more than 80 per cent of tank performance. There is no much variations across regions (Table.3.20). This is mainly due to the fact that the study year is a normal year and almost 95 per cent of the tanks (1913 tanks out of 2013 tanks) have witnessed more than 75 per cent filling of tank.

Table 3.20.Tank performance across typologies

(Per cent)

S. No.	District	Head		Middle		Tail		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern Districts								
1	Chengalpattu	91.01	94.15	89.38	95.14	93.08	92.51	90.71	93.93
2	Kallakurichi	..	84.69	..	86.31	..	86.11	..	85.72
3	Kancheepuram	81.52	84.58	84.70	93.77	93.68	94.26	85.87	91.00
4	Krishnagiri	92.62	94.65	95.98	94.38	93.99	93.81	94.00	94.35
5	Thiruvallur	..	96.92	92.87	97.91	..	96.11	92.87	97.26
6	Villupuram	77.31	96.92	96.17	91.50	96.68	90.72	90.50	92.76
	Average	85.62	91.98	91.82	93.17	94.36	92.25	90.79	92.47
	Southern Districts								
7	Madurai	87.68	96.91	83.03	93.01	88.50	93.09	86.28	94.39
8	Pudukottai	91.48	82.36	88.53	86.63	94.52	85.70	90.02	84.85
9	Ramanathapuram	86.53	86.95	84.52	86.61	83.96	86.98	85.05	86.84
10	Sivagangai	95.58	86.99	93.20	86.94	93.35	88.19	93.55	87.25
11	Tenkasi	99.43	97.45	99.53	99.82	92.86	95.83	97.02	97.60
12	Thoothukudi	89.04	90.09	87.29	92.69	91.74	92.05	88.99	91.48
13	Tirunelveli	87.49	94.21	88.25	94.62	88.42	93.32	88.06	94.06
14	Virudhunagar	85.67	87.48	84.91	84.68	89.02	84.15	86.78	85.54
15	Kanyakumari	87.22	87.64	84.30	94.15	89.83	91.75	87.04	91.64
	Average	90.01	90.01	88.17	91.02	90.24	90.12	89.20	90.41

Source: Field survey data collected during 2022

Note: Tank performance is mainly based on 2020-21 data collected from the PU and PWD officials

In the tank command areas, due to insufficient tank water, farmers practice conjunctive use of groundwater and tank water. Hence to account groundwater in the irrigated area, groundwater adjusted tank performance (GATP) was worked out for different typologies of tanks. The GATP was worked out as the ratio of Actual irrigated area (Area irrigated by tank + area irrigated by Wells) to the Registered command area of the tank.

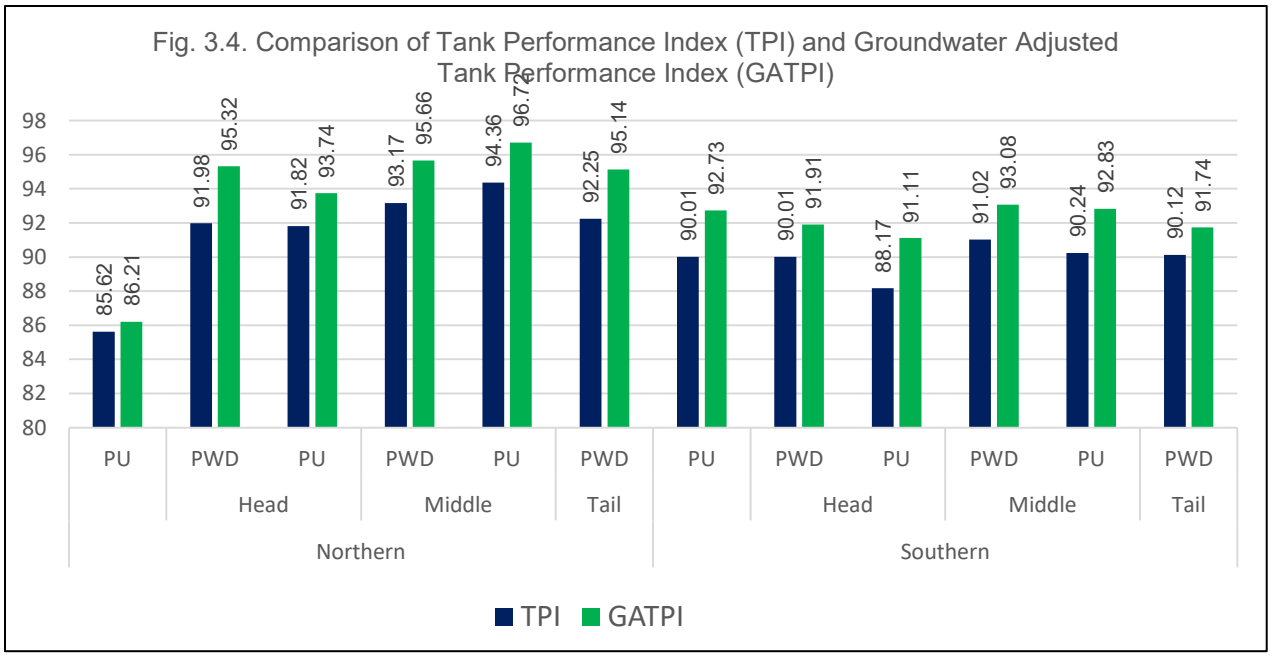
The wells assume very critical in the tank command as it provides supplemental irrigation. At time of water scarcity during end of crop season, the wells provide supplemental irrigation which

saves the crop from failure. Suresh Kumar and Palanisami (2019) found that farmers will forego an income of Rs.12657 to 13065 /ha/year if they fail to make investment on wells.

Table 3.21. Tank performance including area under well irrigation across typologies

(Per cent)

S. No.	District	Head		Middle		Tail		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern Districts								
1	Chengalpattu	91.01	96.61	89.38	96.17	95.58	96.38	91.30	95.87
2	Kallakurichi	..	93.66	..	91.10	..	93.48	..	92.65
3	Kancheepuram	81.52	88.19	85.02	94.21	95.21	94.81	87.12	92.50
4	Krishnagiri	94.99	95.62	99.29	96.86	98.06	96.11	97.24	96.21
5	Thiruvallur	..	98.66	96.10	99.14	..	97.85	96.10	98.60
6	Villupuram	77.32	99.15	98.91	96.46	98.04	92.20	92.72	96.43
	Average	86.21	95.32	93.74	95.66	96.72	95.14	92.90	95.38
	Southern Districts								
7	Madurai	89.63	97.70	86.01	95.01	90.56	94.40	88.64	94.62
8	Pudukottai	91.48	82.36	88.53	86.63	..	85.70	90.02	84.86
9	Ramanathapuram	86.53	86.95	84.52	86.61	83.96	86.98	85.05	86.84
10	Sivagangai	95.78	87.85	93.42	88.51	93.35	86.25	94.37	87.41
11	Tenkasi	99.43	98.34	99.56	100.00	97.02	95.83	98.60	98.17
12	Thoothukudi	89.94	90.75	89.69	93.19	93.70	92.32	90.71	94.85
13	Tirunelveli	93.57	95.71	93.68	97.55	94.22	95.02	93.57	96.02
14	Virudhunagar	100.00	94.90	100.00	95.91	100.00	97.41	100.00	95.95
15	Kanyakumari	88.24	92.64	84.60	94.30	89.83	91.75	87.15	91.72
	Average	92.73	91.91	91.11	93.08	92.83	91.74	92.01	92.27



The analysis indicates that GATP is worked to be more than 85 per cent in most of the PU and PWD tanks across districts of the state. This is mainly due to supplementary well water enabled the farmers to adopt conjunctive use both surface and groundwater. The GATP is 92.9 per cent and 95.38 per cent respectively for PU and PWD tanks in northern districts where as it is 92.01 per cent and 92.27 per cent for tanks in southern districts.

The factors influencing the tank performance is estimated using multiple regression analysis (Table 3.22).

Our main interest in this research is to examine the factors which influence the tank performance and to study the effect of rainfall on tank performance. The analysis confirms that as expected the factors such as encroachment in supply channel, siltation in tank water spread area, number of functioning wells and area under land put to non-agricultural uses are found to be significantly and negatively influence the tank performance.

The siltation in the tank water spread area reduced the storage capacity of the tanks and in turn the tank performance. The dependence on tank water is an important factor that affects the tank performance. To capture the effects of resource dependence, number of functioning wells is included. Greater the number of wells in the command area of the tank lesser will be the dependence of farmers on tank irrigation. An adverse consequence of this is that there is no incentive for farmers to contribute to labour and other costs to tank management and maintenance.

Table 3.22. Factors affecting the performance of Tanks in Northern Region

(N = 527)

Variables	B	Std. Error	't' value
Constant	85.655	3.061	27.981
Encroachments in tank catchment (%)	0.059	.037	1.600
Encroachments in tank foreshore (%)	-0.053	.050	-1.060
Encroachment in supply channel (%)	-0.067***	.025	-2.639
Location of the tank in the cascade	-0.452	.394	-1.147
Number of fillings	0.798	.718	1.112
Tank bund condition	-0.324	.669	-.484
Activeness of Water User Association	-0.344	.674	-.510
Siltation of the tank water spread area (%)	-0.208***	.032	-6.420
Number of functioning wells	-0.021***	.005	-3.841
Actual Rainfall in mm	0.007***	.002	3.153
Share of LPUNAU(%)	-0.188***	.062	-3.047
R^2	0.274		
F value	16.2***		

(*** indicates 1% level of significance and *indicates 10 % level of significance)

(Note: Location of the tank in the cascade if in Tail -1,Middle -2 and Head-3: Tank bund condition if breached- 0 and Good condition- 1; Activeness of Water User Association if not-active -0 active -1 and Share of LPUNAU-share of land put under non agricultural use to the total geographical area)

Another important factor which influences tank performance is urbanisation and the demand for land for non-agricultural uses. In the process of urbanisation, conversion of land for non-agricultural purposes takes place at a faster rate reducing tank water spread, catchment area and area under tank irrigation. Thus, non- agricultural use of land due to urbanization can have a negative influence on tank performance.

The rainfall is found to be significantly and positively influences the tank performance and confirmed our hypothesis.

The initial analysis of factors influencing tank performance in southern region revealed that tank performance is not influenced by the same set of variables used in northern region, although these variables are highly related to tank performance. The major reason may be that almost all the districts in southern region except Kanyakumari (normal rainfall) have experienced excess rainfall during the year 2020-21. There is no much variation in tank performance across tank cascades and districts. Hence, the tank irrigated area is taken as dependent variable. Interestingly tank irrigated area is positively influenced by location of the tanks in the cascade, number of functioning wells, effective tank storage and modernization activities done in the past five years (Table.3.23). Higher the number of functioning wells , more will be the tank area irrigated. This finding confirms that supplementary well irrigation is necessary for improving tank irrigated area thereby the performance of tanks. Effective tank storage is found to be positively influencing the tank area irrigated indicating that siltation and condition of the sluice are important factors affecting tank performance. Hence desilting and sluice repairing may be given priority in tank modernization options.

Table 3.23. Factors influencing the area irrigated by tanks in Southern Region

N = (1484)

Variables	B	Std. Error	't' value	Sig.
Constant	86.132	36.884	2.335	.020
Rainfall Deviation	-1.045***	.482	-2.170	.030
Population Density	-0.036***	.012	-3.077	.002
Location of the tank in the cascade	12.553*	6.969	1.801	.072
Number of fillings	7.049	9.869	.714	.475
Number of functioning wells	1.377***	.162	8.523	.000
Effective Tank storage (mcft)	7.929***	.353	22.456	.000
Modernization (Yes1; No 0)	20.978*	12.097	1.734	.083
Water User Association	-22.454*	13.186	-1.703	.089
R^2	0.335			
F value	79.03			0.000

(*** indicates 1% level of significance and * indicates 10 % level of significance)
(Note: Location of the tank in the cascade if in Tail -1,Middle -2and Head-3 and Activeness of Water User Association if not-active -0 active -1)

The factors such as rainfall deviation, population density, non-activeness of WUA are found to be negatively influencing the tank irrigated area.

The tank filling behaviour and factors which might influence the filling behaviour of tanks namely encroachment in tank supply channel, tank foreshore area and tank water spread area, siltation, percentage of social forestry plantations, prosopis and other tree plantations are furnished in the following tables (Table 3.24 and 3.25). Surprisingly tank performance and tank filling pattern are not correlated both in northern and southern region.

Table .3.24. Tank performance and Tank Filling

S. No.	District	Full Tank (100%)		3/4th filled =75%		half-filled =50%		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern								
1	Chengalpattu	90.72	94.65	..	92.72	..	95.44	90.72	94.08
2	Kallakurichi	..	84.97	..	86.01	..	82.83		84.42
3	Kancheepuram	86.75	88.33	84.39	94.24	..	93.99	85.57	92.19
4	Krishnagiri	91.26	95.98	97.42	91.92	..	95.12	94.34	94.34
5	Thiruvallur	92.86	97.25	..	97.24	..	97.31	92.86	97.27
6	Villupuram	90.88	91.61	89.50	95.78	93.23	87.82	91.20	91.74
	Average	90.49	93.30	90.44	92.99	93.23	92.08	91.39	92.79
	Southern								
7	Madurai	86.63	94.57	75.83	92.73	91.40		84.62	93.65
8	Pudukottai	90.27	85.33	..	85.16	87.75	80.02	89.01	83.50
9	Ramanathapuram	85.12	86.51	84.81	88.42	..	..	84.96	87.47
10	Sivagangai	90.49	85.83	93.63	87.70	95.27	88.10	93.13	87.21
11	Tenkasi	99.12	..	96.32	97.6	..		97.72	97.60
12	Thoothukudi	89.60	90.61	88.03	92.72	..	99.13	88.81	94.15
13	Tirunelveli	88.30	94.77	87.73	93.27	89.06	95.08	89.28	95.41
14	Virudhunagar	86.37	84.90	90.50	87.28	..	..	88.44	86.09
15	Kanyakumari	87.83	92.15	83.72	89.22	..	..	85.78	90.69
	Average	89.30	89.33	87.57	90.46	90.87	90.58	89.94	92.23

Normally it is expected when a tank has 75 or half filling, it will be affecting the area irrigated by tanks. When tank is ¾th or half filled, it will not able to irrigate its full registered command area. But as expected the encroachments and siltation percentage showed negative correlation with tank filling pattern. But actual area irrigated did not show any change due to the changes in the tank filling pattern. This might be due to the supplementation of wells to the tank storage. This is an important message from this study. It is evidenced from the above section, siltation, condition of the sluice and encroachment in supply channel are the major important factors that have be taken into account while doing tank modernization.

Table 3.25. Groundwater Adjusted Tank Performance including well irrigated area and tank filling

S. No.	District	Full Tank (100%)		3/4th Filled =75%		Half Filled =50%		Total	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD
	Northern								
1	Chengalpattu	91.23	96.41	..	94.90	..	97.13	91.23	96.15
2	Kallakurichi	..	91.14	..	93.14	..	89.03	..	91.10
3	Kancheepuram	89.27	92.17	84.86	95.12	..	94.12	87.07	93.80
4	Krishnagiri	98.66	95.98	98.02	96.30	..	100.00	98.34	97.43
5	Thiruvallur	96.10	97.89	..	99.17	..	97.78	96.10	98.28
6	Villupuram	97.21	95.48	89.50	96.98	100.00	99.09	95.57	97.18
	Average	94.49	94.85	90.79	95.94	100.00	96.19	95.10	95.66
	Southern								
7	Madurai	89.10	94.76	77.42	93.49	91.44	..	85.99	94.13
8	Pudukottai	90.27	85.33	..	85.16	87.75	80.02	89.01	83.50
9	Ramanathapuram	85.12	86.51	84.81	88.42	..	..	84.97	87.47
10	Sivagangai	90.49	85.83	94.45	88.73	96.17	88.21	93.70	87.59
11	Tenkasi	99.12	97.91	98.57	98.34	..	..	98.85	98.13
12	Thoothukudi	89.68	92.14	93.23	93.72	..	99.13	91.46	95.00
13	Tirunelveli	93.57	96.25	93.56	95.88	94.12	96.02	93.32	96.67
14	Virudhunagar	100.0	94.26	100.00	94.26	..	..	100.0	94.26
15	Kanyakumari	88.49	92.26	89.57	90.08	..	..	89.03	91.17
	Average	91.76	91.69	91.45	92.01	92.37	90.85	91.90	93.27

The analysis clearly show that the performance of tanks improved when conjunctive use of water (surface water and groundwater) is followed.

4 TANK MODERNIZATION AND INVESTMENT OPTIONS

The key strategies for improving performance of the tank irrigation systems include both investment and management options. These measures are generally used to conserve water and ensure surface irrigation for longer period, improve ground water recharge and promote conjunctive use of surface and groundwater. Accordingly, potential investment options were identified for different tank cascades across districts and the same are discussed in this section.

Tank modernization in a much broader sense indicates the efficiency of investment options. Most of the current activities involve rehabilitation below the outlet, while tank modernization as such, refers to rehabilitation and improved water management. It involves multiple tasks such as conservation of the catchments, maintenance of supply channels, removal and prevention of encroachment into tank water spread areas, desilting, and maintenance and repair of the bunds, surplus weir, and sluices etc. .

Firstly, this chapter deals with the identification of potential tank cascades for modernization and secondly, the types of modernization options that can fit into different tank cascades are discussed along with financial feasibilities.

4.1 Potential Tank Cascades for Modernization

Tank modernization index was constructed for the study tanks. Based on the index value tank cascades were grouped into three categories namely high potential, medium potential, and low potential cascades for modernization. The higher index indicates that there is a possibility to generate higher returns due to its diverse income-generating activities viz., fishery, forestry, and groundwater recharging besides irrigation. Based on the modernization index worked out, the following inferences are made:

a) Tank cascades with less than 25% modernization index are not considered for modernization. This is because most of the tanks in these cascades are either known for their dysfunctional or abandonment or conflicts etc.,
b) Tank cascades with a modernization index of 26-50 are low potential cascades
c) Tank cascades with a modernization index of 51-75 are medium potential cascades
d) Tank cascades with a modernization index more than 76 are high potential cascades

Out of the total 315 cascades covered in this study, about 86 cascades (27.3 %) covering about 572 tanks are falling under the high potential cascade category, 215 cascades (68.3%) with 1409 tanks are falling under the medium potential cascade category and the rest (14 cascades with 32 tanks) are low potential tanks. The details of district-wise high-potential tank cascades are given in Figure 4.1.

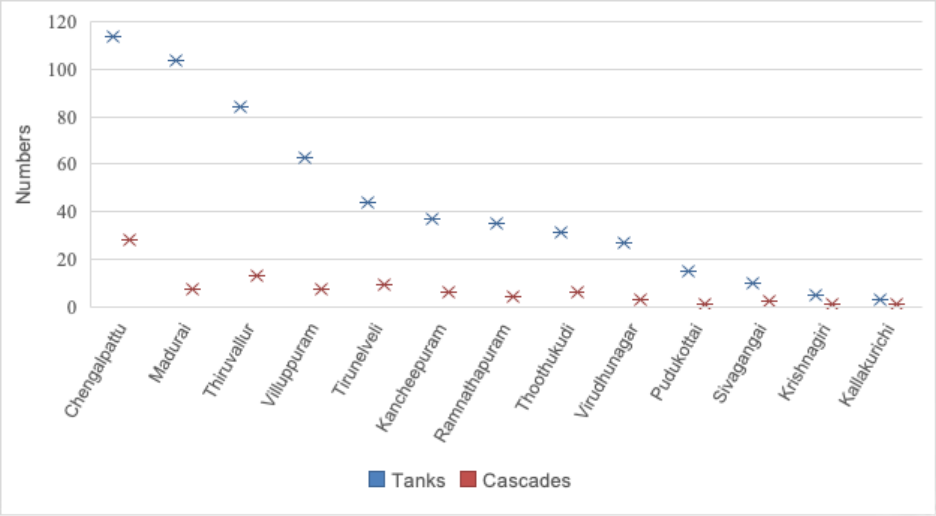


Fig. 4.1 District-wise number of high-potential cascades (n=86) and tanks (n=572) identified for modernization

The details of district-wise medium-potential tanks are presented in Fig.4.2 and it indicates that there is a huge number of tanks identified in Thirunelveli district (26 per cent out of 1409 tanks) among the medium-potential tanks followed by Pudhukottai (18 per cent), Kanyakumari (14 per cent), Sivagangai (12 per cent), Ramanathapuram (7 per cent) and remaining 10 districts have less than five per cent of tanks are to be modernized to reap the complete benefits. The tanks have low potential for modernization and the details are given in Figure 4.3. There are few tanks *i.e.* 32 spread across 15 cascades (1.6 per cent) observed that are classified as low potential tanks based on the tank modernization index. Further, it is observed that some of the tanks also fall in medium potential cascades.

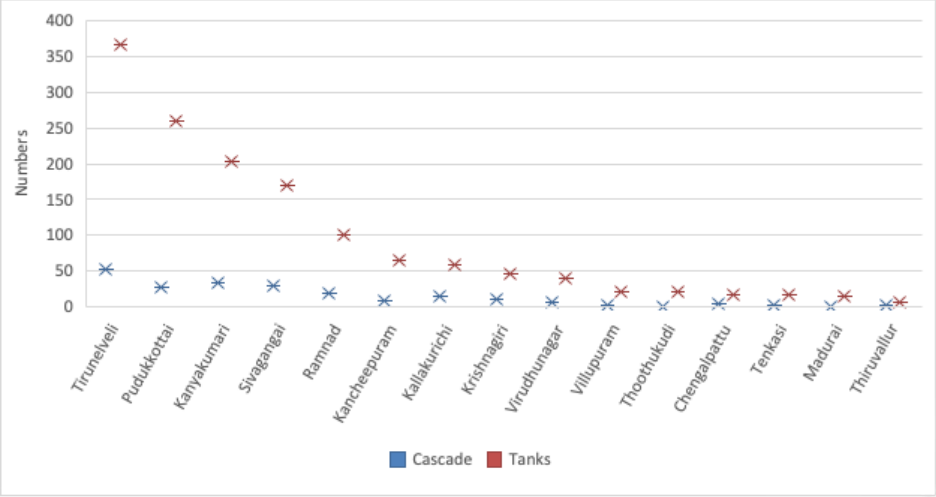


Fig. 4.2 District-wise number of medium-potential cascades (n=215) and tanks (n=1409) identified for modernization

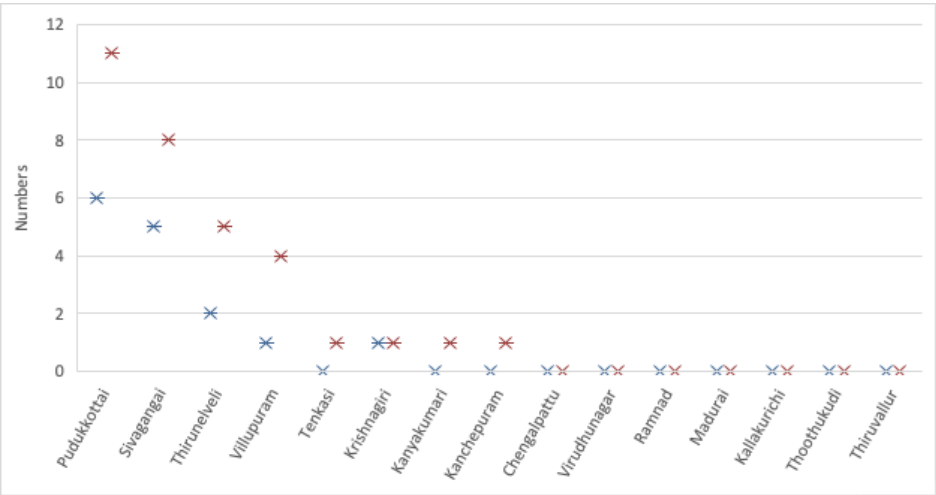


Fig. 4.3 District-wise number of low-potential cascades (n=15) and tanks (n=32) identified for modernization

Once the tank cascades are grouped into different potential categories for modernisation, the potential modernisation options have been identified based on: a) the stakeholder discussions, b) researchers field observations and c) tank data collected. They include (i) partial desilting of the tank and bund strengthening, (ii) supply channel cleaning including desilting and removal of encroachment, (iii) sluice repair and management, (iv) repair of surplus weir and (v) lining of distributaries channel. In general, it is practiced that the earthwork excavating and depositing on the bank together *i.e.* desilting and bund strengthening were combined so that the benefits of both activities would be realised. Similarly, the encroachments are removed while cleaning the supply channels. While selecting the possible tank modernization options for each cascade minor variations within the cascade are also observed depending upon the individual tank requirements. For example, in some cascades, tanks in the upstream region have slightly different modernization options than the tanks in the downstream region. The details of identified tank modernisation options across regions and typologies of tanks are presented in Table. 4.1.

Table 4.1. Tank modernization options for different cascade typologies

PWD						PU				
Northern District										
Modernization potential	1	2	3	4	5	1	2	3	4	5
High	Desilting of tank	Sluice repairing	SCD	RSW	LDC	Desilting of tank	Sluice repairing	BS	SCD	LDC
Medium	Desilting of tank	BS	Sluice repairing	SCD	LDC	Desilting of tank	Sluice repairing	BS	LDC	RE
Low	SCC	Desilting of tank	RE	Sluice repairing	RSW					
Southern District										
Modernization potential	1	2	3	4	5	1	2	3	4	5
High	Desilting of tank	Sluice repairing	BS	SCD	LDC	Desilting of tank	Sluice repairing	BS	RSW	LDC
Medium	Sluice repairing	Desilting of tank	SCD	BS	Sluice repairing	Desilting of tank	SCD	Sluice repairing	LDC	RE
Low	RE	Desilting of tank	SCD	Sluice repairing	RSW	SCD	LDC	Desilting of tank	Sluice repairing	RE

SCC : Supply Channel Cleaning; SCD : Supply Channel Desilting LDC : Lining of Distributary Channel
RE : Removal of Encroachment RSW : Repairing of Surplus Weir BS : Bund Strengthening

4.2. Economics of tank modernization options

4.2.1.Desilting and bund strengthening

Siltation is a major problem affecting tank storage. Silt is impounded in tanks due to sedimentation and the storage capacity of the tanks is reduced. Given the high cost of desilting as well as the problems in the disposal of huge volume of silt, partial desiltation i.e. 30 per cent is recommended. The cost of desilting in these tanks varies from Rs 71/m^3 to Rs 106/m^3 with an average of Rs.88.65/m^3. In general, it is practiced that the earthwork excavating and depositing on the bank together i.e. desilting and bund strengthening are combined so that the benefits of both activities are achieved. The total cost of desilting is arrived at by multiplying the de-silted area by per unit cost of desilting. The average cost was obtained by dividing the total desilting cost by the tank command area.

The total benefits due to desilting are assumed to be 10 per cent increase in irrigated area.

The total value of benefits was worked out as follows: $$BD = \frac{IA * Y * P_R}{IA}$$

Where,

BD : Incremental benefits due to desilting (Rs./ha)

IA : Additional irrigated area due to desilting (ha)

Y : Yield of rice (Kg/ha)

P_R : Price of Rice (Rs/kg)

4.2.2.Supply channel cleaning

In many tanks, the supply channels are heavily silted and, in several cases, supply channels are not seen due to the siltation and encroachment. The use of illegal ‘pattas’ (rights from the government) to encroach on the tank foreshore is a common. The encroachers drain the tank water when their crops in the tank foreshore are about to be submerged. They then argue with the government that the tanks are not full most of the time and hence their right to cultivate the tank foreshore area should be sanctioned. Tank siltation is further aggravated by the deforestation in the tank catchment area both by the encroachers and the tank irrigators. The end result is increasing run-off and severe soil erosion during heavy rains. It is assumed that an additional 15 per cent irrigated area could be achieved as a result of desilting and cleaning of supply channel. The cost of supply channel cleaning including desilting is Rs.10 per M^2.

4.2.3. Lining Distributary Channel

Water loss in the canals is about 30 per cent besides creating inequity in distribution between head and tail regions. Lining the main canals can be undertaken without disturbing the field boundaries. Tank management strategies such as sluice rotation will also help in saving tank water. Currently, the tank sluices are continuously open and the tank water is exhausted within six to eight weeks of tank water release for crop cultivation. The cost of reconstruction and lining of the distributary channel was calculated as follows: The distributary channels were formed under each sluice to irrigate the field. The cost of lining of distributary channel is worked out to be Rs.250/m^3.

4.2.4.Sluice Management

Tank management strategies such as sluice rotation will also help in saving tank water. The tank sluices are continuously open and water is exhausted within six to eight weeks of tank water release for crop cultivation. To keep tank water available for a longer period as well as to recharge the wells, the tank sluices can be opened and closed during alternate weeks. Earlier studies (Palanisami and Flinn 1988) indicated that effective management of sluices arrest water leakages which would save tank water about 10 per cent and extend the tank water supplies to two and a half months instead of the present supply of one and a half month with continuous opening of the sluices. A simple procedure of closing the sluices during the rainy days, when there is no demand for water has been shown to increase the irrigated area by more than 20 per cent. However, the present method of water distribution is continuous irrigation with sluices opened throughout the crop season due to leakages and repair conditions. The approximate cost of reconstruction of sluices and its repairing works including cementing work is Rs. 1.85 lakhs per sluice as suggested by the PWD standard schedule of works 2023.

Sluice management would also increase groundwater recharge. Although non-well-owning farmers would have to pay for groundwater purchase from the well owners during the alternate weeks when the sluices are closed, under the present system too, they buy water after the tank supplies are exhausted. Under sluice rotation, the extension of the season and greater groundwater recharge can actually reduce the cost of purchased groundwater. Further, due to sluice rotation, wells can be used more efficiently. Currently, they can pump for only two to three hours per day due to poor recharge, particularly during the latter part of the tank season (Palanisami 2000). Sluice rotation can allow up to six hours of pumping per day, which increases the profits for well owners as well as water availability for other farmers. A 10 per cent increase in irrigated area is assumed due to sluice repair and maintenance.

4.2.5. Surplus weir repair

The surplus weirs repair helps manage tank capacity otherwise it is not possible to maintain the optimum storage of the tanks. It is observed that the surplus weirs of many tanks are broken and dilapidated. It warrants reconstruction and repair work, which is assumed to increase the water savings by 5 to 10 per cent. The cost of repairing and renovation of surplus weir is assumed to be Rs.846/m^3. It is assumed that there will be a 5 per cent increase in irrigated area due to supply channel cleaning.

Using the expected benefits and costs of different modernization options as given in Table 4.1, detailed analysis was done to work out the economics of tank modernization under different cascade typologies. The average cost varied from Rs. 182 (Lining of distributary channel) to Rs. 12564 (Desilting and bund strengthening) due to the required investment is different for various modernization options (Table.4.2).

Table 4.2. Tank modernization options with the anticipated benefits and costs

Modernization options	Possible major benefit types	Average cost(Rs/ac)
Partial desilting	Additional water storage, ground water recharge, more multiple uses like fishery, increased irrigated area, additional yield	12564
Sluice repair and management	Additional water storage	2890
Supply channel cleaning including desilting and removal of encroachments	Runoff water from fields and gullies flows readily and is stored in tanks, increased water availability to tanks, increased storage	2673
Repairing of surplus weir	Tank storage has been enhanced to hold more water	266
Lining of distributary channel	Reduced leakage and water spillage	182

The overall estimated investment, which is required for the high, medium and low potential tanks were worked out and the details are given in Table 4.3.

Table 4.3.. Estimated investments for different tank modernization options

(Rs in Crores)

Investment Options	High		Medium		Low		Total	
	Investments	Share (%)	Investments	Share (%)	Investments	Share (%)	Investments	Share (%)
Desilting of tank and bund strengthening	155.22	37.48	253.03	61.09	5.89	1.42	414.13	73.42
Sluice repair and management	24.62	25.85	67.57	70.93	2.02	2.12	95.26	16.89
Supply channel cleaning and removal of encroachments	2.30	26.11	6.31	71.62	0.21	2.38	8.81	1.56
Repairing of surplus weir	2.30	26.26	6.44	73.52	0.20	2.28	8.76	1.55
Lining of distributary channel	1.50	25.04	4.27	71.29	0.12	3.51	5.99	1.06
Fisheries and Social Forestry							31.10	5.51
Total							564.05	100.00

The total cost of investments for different tank modernization options is worked out to be Rs. 564.05 crores, of which, the desilting and bund strengthening accounts for (73%) followed by sluice repair and management (17%), fisheries and social forestry (5.51%), supply channel cleaning and removal of encroachments (1.56%), repairing of surplus weir (1.55%) and the lining of distributary channel (1.06%).

The district-wise investment required for the first five different modernization options (except for fisheries and social forestry) is given in Table 4.4.

One of the important issues that the tanks in Tamil Nadu state are facing is nearly one third of the tank storage capacity is reduced due to silt. Hence, desilting is the first and foremost priority for 25 per cent of the total potential tanks which would increase water storage capacity for the selected tanks and the cascade. There are two options (i) desilting only in selected locations in the tank water spread area it normally covers from 20% to 30% of the water spread area and (ii) desilting the entire tank water spread area. The number of tanks needed to carry out the desiltation is more and those districts need more investment for desilting and bund strengthening. Accordingly, the investment for this option is also higher i.e. more than Rs. 30 crores for Ramanathapuram district followed by Villupuram, Pudukottai, Chengalpattu, Thoothukudi, and other districts required less than 30 crores. The desiltation cost was comparatively low in Kanyakumari, Krishnagiri and Tenkasi.

Table 4.4. District-wise total investment for different modernization options

S. No.	Districts	Rupees (Crores)
1	Ramanathapuram	75.73
2	Villupuram	59.26
3	Pudukottai	73.17
4	Chengalpattu	50.66
5	Thoothukudi	42.53
6	Thirunelveli	42.52
7	Sivagangai	41.16
8	Virudhunagar	26.68
9	Madurai	27.54
10	Kallakurichi	20.48
11	Thiruvallur	23.70
12	Kancheepuram	19.72
13	Kanyakumari	15.75
14	Krishnagiri	10.09
15	Tenkasi	3.99
	Total	532.95

Good conditioned sluices are crucial for proper timely release and rationed distribution of water to the farmers across regions. In reality, in many tanks, the sluices are not in good condition and need repairing. Also, most of the cases the sluices are not completely closed and let it open one third to half always. This practice led to complete exhaust of tank water in a shorter period even before end of the cropping season. Hence, repairing and reconditioning of the sluices are preferred investment. The analysis lucidly indicates that based on the number of tanks and sluices, the investment proportionately varies from Rs. 0.97 crores in Tenkasi district to Rs.16.97 crores in Pudukkottai district. Further, it is observed that most of the southern districts (Pudhukottai, Ramanathapuram, Sivagangai, and Tirunelveli) require more investment for sluice

repairs and management as compared to other districts. Many cases, it is observed that supply channels are not present due to heavy siltation and encroachment.

Hence, supply channel cleaning including clearing of bushes, desiltation assumes critical. The district wise investments required for supply channel cleaning and removal of encroachments is ranged from Rs. 7 lakhs in Tenkasi to Rs. 1.13 crores in Tirunelveli. Similarly, renovation and reconditioning of surplus weirs are found to be important in most of the districts. The total investment is estimated to be around Rs. 8.76 crores for all the districts and it is ranged from Rs. 8 lakhs to Rs. 1.54 crores.

Experiences show that canal lining for provisioning of water supply to attain last-mile connectivity in the cascading network has resulted in water conservation by about 21 per cent (Asian Development Bank, 2006). Lining distributary channels is very important to distribute water during the monsoon period without much loss. The estimated investments for the distributary channel is varied from Rs. 6 lakhs (Tenkasi) to Rs. 1.04 crores (Pudukottai). This would help to minimise the conveyance losses through reduction in seepage and percolation losses and improve the conveyance efficiency.

It's worth mentioning that there is an opportunity to invest in fisheries and social forestry activities within the chosen tanks, with an estimated investment requirement of approximately 31.10 crores. These activities have the potential to create employment and generate income. Apart from being a source of irrigation, the tanks are sources of fish, groundwater recharge etc. During the social forestry scheme, the benefits were shared in a ratio of 60:40 between panchayats and communities. A certain percentage of this amount was allotted to the maintenance of tanks by the panchayats. During the course of time, this practice was discontinued, and as the community people lost their certain area under forestry. The loss of usufructuary rights of the local communities over these resources and its consequence on the alienation of user community from these resources were given the least priority. This leads to reduced revenue mobilization from these resources and loss of interest by village communities in protecting /maintaining resources like tanks.

The Government of Tamil Nadu has started the Tamil Nadu Green Mission and it is planned to increase the green cover in private lands, and community lands including tank bunds and water spread areas. Tree plantations can be carried out with the help of this scheme. Only three years of maintenance cost is needed. Fish culture is practiced in a few panchayat-maintained tanks and the income ranges from 3.00 lakh to 12.00 lakh per year. Fish culture may be encouraged in both PWD and PU tanks. Tree plantation cost is approximately Rs 5/tree @ 50 /ac in case of water spread area and Rs.5/tree/meter in case of tank bund. The initial investment required for the fishery is @50000/tank.

4.3. Financial Evaluation of Tank Modernisation

To prioritize the tank modernisation interventions across cascades, financial feasibility analysis has been carried out using the costs of investments and expected benefits of different tank modernisation interventions. While working out the costs and benefit streams for different modernisation interventions, it is assumed that the full benefits are realised for three years during 100 per cent filling, partial benefits (50 per cent) due to 50% filling, and zero benefits for the remaining five years. To account for maintenance cost, 10 per cent of the total investments was considered.

The financial feasibility of different tank modernization options was evaluated and the results are presented in Table 4.5 and Table 4.6. The ex-ante analysis tank modernisation investments indicates that It is observed that the expected benefit cost ratio is found to be greater than one for all the investment options indicating the investment options are financially feasible. Similarly, the IRR is found to be financially feasible. This phenomenon is observed for both the high and medium potential tanks (Table 4.5 and 4.6).

Table 4.5. Financial analysis of tank modernization options: High potential tank cascades

Modernization options	BC ratio	IRR %
Desilting of tank and bund strengthening	2.16	19.5
Sluice repair and management	1.10	13.2
Supply channel cleaning including desilting and removal of encroachments	1.26	14.18
Repairing of surplus weir	1.05	13.34
Lining of distributary channel	1.08	16.62

Table 4.6 Financial analysis of tank modernization options: Medium potential tank cascades

Modernization options	BC ratio	IRR %
Desilting of tank and bund strengthening	2.09	18.1
Sluice repair and management	1.10	12.7
Supply channel cleaning including desilting and removal of encroachments	1.12	13.83
Repairing of surplus weir	1.01	12.27
Lining of distributary channel	1.02	13.71

The district wise ex-ante analysis of financial analysis of tank modernisation investments indicates that the BCR is found to financially feasible in almost all the districts for both the high and medium potential tanks. The BCR is worked out to be 1.68 for high potential tanks whereas it is 1.53 for the medium potential tanks. In high potential tank districts, the BCR is ranged from 1.26 in Kallakurichi district to 2.02 in Villupuram district, where for medium potential tanks it is ranged from 1.40 in Thiruvallur district to 1.69 in Chengalpattu district.

Table 4.7.District-wise financial feasibility analysis of the package of tank modernization options for high potential tanks

(Rs. in Crores)

District	Cascades (No.)	Tanks (No.)	Total Investment	Total Returns	BCR
Virudhunagar	3	27	5.55	6.72	1.61
Chengalpattu	28	114	42.18	52.73	1.55
Thoothukudi	4	31	23.32	29.15	1.45
Thirunelveli	9	44	10.64	12.66	1.69
Villupuram	7	63	42.99	67.06	2.02
Sivagangai	2	10	2.8	4.59	1.94
Ramanathapuram	4	35	13.4	17.29	1.98
Pudukottai	1	15	6.77	9.95	1.71
Krishnagiri	1	5	1.26	2.12	1.68
Madurai	7	104	22.13	34.52	1.67
Kallakurichi	1	3	4.04	5.09	1.26
Kancheepuram	6	37	7.36	9.86	1.65
Thiruvallur	13	84	18.71	26.38	1.66
Total	86	572	201.15	278.12	1.68

Table. 4.8. District-wise financial feasibility analysis of the package of tank modernization options for medium potential tanks

(Rs. Crores)

District	Cascades (No.)	Tanks (No.)	Total Investment	Total Returns	BCR
Virudhunagar	7	39	21.13	26.20	1.50
Chengalpattu	5	17	8.48	11.11	1.69
Thoothukudi	1	21	19.21	25.55	1.59
Thirunelveli	53	355	31.88	49.73	1.41
Villupuram	2	22	16.27	23.10	1.65
Tenkasi	3	18	3.99	5.15	1.42
Sivagangai	30	170	38.36	49.48	1.44
Ramanathapuram	18	101	62.33	69.19	1.56
Pudukottai	27	259	66.4	78.35	1.49
Krishnagiri	10	47	8.83	11.57	1.60
Madurai	1	15	5.41	7.14	1.65
Kallakurichi	15	59	16.44	20.06	1.53
Kanyakumari	33	204	15.75	20.32	1.44
Kancheepuram	8	66	12.36	16.69	1.52
Thiruvallur	2	6	4.99	6.99	1.40
Total	215	1399	331.83	420.62	1.53

Hence, appropriate tank modernisation interventions under tank cascade approach would benefit largely the tank irrigation management in the state.

5. CONCLUSION AND THE WAY FORWARD

The key research question of the present study is: Why all the tanks in a cascade not getting filled up even during the normal rainfall years?. This study covering 2013 tanks in 315 cascades across 15 tank-intensive districts has made a breakthrough in tank irrigation research by examining the tank filling behaviour in normal rainfall periods of 2020-21. It is found that 54.3 per cent of the tanks had 100 per cent filling, 40.7 per cent of tanks had 75 per cent filling, 4.8 per cent of tanks had 50 per cent filling and the rest 0.2 per cent had deficit filling(less than 50%). The effective storage of tanks shows that tanks receive about 87 per cent of the physical filling. The study on rainfall and tank storage has brought out important observations that would help the policy makers to make appropriate investment options for sustainable management of irrigation tanks in the state. The major conclusions and identified policy options are discussed here.

- The main reasons for the comparatively lesser physical tank filling and low effective storage in normal rainfall periods are siltation in the tank water spread area, poor condition of the sluice, and encroachment in supply channel encroachment. These issues confirm the need for tank modernization. Accordingly, the type of tank modernization activities/strategies needed in different tank filling typologies also vary. The district wise list of Tank Cascades selected for Modernization is given in Appendix. 41. The following tank modernisations are needed.

    - For 100 per cent filling tanks, desilting, and sluice repairing activities are needed to maintain the 100 per cent filling in the future.

    - For 75 per cent filling tanks desilting, supply channel cleaning and sluice repairing activities are needed to keep up the filling up to 100 per cent

    - For 50 per cent filling tanks, supply channel cleaning, and desilting activities are needed to keep up the filling to 75 per cent level and sluice repairing, activities to keep up the filling up to 100 per cent level.

- For the tanks which have less than 50 per cent filling, the study suggests that these tanks may be converted into percolation tanks for groundwater recharge as the issues related to tank filling such as supply channel encroachment, poor water supply, etc., are observed to be seriously embedded with other socio-political issues.

- Among the various tank modernization activities examined for different tank typologies (PU and PWD), the results show that the desilting of tanks and bund strengthening would result in high returns. The IRR is worked out to be 19.50 per cent for high potential tanks and 18.10 per cent for medium potential tanks, whereas the BCR is worked out to be 2.16 and 2.09. The modernisation interventions namely cleaning of supply channel

including desilting and removal of encroachment would result in 14.18 per cent and 13.53 per cent IRR for the high potential and medium potential tanks respectively, whereas the BCR is 1.26 and 1.12 for the above tank typologies. The other tank modernisation options including sluice repair and management, repairing of surplus weir and lining of distributor channels are found to be financially feasible for both tank typologies.

- Even though, within the cascade, both PU and PWD tanks perform the same in terms of filling, the less than 50 per cent filling tanks need not be considered for tank modernisation under cascade approach. Tanks located in the tail end of the cascade may have varying levels of filling (50 to 100 per cent) and this can be addressed when the tank modernization focussing on the entire supply channel cleaning is done. Strengthening the WUAs in the tank cascades is considered to be important as a compliment to the physical tank modernization activities.

- The results also confirm that even with lesser fillings, many tanks perform well mainly due to supplementary water from wells in the command area. Hence, augmenting ground water /well development up to the threshold levels in each tank in the tank cascade should be given priority in future tank modernization programs.

- As indicated only 572 tanks out of 2013 tanks (28 per cent) have high potential for tank modernization (i.e. first-category tanks); 70 per cent are categorized as medium-potential tanks and the remaining 2 per cent are categorized as low-potential tanks. Five different potential options for tank modernisation are identified: (i) desilting of tanks and bund strengthening, (ii) supply channel cleaning including desilting and removal of encroachments, (iii) sluice repair and management, (iv) repairing of surplus weir and (v) lining of distributary channel. The total investment for the above modernization activities is estimated to be around Rs. 564.05 crores. The estimated benefits are high in high-potential tanks than in medium and low-potential tanks. The financial feasibility analysis confirms that the identified tank modernisation interventions are found to be financially feasible across tank typologies. Since the study recommends the cascade approach, it is important to include all the tanks for modernization as the modernization options with different priorities.

- Given the scope of modernization of all the potential tanks in the state (like Kakatia mission in Telangana state), the budget estimate (for a 5-year cycle) will be roughly about Rs.564.05 crores[8].

- The study found that wells in the tank command areas found to be very effective for supplemental irrigation which help to save crops, increase returns and so on. Hence, it is suggested that adequate support may be extended to farmers in the tank dominated situations, particularly in the non-system tank commands for construction of wells.

[8] This was worked out taking into account the cost of combination of first two modernization options of different tank filling typologies

However, it should be carefully noted that the number of wells should not exceed threshold level.

- Water Users Associations (WUAs) to manage and maintain tanks are yet to be more active in resource mobilisation, manage and maintain tanks. Considering the importance of various institutions, in relation to tank management, defining the roles of different organizations is crucial at this stage so as to achieve sustainable management of tanks in the country. This will facilitate developing linkages between different organizations involved in natural resource management, tank management in particular, resolve conflicts and promote proper maintenance and management of tanks. There is also a need for comprehensive and accessible database and inventory of resources that would enable better local level planning. Stable and sufficient financial resources are crucial for better long-term planning and sustainable management of natural resources and tanks in particular.

- **Research:** Research system may be encouraged to evolve crop varieties and water management technologies so as to suit to different types of soils, tank typologies. Research on the effect of irrigation and sustainability of yields under various water saving methods and irrigation technologies may be encouraged. Exploratory and in depth socio-economic research is highly warranted to identify the extent of awareness and knowledge about climate change impacts, adaptation, constraints in adoption of various coping and adaptation strategies, transaction costs in technology adoption and identify policy options for various tank typologies.

- **Capacity building**: Though farmers are aware of impact of climate variability, coping and adaptation strategies, still there is lack of awareness among farmers about water management technologies, irrigation scheduling, best agricultural practices etc. Thus, there is a dire need for building capacity of the farming community. Implement proper educational and training programs for farmers with emphasis on major issues on the involvement of users of water on drought problems, floods, and other extreme events. Also, adequate technical support in water management technologies and cultivation of crops, cropping pattern and crop allocation decisions will help them better cope with climate variability.

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APPENDICES

A.1.Hydraulic features of tank cascades in sample districts

S. No	Name of the District	No. of Cascades	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Water spread area (ac)	Tank Storage capacity (Mcft)	Number of fillings	Number of sluices
1	Chengalpattu	33	130	296.15	285.55	96.42	180.44	18.67	1.84	2.21
2	Kallakurichi	16	62	203.30	175.17	86.16	144.05	20.29	1.83	2.24
3	Kancheepuram	14	104	377.92	293.84	77.75	62.75	22.99	1.06	2.91
4	Krishnagiri	11	53	122.68	115.88	94.46	57.66	15.90	1.89	1.84
5	Thiruvallur	15	93	365.60	359.56	98.35	107.34	20.74	1.59	7.00
6	Villupuram	10	89	203.58	241.65	118.71	138.84	166.61	1.57	2.27
	Average	99	529	261.54	245.28	95.31	115.18	44.20	1.63	3.25
7	Madurai	8	119	171.27	161.77	94.45	82.10	12.21	1.44	2.55
8	Pudukottai	34	284	135.33	117.76	87.02	81.47	6.59	3.35	3.22
9	Ramanathapuram	22	136	295.15	265.80	90.05	323.54	14.50	1.99	4.69
10	Sivagangai	37	188	185.01	161.43	87.25	82.49	..	2.29	3.59
11	Tenkasi	3	18	370.02	355.91	96.19	92.26	1.91	1.93	3.01
12	Thootrhukudi	5	52	284.31	263.83	92.80	158.39	19.83	1.06	3.36
13	Tirunelveli	64	415	94.34	87.29	92.53	52.72	9.46	1.82	1.57
14	Virudhunagar	10	66	220.73	188.68	85.48	147.84	47.93	1.79	2.68
15	Kanyakumari	33	205	30.12	27.38	90.89	1087.61	2.59	2.10	1.29
	Average	216	1484	198.48	181.09	90.74	234.27	14.38	1.97	2.88

A2. Full Tank Filling and Encroachment, Siltation and Tree plantations

S. No.	District	% encroachments in tank catchment		% encroachments in tank foreshore		% encroachment in supply channel		% siltation of the tank water spread area		% Social forestry (acacia trees) still present		% area under Prosophis tree in tank water spread	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD
1	Chengalpattu	5.00	8.06	..	12.43	5.00	11.72	15.00	18.87	..	20.00	30.00	10.52
2	Kallakurichi	..	..	..	0.83	..	5.00	..	15.27	..	..	..	10.45
3	Kancheepuram	1.00	1.04	0.50	0.46	6.50	5.73	17.80	22.81	..	12.00	7.86	6.33
4	Krishnagiri	5.00	5.00	7.86	8.64	5.00	5.00	19.79	20.50	..	..	22.50	11.67
5	Thiruvallur	..	6.18	..	6.25	..	9.00	17.33	15.08	..	8.33	5.00	6.46
6	Villupuram	32.00	19.91	18.33	8.03	11.67	4.13	23.86	26.79	12.50	24.29	19.00	14.52
	Average	8.60	8.04	6.67	6.11	7.04	6.76	18.76	19.89	12.50	16.15	16.87	9.99
7	Madurai	1.86	2.23	1.48	1.85	3.07	3.00	17.50	17.62	3.14	9.31	4.98	7.27
8	Pudukottai	7.50	7.04	8.75	6.38	10.00	5.41	20.89	21.76	..	1.28	17.43	15.89
9	Ramanathapuram	0.97	0.88	0.97	1.13	1.61	1.44	19.00	17.89	..		26.37	24.72
10	Sivagangai	6.67	12.90	1.67	5.16	5.00	5.16	33.33	15.48	..	..	10.00	16.45
11	Tenkasi	5.00	..	..	..	5.00	..	12.00	..	..	..	..	..
12	Thoothukudi	3.13	2.12	2.50	2.88	3.13	3.85	20.63	18.38	..	..	7.75	8.85
13	Tirunelveli	3.99	7.29	4.11	5.83	7.55	8.17	19.52	23.14	..	..	11.98	12.61
14	Virudhunagar	18.33	14.50	6.25	4.49	7.78	8.38	45.00	21.95	..	..	46.11	24.27
15	Kanyakumari	2.64	3.95	1.05	3.26	..	..	14.55	14.00		15.00	0.25	
	Average	5.57	6.36	3.35	3.87	5.39	5.06	22.49	18.78	3.14	8.53	15.61	15.72

A3. 3/4th Tank Filling and Encroachment, Siltation and Tree plantations

S. No.	District	% encroachments in tank catchment		% encroachments in tank foreshore		% encroachment in supply channel		% siltation of the tank water spread area		% Social forestry (acacia trees) still present		% area under Prosophis tree in tank waterspread	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD
1	Chengalpattu	..	12.33	..	14.84	..	18.44	..	17.61	..	5.00	..	17.14
2	Kallakurichi	..	0.77	..	0.21	..	15.51	..	16.06	..	..	..	12.55
3	Kancheepuram	5.00	6.83	..	2.34	14.17	16.14	20.00	19.71	30.00	36.25	5.00	14.63
4	Krishnagiri	6.88	7.22	7.50	10.00	13.13	10.71	22.18	27.30	..	..	20.00	30.00
5	Thiruvallur	..	5.04	..	8.33	..	7.65	..	16.86	..	8.00	..	10.61
6	Villupuram	32.14	17.30	27.83	12.56	30.00	18.08	25.38	29.72	10.00	15.25	14.29	15.88
	Average	14.67	8.25	17.67	8.05	19.010	14.42	22.52	21.21	20.00	16.13	13.10	16.80
7	Madurai	..	7.14	5.00	3.57	5.00	15.71	18.50	15.71	2.50	5.83	10.00	22.14
8	Pudukottai	..	18.06	..	11.63	..	11.78	..	21.98	..	2.53	..	22.15
9	Ramanathapuram	1.25	2.06	1.25	1.18	5.63	7.35	20.88	16.35	..	..	26.88	19.71
10	Sivagangai	2.38	9.21	2.38	3.41	18.24	17.10	15.62	18.02	..	10.00	21.06	17.59
11	Tenkasi	18.75	8.83333	10.50	11	11.67	15	30.00	30.2857	..	..	5.00	8.4
12	Thoothukudi	4.00	4.58	2.00	3.75	12.00	7.08	17.80	20.33	..	..	6.60	17.67
13	Tirunelveli	4.80	5.20	4.27	5.74	6.66	8.02	18.80	22.83	0.09	1.02	13.07	12.38
14	Virudhunagar	..	19.67	0.00	6.00	..	4.67	10.00	23.40	..	..	50.00	31.33
15	Kanyakumari	1.71	10.00	2.91	3.75	7.00	7.50	11.46	12.50	..	..	0.07	5.00
	Average	5.48	9.42	4.04	5.56	9.46	10.47	17.88	20.16	1.29	4.84	16.58	17.37

A4.Half Tank Filling and Encroachment, Siltation and Tree plantations

S. No.	District	% encroachments in tank catchment		% encroachments in tank foreshore		% encroachment in supply channel		% siltation of the tank water spread area		% Social forestry (acacia trees) still present		% area under Prosophis tree in tank water spread	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD
1	Chengalpattu	..	10.00	..	12.50	..	60.00	..	20.00	..	..	..	10.00
2	Kallakurichi	..	..	..	2.50	..	30.00	..	17.00	..	..	..	22.50
3	Kancheepuram	..	2.00	..	1.00	..	41.00	..	15.60	..	30.00	..	23.33
4	Krishnagiri	..	52.50	..	10.00	..	17.50	..	70.00	..	..	..	25.00
5	Thiruvallur	..	10.50	..	5.00	..	1.88	..	18.00	..	10.00	..	11.00
6	Villupuram	3.50	26.25	50.00	26.00	70.00	58.75	65.00	34.38	5.00	7.50	32.50	21.43
	Average	3.50	20.25	50.00	9.50	70.00	34.85	65.00	29.14	5.00	15.83	32.50	18.88
7	Madurai	10.00	..	..	..	25.00	..	30.00	..	40.00	..	5.00	..
8	Pudukottai	20.00	31.90	30.00	21.67	25.00	25.33	5.00	23.95	10.00	1.67	25.00	28.33
9	Ramanathapuram	..	..	..	..	..	..	..	..	..	..	..	..
10	Sivagangai	..	10.00	..	1.25	31.67	45.00	13.33	23.75	..	..	16.67	21.25
11	Tenkasi	..	..	..	..	..	..	..	..	..	..	..	..
12	Thoothukudi	..	5.00	..	5.00	..	50.00	..	20.00	..	..	..	5.00
13	Tirunelveli	13.53	5.00	8.18	5.00	17.31	8.75	19.29	20.25	..	7.50	10.30	12.50
14	Virudhunagar	..	..	..	..	..	..	..	..	..	..	..	..
15	Kanyakumari	..	..	..	..	..	..	..	..	..	..	..	..
	Average	14.51	12.98	9.09	8.23	24.74	32.27	16.91	21.99	25.00	4.58	14.24	16.77

A5. Less than half Tank Filling and Encroachment, Siltation and Tree plantations

S. No	District	% encroachments in tank catchment		% encroachments in tank foreshore		% encroachment in supply channel		% siltation of the tank water spread area		% Social forestry (acacia trees) still present		% area under Prosophis tree in tank waterspread	
		PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD	PU	PWD
1	Chengalpattu	..	..	..	..	..	..	..	..	..	..	..	..
2	Kallakurichi	..	..	..	..	..	..	..	..	..	..	..	..
3	Kancheepuram	..	..	..	..	..	..	..	..	..	..	..	..
4	Krishnagiri	..	..	..	..	..	..	..	..	..	..	..	..
5	Thiruvallur	..	..	..	..	..	..	..	..	..	..	..	..
6	Villupuram	..	..	..	..	..	..	..	..	..	..	..	..
7	Madurai	..	..	..	..	..	..	..	..	..	..	..	..
8	Pudukottai	..	..	..	..	..	..	..	..	..	..	..	..
9	Ramanathapuram	..	..	..	..	..	..	..	..	..	..	..	..
10	Sivagangai	..	..	..	..	..	..	..	..	..	..	..	..
11	Tenkasi	..	..	..	..	..	..	..	..	..	..	..	..
12	Thoothukudi	..	..	..	..	..	..	..	..	..	..	..	..
13	Tirunelveli	5.00	0.00	..	0.00	..	10.00	18.50	10.00	..	..	..	..
14	Virudhunagar	..	..	..	..	..	..	..	..	..	..	..	..
15	Kanyakumari	..	..	..	..	..	..	..	..	..	..	..	..
	Average	5.00	0.00	..	0.00	..	10.00	18.50	10.00				

A6.. Tank performance influencing factors of tank cascades in sample districts

S. No	Name of the District	No. of Cascades	No. of Tanks Surveyed	Tank filling %	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% siltation of the tank water spread area	% Social forestry	% area under Prosophis tree in tank waterspread	4. Number of wells	Number of functioning wells
1	Chengalpattu	33	130	93.85				18.48			15.00	14.92
2	Kallakurichi	16	62	85.11						12.40	18.07	17.67
3	Kancheepuram	14	104	89.41	2.90	1.26	12.14	21.82			12.11	11.85
4	Krishnagiri	11	53	90.51	9.76			25.86			28.26	25.81
5	Thiruvallur	15	93	84.19				15.64		9.44	13.50	13.30
6	Villupuram	10	89	86.89	20.69	14.46	28.34	30.02	14.23	16.93	46.97	38.32
	Average	99	529	88.33	11.12	7.86	20.24	22.37	14.23	12.93	24.06	21.73
7	Madurai	8	119	97.55	2.45	1.76	4.08	17.64	7.12	7.30	14.31	12.33
8	Pudukottai	34	284	89.21				22.36		19.57		
9	Ramanathapuram	22	136	96.68	1.13	0.90	3.21	17.51		22.84		
10	Sivagangai	37	188	83.29					17.88		8.01	7.01
11	Tenkasi	3	18	82.42	12.29		13.52	33.50		6.13	155.60	155.60
12	Thoothukudi	5	52	95.92	2.82	2.27	5.71	18.49	0.00	9.11	2.05	2.05
13	Tirunelveli	64	415	87.23				19.61			8. 68	8. 57
14	Virudhunagar	10	66	94.78	15.43	4.37	6.80	24.78		30.61	35.99	35.91
15	Kanyakumari	33	205	95.46	1.45	1.28		13.42			3.26	3.26
	Average	216	1484	91.39	5.93	2.11	6.66	20.91	8.33	15.93	36.95	32.20

A7.HydraulicFeatures of tank cascades in Chengalpattu district

S.No	Name of the tank cascade	No. of Cascades	Registered Ayacut Area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Acharavakkam	5	300.65	285.40	94.93	100.00	21.68
2	Adavilagam	3	197.93	190.33	96.16	96.67	21.76
3	Anumanthapuram	3	399.37	379.67	95.07	96.67	13.88
4	Kaatoor	3	510.67	496.00	97.13	100.00	60.75
5	Kaatrampalli cascade	2	592.00	585.00	98.82	100.00	9.53
6	Kalanipakkam tank cascade	2	103.20	100.00	96.90	95.00	7.06
7	Karumbakkam	2	136.65	127.50	93.30	100.00	9.33
8	Kothimangalam	5	191.34	175.60	91.77	100.00	12.50
9	Kunnavakkam tank cascade	4	106.50	99.75	93.66	100.00	7.92
10	Lower palar basin	7	248.58	241.43	97.12	97.86	7.26
11	Mambakkam	2	744.50	720.00	96.71	100.00	7.59
12	Marutheri	6	404.45	387.00	95.69	94.17	55.19
13	Nallanpillaipetralperiyaeri	2	159.29	140.00	87.89	90.00	7.42
14	Narapakkam tank cascade	4	171.87	165.75	96.44	100.00	12.61
15	Nenmeliperiyaeri	10	403.97	348.00	86.15	84.50	41.65
16	Orakadam	2	311.15	300.00	96.42	95.00	25.73
17	Periyairumbedu	2	168.95	165.00	97.66	100.00	10.42
18	Porunthavakkam cascade	2	751.70	741.00	98.58	77.50	30.19
19	Pulikundram tank	3	123.57	118.00	95.50	95.00	11.18
20	Sembakkam	5	471.72	447.60	94.89	81.00	36.57
21	Sooradimangalam cascade	5	238.00	228.00	95.80	90.00	12.29
22	Thirukalukundram tank	10	287.72	281.00	97.66	90.50	9.06
23	Arungundramperiyaeri	3	155.78	145.67	93.51	90.00	14.12
24	Veerapuram	2	366.69	361.00	98.45	100.00	4.81
25	Kayaru cascade	4	699.54	648.00	92.63	86.25	37.68
26	Thunjam tank cascade	3	138.89	134.67	96.96	93.33	10.87
27	Venbedu cascade	7	238.39	229.29	96.18	94.29	8.59
28	Vengampakkam	4	199.04	192.50	96.72	88.75	9.18
29	Karumarapakkamperiyaeri	3	145.97	137.33	94.09	96.67	12.12
30	Kadumbadi	5	240.40	265.20	110.32	79.00	18.65
31	Salurthangal	5	186.60	339.40	181.89	90.00	10.58
32	Mannivakkam cascade	2	173.50	50.50	29.11	95.00	48.20
33	Thalambedu tank cascade	3	204.49	197.67	96.66	100.00	9.77
	Average		296.15	285.55	96.39	93.85	18.67

A8. Tank performance influencing factors of tank cascades in Chengalpattu district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Acharavakkam	5	11.00	14.00	23.00		0.00	0.05
2	Adavilagam	3.00	5.00	5.00	5.00			0.00
3	Anumanthapuram	3.00	15.00	22.50	15.00			0.01
4	Kaatoor	3.00	15.00	20.00	18.33			0.01
5	Kaatrampalli	2.00	10.00	15.00	20.00			0.02
6	Kalanipakkam tank	2.00	15.00	20.00	25.00			0.06
7	Karumbakkam	2.00	10.00	15.00	19.00		10.00	0.05
8	Kothimangalam	5.00	9.00	14.00	18.00		6.00	0.04
9	Kunnavakkam tank	4.00			5.00			0.00
10	Lower palar basin	7.00	10.00	16.25	20.00		10.00	0.00
11	Mambakkam	2.00	7.50	12.50	17.50			0.01
12	Marutheri	6.00	15.00	22.50	16.67		17.50	0.01
13	Nallanpillaipetralperiyaeri	2.00	5.00	7.50	10.00		10.00	0.02
14	Narapakkam tank	4.00	5.00		5.00			0.01
15	Nenmeliperiyaeri	10.00	8.40	17.50	17.00			0.04
16	Orakadam	2.00	15.00	20.00	10.00		0.00	0.01
17	Periyairumbedu	2.00	7.50	12.50	5.00		0.00	0.03
18	Porunthavakkam	2.00	5.00	10.00	15.00		20.00	0.01
19	Pulikundram tank	3.00	5.00	10.00	10.00			0.01
20	Sembakkam	5.00	13.75	15.00	21.25			0.01
21	Sooradimangalam	5.00	6.00	2.40	10.00	5.00	8.00	0.07
22	Thirukalukundram tank cascade	10.00	10.83	16.00	11.25		25.00	0.04
23	Arungundramperiyaeri	3.00	8.33	15.00	13.33		31.67	0.01
24	Veerapuram	2.00	2.00				12.50	0.16
25	Kayaru	4.00	10.67	11.67	15.00		27.50	0.01
26	Thunjam tank	3.00	5.00	5.00	5.00			0.04
27	Venbedu	7.00	11.43	15.00	9.29		16.67	0.01
28	Vengampakkam	4.00	11.67	11.67	18.33			0.04
29	Karumarapakkamperiyaeri	3.00	3.33	1.67	5.00		0.00	0.00
30	Kadumbadi	5.00	10.00	18.33	21.67		23.33	0.02
31	Salurthangal	5.00	7.00	5.00	90.00	20.00		0.02
32	Mannivakkam	2.00	15.00	10.00			2.00	1.46
33	Thalambedu tank	3.00			5.00		50.00	0.09
	Average		9.30	13.14	16.12	12.50	14.22	0.07

A9.Hydraulic Features of tank cascades in Kallakurichi district

S. No.	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Alathur cascade	3	388.70	331.00	85.16	88.33	12.37
2	Emapair cascade	4	214.99	186.25	86.63	75.00	28.48
3	Eriyur cascade	3	122.59	104.33	85.11	90.00	12.68
4	Kalathur cascade	3	253.60	217.33	85.70	95.00	28.02
5	Killiyur cascade	3	152.19	130.00	85.42	85.00	14.83
6	Kumaramangalam cascade	3	144.27	133.33	92.42	78.33	19.28
7	Nagalur cascade	3	351.33	298.33	84.91	90.00	13.24
8	Neelamangalam cascade	9	151.34	124.56	82.30	84.44	17.51
9	Orathur cascade	3	171.40	146.00	85.18	91.67	40.07
10	Pallagacheri cascade	2	227.63	193.50	85.01	80.00	34.73
11	Pasungayamangalam cascade	8	154.57	134.88	87.26	79.38	9.52
12	Pinnalvadi cascade	4	133.44	113.75	85.25	82.50	24.81
13	U Keeranur cascade	4	298.81	273.75	91.61	88.75	25.02
14	Udayampattu cascade	3	120.87	101.67	84.11	83.33	6.82
15	Ulundur cascade	3	144.35	125.00	165.67	85.00	2.00
16	Vellar basin cascade	4	222.70	189.00	84.87	85.00	35.20
		62	203.30	175.17	86.16	85.11	20.29

A10. Tank performance influencing factors of tank cascades in Kallakurichi district

S. No.	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Alathur cascade	3	0.00	0.00	13.33		16.67	0.06
2	Emapair cascade	4	0.00	0.00	21.25		13.75	0.06
3	Eriyur cascade	3	0.00	0.00	6.67		6.67	0.11
4	Kalathur cascade	3	0.00	0.00	6.67		10.00	0.05
5	Killiyur cascade	3	5.00		11.67		5.00	0.12
6	Kumaramangalam cascade	3			16.67		13.33	0.15
7	Nagalur cascade	3	5.00		6.67		15.00	0.05
8	Neelamangalam cascade	9		5.00	15.56		12.22	0.13
9	Orathur cascade	3			8.33		16.67	0.09
10	Pallagacheri cascade	2			17.50		15.00	0.04
11	Pasungayamangalam cascade	8	0.63	0.00	20.63		15.00	0.12
12	Pinnalvadi cascade	4	0.00	0.00	13.75		15.00	0.15
13	U Keeranur cascade	4	0.00	0.00	11.25		10.00	0.13
14	Udayampattu cascade	3			16.67		8.33	0.12
15	Ulundur cascade	3	5.00	13.33		11.67	13.33	0.05
16	Vellar basin cascade	4		5.00	12.50		12.50	0.09
		62	1.56	2.33	13.27	11.67	12.40	0.09

A11. Hydraulic Features of tank cascades in Kancheepuram district

S. No.	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Kambakal channel cascade	10	336.62	323.80	96.19	91.00	5.33
2	Ekanapuramkadappanthangal cascade	4	316.94	300.50	94.81	85.00	3.98
3	Kannan thangal Cascade	4	159.93	141.50	88.48	97.50	8.29
4	Keeranallur cascade (kambakkal)	3	158.69	142.33	89.69	93.33	13.89
5	Maduramangalam cascade	6	226.70	226.67	99.98	91.67	2.64
6	Mambakkam section (Kambakal)	6	245.84	235.50	95.79	84.17	26.34
7	MelkathirpurHissa cascade	3	386.09	365.67	94.71	86.67	24.72
8	Pudhupattu section (Kambakal channel)	3	230.23	214.33	93.09	73.33	6.71
9	Singalpadi section (Kambakkal channel)	3	573.04	120.00	20.94	91.67	1.73
10	Thenneri cascade	11	847.42	309.10	36.48	97.27	36.52
11	Thenneri cascade(kattavakkam)	16	368.95	359.56	97.46	93.44	27.71
12	Thenneri cascade (podavoor)	20	360.48	336.65	93.39	88.25	26.64
13	Ullavur maduvu cascade	10	464.25	434.20	93.53	90.50	52.69
14	Vegavathi cascade	5	615.67	604.00	98.11	88.00	84.69
		104	377.92	293.84	84.06	89.41	22.99

A12. Tank performance influencing factors of tank cascades in Kancheepuram district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry (acacia trees) still present	% area under Prosophis tree in tank waterspread	no. of wells / ac
1	Kambakal channel cascade	10	0.50	2.00	12.50		8.75	0.00
2	Ekanapuramkadappanthangal cascade	4	0.00	1.00	8.75	12.00	12.50	0.00
3	Kannan thangal Cascade	4	1.25	0.00	12.50		9.00	0.00
4	Keeranallur cascade (kambakkal)	3	11.67	6.67	6.67			0.02
5	Maduramangalam cascade	6	0.00	0.00	9.17		16.67	0.00
6	Mambakkam section (Kambakal)	6	3.33	0.83	15.00		13.00	0.00
7	MelkathirpurHissa cascade	3	0.00	0.00	13.33		20.00	0.17
8	Pudhupattu section (Kambakal channel)	3	3.33	1.67	31.67	30.00	7.50	0.00
9	Singalpadi section (Kambakkal channel)	3	0.00	0.00	10.00		5.00	0.00
10	Thenneri cascade	11	0.00	0.00	8.18		2.73	0.00
11	Thennericascade(kattavakkam)	16	3.13	0.94	10.63	20.00	7.31	0.05
12	Thenneri cascade (podavoor)	20	7.45	1.50	13.50	35.00	10.83	0.07
13	Ullavur maduvu cascade	10	3.00	0.00	7.00		14.17	0.02
14	Vegavathi cascade	5	7.00	3.00	11.00	50.00	12.50	0.06
		104	2.90	1.26	12.14	29.40	10.77	0.03

A13.Hydraulic Features of tank cascades in Krishnagiri district

S. No.	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Bandapalli	3	86.67	76.67	88.46	96.67	0.00
2	Barur cascade	16	253.94	241.50	95.10	95.31	5.06
3	Jeenureri	2	105.00	101.50	96.67	90.00	0.00
4	Karim shahib	3	128.39	125.00	97.36	80.00	140.08
5	Left main canal	5	273.00	258.40	94.65	91.00	10.36
6	Nedumaruthueri	3	204.67	190.00	92.83	83.33	0.00
7	Pennaiyar river	2	88.03	86.00	97.69	95.00	6.93
8	Pennaiyar river (rmc) ii	3	19.40	18.67	96.20	93.33	2.40
9	Pennaiyar river (RMC) IV	5	41.82	40.60	97.09	95.00	2.64
10	Pennaiyar river (RMC) III	5	84.37	73.80	87.47	86.00	1.74
11	Right main canal (RMC) I	6	64.16	62.50	97.42	90.00	5.67
		53	122.68	115.88	94.46	90.51	15.90

A14. Tank performance influencing factors of tank cascades in Krishnagiri district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Bandapalli	3	10.00			31.67	0.46
2	Barur cascade	16	4.55	7.69	5.42	0.00	0.04
3	Jeenureri	2	10.00	5.00	15.00	25.00	0.48
4	Karim shahib	3	38.33	7.50	16.67	25.00	0.12
5	Left main canal	5	5.00	12.50	7.50	10.00	0.16
6	Nedumaruthueri	3	5.00	10.00	5.00	53.33	0.21
7	Pennaiyar river	2	10.00	7.50	7.50		0.14
8	Pennaiyar river (rmc) ii	3	7.50	10.00	15.00	10.00	0.53
9	Pennaiyar river (RMC) IV	5	5.00	8.75	8.33		0.39
10	Pennaiyar river (RMC) III	5	5.00	8.33	11.67	10.00	0.33
11	Right main canal (RMC) I	6	7.00	10.00	11.00		0.24
		53	9.76	8.73	10.31	20.63	0.21

A15. Hydraulic Features of tank cascades in Thiruvallur district

S. No.	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Adigathur cascade	4	200.85	200.25	99.70	100.00	17.91
2	Ekkadu cascade	8	285.81	284.00	99.37	78.75	2.31
3	Govindamedu tank cascade	11	262.99	250.64	95.30	79.55	4.76
4	Kakkalur cascade	5	283.54	282.80	99.74	91.00	0.44
5	Kannur tank cascade	5	277.58	276.60	99.65	74.00	6.95
6	Koramangalam cascade	10	154.62	139.50	90.22	97.50	48.55
7	Pudhumavilangai cascade	9	197.31	182.11	92.30	82.22	13.41
8	Putlur cascade	4	404.75	404.75	100.00	80.00	0.47
9	Selai cascade	4	303.50	303.50	100.00	80.00	6.09
10	Sirugumi cascade	4	117.64	113.50	96.48	92.50	9.54
11	Keelanur	2	1302.50	1302.50	100.00	77.50	90.37
12	Keelmuthalambedu	9	362.62	354.33	97.72	82.22	18.04
13	Vanjivakkam cascade	7	311.64	294.86	94.61	82.14	35.08
14	Kooduvanjeri	7	331.01	322.00	97.28	84.29	18.56
15	Medur	4	687.64	682.00	99.18	81.25	38.63
		93	365.60	359.56	98.35	84.19	20.74

A16. Tank performance influencing factors of tank cascades in Thiruvallur district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry (acacia trees) still present	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Adigathur cascade	4	3.33	3.33	1.00		2.50	0.00
2	Ekkadu cascade	8	10.86	7.86	11.43	10.00	10.25	0.02
3	Govindamedu tank cascade	11	7.50	7.50	2.50		9.09	0.00
4	Kakkalur cascade	5	1.00	6.00	2.00		5.00	0.04
5	Kannur tank cascade	5					21.25	-0.01
6	Koramangalam cascade	10	5.00	5.00	0.00		6.11	0.01
7	Pudhumavilangai cascade	9	20.00	19.00	21.25		10.00	0.01
8	Putlur cascade	4	0.00	0.00	0.25	5.00	8.75	0.01
9	Selai cascade	4	15.00	13.33	5.00		27.50	0.02
10	Sirugumi cascade	4	2.50	3.75	1.25		7.50	0.05
11	Keelanur	2	7.50	10.00	20.00	7.50	7.50	0.77
12	Keelmuthalambedu	9	6.00	8.33	8.75	10.00	5.71	0.00
13	Vanjivakkamcascade	7	3.00	2.00	5.00	7.50	8.00	0.01
14	Kooduvanjeri	7	3.33	6.25	6.00	12.00	5.83	0.00
15	Medur	4	5.00	7.50	15.00	5.00	6.67	0.03
		93	6.43	7.13	7.10	8.14	9.44	0.22

A17. Hydraulic Features of tank cascades in Villupuram district

S. No.	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Alangal cascade	7	333.42	292.09	87.60	87.14	122.34
2	Gangavaram cascade	15	185.75	180.86	97.37	97.00	67.56
3	Nannadu cascade	5	180.10	174.43	96.85	78.00	15.12
4	Palliyandur cascade	8	172.40	171.10	99.24	90.00	82.83
5	Pamboondi cascade	7	277.71	292.86	105.45	89.29	38.49
6	RadhapuramIyyanar cascade	13	81.39	79.15	97.25	91.92	187.04
7	Sembakkam cascade	5	189.12	536.00	283.42	81.00	17.04
8	Tirukoilur tank cascade	8	254.83	248.63	97.56	85.63	707.12
9	Tirukoilur tank cascade	9	166.07	163.11	98.22	93.89	408.42
10	Kambur cascade	12	194.97	278.33	142.76	75.00	20.18
		89	203.58	241.65	118.71	86.89	166.61

A18. Tank performance influencing factors of tank cascades in Villupuram district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry (acacia trees) still present	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Alangal cascade	7	19.29	17.14	15.71	11.67	25.83	0.00
2	Gangavaram cascade	15	18.93	5.00	5.38	43.33	9.62	0.06
3	Nannadu cascade	5	12.50	11.25	34.00	20.00	16.67	0.16
4	Palliyandur cascade	8	17.50	14.40	15.00	10.00	10.00	0.23
5	Pamboondi cascade	7	24.14	20.67	62.50	18.50	22.57	0.28
6	RadhapuramIyyanar cascade	13	28.00	22.50	13.75	15.00	23.00	0.01
7	Sembakkam cascade	5	29.40	15.00	70.00	0.00	20.00	0.85
8	Tirukoilur tank cascade	8	15.63	9.00	13.75	8.75	13.57	0.07
9	Tirukoilur tank cascade	9	16.11	7.78	8.33	5.00	8.13	0.09
10	Kambur cascade	12	25.42	21.88	45.00	10.00	19.91	0.17
		89	20.69	14.46	28.34	14.23	16.93	0.19

A19. Hydraulic Features of tank cascades in Madurai district

S.No	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Ayanarkulam tank cascade	13	160.86	149.23	92.77	96.15	17.84
2	Kallanai cascade	21	197.63	182.19	92.19	100.0	10.09
3	Melakkal cascade	10	154.68	146.10	94.45	92.50	10.03
4	Periyarvaigai basin	12	422.23	409.42	96.97	97.92	29.94
5	PMC maincanelcascade	15	94.64	87.33	92.28	100.0	2.73
6	Uppar Sub basin cascade	15	58.54	60.73	103.75	100.0	0.91
7	Valandur tank cascade	18	142.87	131.67	92.16	97.50	15.95
8	Vikkramangalam cascade	15	138.68	127.47	91.92	96.33	10.15
		119	171.27	161.77	94.45	97.55	12.21

A20. Tank performance influencing factors of tank cascades in Madurai district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry (acacia trees) still present	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Ayanarkulam tank cascade	13	3.85	1.92	4.23	16.31	17.08	0.03
2	Kallanai cascade	21	1.90	3.57	3.57	5.71	8.95	0.01
3	Melakkal cascade	10	3.50	1.00	5.00	9.50	7.50	0.26
4	Periyarvaigai basin	12	2.08	1.67	5.42	7.33	3.58	0.02
5	PMC maincanel cascade	15	0.47	0.00	0.67	0.67	1.33	0.02
6	Uppar Sub basin cascade	15	1.67	0.33	4.33	0.00	1.33	0.02
7	Valandur tank cascade	18	4.17	0.56	4.72	13.61	11.83	0.32
8	Vikkramangalam cascade	15	2.00	5.00	4.67	3.85	6.80	0.09
		119	2.45	1.76	4.08	7.12	7.30	0.08

A21.Hydraulic Features of tank cascades in Pudukottai district

S.No	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Aavudayarkoil cascade	11	340.45	333.18	97.87	88.18	21.83
2	Chittampattikanmoi Cascade	11	58.23	44.55	76.50	92.27	3.24
3	Edayankulam cascade	4	183.90	153.50	83.47	95.00	10.81
4	Kadiyakulam	5	89.74	85.20	94.94	90.00	4.11
5	Kavinadu cascade	5	39.79	37.50	94.24	98.00	0.81
6	Konnaikulam	4	62.42	57.25	91.72	93.75	0.08
7	Manaluranaicut cascade	11	169.61	157.09	92.62	77.73	2.65
8	Manamelgudi cascade	4	275.99	228.15	82.67	100.00	0.35
9	Maniyavayalkulam cascade	5	115.28	88.00	76.34	79.00	2.85
10	Melnilaikanmai cascade	7	80.78	65.00	80.46	100.00	6.08
11	Mirattunilai cascade	10	158.00	147.00	93.04	74.50	4.39
12	Muthaneri cascade	6	38.02	31.50	82.85	86.67	6.17
13	NanjurPeriyakulam cascade	6	227.83	188.20	82.60	78.00	6.13
14	Narasinga Cauveri Channel	20	47.81	33.95	71.01	95.25	2.36
15	NarpavalakudiAnaicut cascade	12	116.41	115.92	99.58	85.42	10.11
16	Olliyamangalam cascade	11	196.27	189.91	96.76	96.36	9.21
17	PanangulamAnaicut cascade	3	110.45	103.67	93.86	91.67	0.08
18	Panchathianaicut cascade	10	89.46	49.30	55.11	99.00	0.23
19	Pudunilai cascade	8	90.62	74.88	82.63	89.38	3.91
20	RajakiriKakakudikulam cascade	4	210.02	180.75	86.06	72.50	4.00
21	Sethukanmai cascade	10	135.53	121.30	89.50	90.00	16.34
22	Therkuperambikulam cascade	10	107.74	81.60	75.74	78.50	1.84
23	Thuvar big tank cascade	14	76.42	59.93	78.42	92.14	5.76
24	Valayan cascade	3	101.24	84.67	83.63	80.00	0.76
25	Vallanadukanmoi cascade	7	141.48	132.00	93.30	97.14	1.40
26	Vilathikulam cascade	7	187.69	140.00	74.59	85.00	21.08
27	Visalurvisalikulam cascade	4	203.46	162.25	79.74	68.75	11.96
28	Edayarkulam	3	265.23	258.33	97.40	100.00	23.88
29	Embakottaiyur	3	148.02	116.67	78.82	100.00	11.41
30	Mekkakulam cascade	4	96.57	90.00	93.20	75.00	0.14
31	Rethinakottai	18	82.78	79.00	95.44	100.00	12.41
32	Sethukulam cascade	27	161.59	141.63	87.65	99.07	11.11
33	Theethankudipudukulam	2	76.10	67.00	88.05	85.00	1.41
34	Veeramangalamanaicut cascade	15	116.17	105.07	90.44	100.00	5.02
		284	135.33	117.76	87.02	89.21	6.59

A22. Tank performance influencing factors of tank cascades in Pudukottai district

S. No.	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry (acacia trees)	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Aavudayarkoil cascade	11	11.36	16.82	11.09	1.55	16.36	0.00
2	Chittampattikanmoi Cascade	11	21.36	6.82	7.27	0.00	20.45	0.23
3	Edayankulam cascade	4	26.25	21.25	6.25	0.00	43.75	0.07
4	Kadiyakulam	5	3.00	10.00	8.40	0.00	17.00	0.00
5	Kavinadu cascade	5	13.00	13.00	5.40	0.00	17.00	0.20
6	Konnaikulam	4	2.50	0.00	13.25	0.00	16.25	0.04
7	Manaluranaicut cascade	11	10.45	18.18	16.82	4.27	21.36	0.00
8	Manamelgudi cascade	4	3.75	7.50	0.00	1.25	13.75	0.00
9	Maniyavayalkulam cascade	5	19.00	12.00	25.00	8.00	15.00	0.19
10	Melnilaikanmai cascade	7	13.57	11.43	2.14	0.00	13.57	0.12
11	Mirattunilai cascade	10	16.50	11.50	15.00	0.00	19.50	0.00
12	Muthaneri cascade	6	20.00	13.33	10.83	0.00	13.33	0.26
13	NanjurPeriyakulam cascade	6	18.00	12.00	8.00	0.00	15.00	0.11
14	Narasinga Cauveri Channel	20	7.00	4.75	3.00	0.75	19.15	0.00
15	NarpavalakudiAnaicut	12	21.67	15.00	15.00	6.67	15.00	0.00
16	Olliyamangalam cascade	11	2.73	1.36	3.18	7.73	16.27	0.14
17	PanangulamAnaicut	3	8.33	3.33	15.00	0.00	12.33	0.00
18	Panchathianaicut cascade	10	3.50	2.00	4.50	0.00	15.50	0.00
19	Pudunilai cascade	8	15.63	4.38	11.25	0.00	20.00	0.06
20	RajakiriKakakudikulam	4	25.00	20.00	6.25	1.25	45.00	0.25
21	Sethukanmai cascade	10	14.00	7.50	11.00	0.00	27.00	0.19
22	Therkuperambikulam	10	26.00	17.00	12.50	0.00	47.00	0.23
23	Thuvar big tank cascade	14	9.29	6.07	6.57	5.00	19.64	0.24
24	Valayan cascade	3	21.67	8.33	5.00	0.00	10.00	0.08
25	Vallanadukanmoi cascade	7	2.86	0.00	0.00	0.00	15.71	0.00
26	Vilathikulam cascade	7	17.86	10.71	11.43	2.14	13.57	0.16
27	Visalurvisalikulam cascade	4	25.00	21.25	11.25	0.00	11.25	0.23
28	Edayarkulam	3					23.33	0.00
29	Embakottaiyur	3					20.00	0.00
30	Mekkakulam cascade	4	11.25	5.00	18.75		15.50	0.00
31	Rethinakottai	18	7.00	12.00	15.83		16.92	0.00
32	Sethukulam cascade	27	7.33	3.21	4.05		5.89	0.01
33	Theethankudipudukulam	2	35.00	17.50	30.00		35.00	0.08
34	Veeramangalamanaicut	15	8.13	14.38	15.63		19.07	0.00
		284	14.00	10.24	10.30	1.43	19.57	0.08

A23.Hydraulic Features of tank cascades in Ramanathapuram district

S. No.	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Aavarendhal	4	132.17	113.00	85.50	100.00	22.22
2	Athiuthu	2	232.51	212.00	91.18	85.00	0.36
3	Chinnaidambadal	3	332.80	283.00	85.04	91.67	5.50
4	Devipattinam cascade	5	161.64	143.00	88.47	92.00	14.59
5	Ettivayal cascade	7	206.95	183.00	88.43	100.00	18.84
6	Kaakanendhal	4	203.66	187.00	91.82	100.00	35.58
7	Karuthanendhal	13	129.58	111.31	85.90	97.69	11.54
8	Kavarangulam	3	194.65	172.67	88.71	100.00	7.00
9	Landhai	2	968.43	940.50	97.12	85.00	6.11
10	Madhavanur	8	201.94	185.38	91.80	97.50	17.97
11	Melnaatar kaal	5	280.33	238.60	85.11	98.00	22.95
12	Paranur cascade - I	10	92.44	78.20	84.59	100.00	8.27
13	Paranur cascade - II	8	156.38	133.38	85.29	100.00	2.27
14	Poovilathur	2	123.81	109.00	88.04	100.00	13.56
15	Pullangudi	5	341.56	298.60	87.42	100.00	29.58
16	Ramanathapuram big tank	4	1175.68	1135.00	96.54	92.50	3.99
17	Ramanathapuram channel	26	200.42	171.00	85.32	87.50	23.47
18	RS Managalam big tank -II	8	799.73	675.75	84.50	100.00	18.23
19	RS Managalam big tank-I	9	125.06	106.00	84.76	100.00	4.85
20	Sakkaravanallur	2	157.07	142.50	90.72	100.00	7.73
21	Thennavanur	3	153.10	124.00	81.00	100.00	31.42
22	Vairavanendhal	3	123.48	104.67	84.77	100.00	12.92
		136	295.15	265.80	90.05	96.68	14.50

A24. Tank performance influencing factors of tank cascades in Ramanathapuram district

S.No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social fore stry	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Aavarendhal	4	2.50	2.50	5.00		22.50	0.00
2	Athiuthu	2	0.00	0.00	15.00		22.50	0.00
3	Chinnaidambadal	3	5.00	1.67	8.33		16.67	0.00
4	Devipattinam cascade	5	0.00	1.00	6.00		22.00	0.00
5	Ettivayal cascade	7	2.14	5.00	4.29		41.43	0.00
6	Kaakanendhal	4	0.00	0.00	1.25		25.00	0.00
7	Karuthanendhal	13	1.15	1.54	2.69		38.46	0.00
8	Kavarangulam	3	0.00	1.67	0.00		28.33	0.00
9	Landhai	2	0.00	0.00	7.50		32.50	0.00
10	Madhavanur	8	0.63	0.00	1.25		9.38	0.00
11	Melnaatar kaal	5	1.00	0.00	3.00		12.00	0.00
12	Paranur cascade - I	10	0.50	1.00	0.50		25.00	0.00
13	Paranur cascade - II	8	0.00	1.25	1.25		25.00	0.00
14	Poovilathur	2	2.50	0.00	0.00		5.00	0.00
15	Pullangudi	5	1.00	1.00	0.00		27.50	0.00
16	Ramanathapuram big tank	4	1.25	1.25	6.25		23.75	0.00
17	Ramanathapuram channel	26	1.35	1.35	1.35		25.96	0.00
18	RS Managalambig tank -II	8	0.63	0.00	0.63		17.00	0.00
19	RS Managalam big tank-I	9	1.11	0.56	3.89		24.22	0.00
20	Sakkaravanallur	2	2.50	0.00	2.50		20.00	0.00
21	Thennavanur	3	0.00	0.00	0.00		18.33	0.00
22	Vairavanendhal	3	1.67	0.00	0.00		20.00	0.00
		136	1.13	0.90	3.21		22.84	0.00

A25. Hydraulic Features of tank cascades in Sivagangai district

S. No.	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Amarani cascade	8	52.45	50.88	97.00	81.25	7.21
2	Anaiperiyakanmoi	3	43.88	30.33	69.14	78.33	
3	Bagani cascade	3	125.95	106.33	84.43	75.00	11.58
4	Cheyyalur cascade	8	158.15	133.38	84.33	85.63	1.05
5	Chokkanaranyana cascade	10	46.98	45.30	96.43	74.50	4.79
6	Egaraikottavayal cascade	15	115.20	104.93	91.09	76.67	11.74
7	Erumaikulam cascade	5	373.83	357.40	95.61	80.00	18.22
8	Ilupakudi cascade	5	285.59	240.60	84.25	95.00	7.34
9	Karuvi	2	96.79	71.50	73.87	70.00	9.59
10	Keelapasalai cascade	5	318.68	287.00	90.06	87.00	12.64
11	Keeranur cascade	6	147.93	132.33	89.46	74.17	22.50
12	Konnakulam cascade	3	126.73	107.33	84.70	86.67	1.83
13	Kumli tank cascade	12	110.15	102.17	92.75	81.25	4.03
14	Maanampaaki cascade	4	257.77	217.75	84.48	90.00	5.19
15	Maravamangalam cascade	6	198.76	160.50	80.75	87.50	19.54
16	Nagadipudhukanmai	3	130.04	103.00	79.21	78.33	5.38
17	Namanur cascade	3	272.04	223.67	82.22	91.67	765.27
18	Narkanimangalam cascade	3	407.07	345.33	84.83	81.67	8.01
19	P. Velangulam cascade	4	157.65	131.25	83.25	92.50	0.27
20	Palayaneduvayal	4	120.19	116.25	96.72	82.50	10.70
21	Pattathikanmoi	3	127.48	108.67	85.24	81.67	12.23
22	Periyairuvankanmoi cascade	5	180.90	161.00	89.00	83.00	1.43
23	Rajagampiram cascade	6	224.18	179.67	80.14	85.00	2.49
24	Sekkadi cascade	3	152.33	143.33	94.10	88.33	204.32
25	Siramam cascade	2	160.83	136.00	84.56	92.50	1.44
26	Siriyur cascade	4	125.84	106.00	84.24	93.75	3.56
27	Sirukudi cascade	3	273.99	253.67	92.58	91.67	5.56
28	Sirumarthur	5	72.30	69.60	96.27	84.00	3.59
29	Sithamalli cascade	2	386.83	370.00	95.65	77.50	30.01
30	Surucha cascade	4	38.40	37.00	96.35	77.50	1.32
31	Thamaraaki cascade	3	432.67	345.67	79.89	88.33	8.83
32	Vadakusanthanallur	4	201.26	171.50	85.21	87.50	1.85
33	Vaigai right main canal	15	337.40	324.07	96.05	87.33	10.24
34	Vaviarendhal cascade	4	136.18	114.50	84.08	73.75	0.96
35	Veelaneri cascade	2	176.04	149.50	84.93	60.00	1179.14
36	Vetrialangulam	7	114.16	100.83	88.32	86.43	9.50
37	Vilankatur cascade	4	158.86	134.50	84.67	93.75	7.50
		188	185.01	161.43	87.25	83.29	66.97

A26. Tank performance influencing factors of tank cascades in Sivagangai district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Amarani cascade	8			15.00	27.50	0.00
2	Anaiperiyakanmoi	3			18.33	8.33	0.00
3	Bagani cascade	3	16.67	3.33	28.33	13.33	0.05
4	Cheyyalur cascade	8	9.38	3.75	15.00	14.38	0.04
5	Chokkanaranyana cascade	10	5.00	10.00	24.50	23.20	0.02
6	Egaraikottavayal cascade	15	0.00	0.00	18.33	26.43	0.00
7	Erumaikulam cascade	5	12.00	5.00	14.00	28.00	0.02
8	Ilupakudi cascade	5	10.00	5.00	15.00	29.00	0.04
9	Karuvi	2	15.00	5.00	7.00	10.00	0.00
10	Keelapasalai cascade	5			27.50	14.00	0.06
11	Keeranur cascade	6	6.00	3.00	16.00	11.67	0.13
12	Konnakulamcascade	3	7.50	1.67	26.67	10.00	0.07
13	Kumli tank cascade	12	11.67	1.67	13.33	25.83	0.00
14	Maanampaaki cascade	4	0.00	0.00	17.50	12.50	0.05
15	Maravamangalam cascade	6	6.25	3.75	13.75	15.00	0.05
16	Nagadipudhukanmai	3	12.50	4.17	13.33	16.67	0.00
17	Namanur cascade	3	0.00	0.00	18.33	25.00	0.03
18	Narkanimangalam cascade	3	13.33	1.67	11.67	16.67	0.08
19	P. Velangulam cascade	4	10.00	0.00	10.00	15.00	0.06
20	Palayaneduvayal	4	13.75	5.00	10.00	13.75	0.02
21	Pattathikanmoi	3			15.00	23.33	0.00
22	Periyairuvankanmoi cascade	5	9.00	3.00	15.00	6.00	0.06
23	Rajagampiram cascade	6	7.00	1.00	17.50	14.17	0.03
24	Sekkadi cascade	3	13.33	6.67	10.00	28.33	0.08
25	Siramam cascade	2	7.50	7.50	12.50	10.00	0.05
26	Siriyur cascade	4	7.50	7.50	10.00	18.75	0.03
27	Sirukudi cascade	3	5.00	0.00	11.67	20.00	0.04
28	Sirumarthur	5	10.00		15.00	12.00	0.17
29	Sithamalli cascade	2			17.50	15.00	0.03
30	Surucha cascade	4			15.00	12.50	0.18

31	Thamaraaki cascade	3	16.67	5.00	15.00	16.67	0.03
32	Vadakusanthanallur cascade	4	7.50	7.50	12.50	10.00	0.09
33	Vaigai right main canal cascade	15	13.67	6.00	14.00	13.00	0.03
34	Vaviarendhal cascade	4	3.75	1.25	18.75	15.00	0.04
35	Veelaneri cascade	2	17.50	0.00	40.00	60.00	0.07
36	Vetrialangulam	7	0.00	0.00	12.86	9.29	0.00
37	Vilankatur cascade	4	7.50	8.75	10.00	21.25	0.04
		188	8.87	3.57	16.10	17.88	0.04

A27.Hydraulic Features of tank cascades in Tenkasi district

S. No	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Pavoor cascade	5	631.65	599.20		81.00	0.76
2	Puliyoor cascade	9	188.94	179.78	95.15	85.00	4.70
3	Thiruchitrambalam cascade	4	289.48	288.75	99.75	81.25	0.28
		18	370.02	355.91	96.19	82.42	1.91

A28. Tank performance influencing factors of tank cascades in Tenkasi District

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Pavoor cascade	5	5.00	10.00	15.00		5.00	0.47
2	Puliyoor cascade	9	11.86	11.00	10.56		8.40	0.12
3	Thiruchitrambalam cascade	4	20.00		15.00		5.00	0.50
		18	12.29	10.50	13.52		6.13	0.42

A29.Hydraulic Features of tank cascades in Thoothukudi District

S. No	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Kayathar cascade	3	120.86	94.67	78.33	100.00	3.46
2	Marudurkeelakal channel section	16	340.10	321.25	94.46	92.50	20.10
3	Marudurmelakkal channel section	15	517.82	499.87	96.53	92.67	22.66
4	Mela arasavaianaicut cascade	11	211.81	188.09	88.80	97.27	20.65
5	Ottanatham cascade	7	230.95	215.29	93.22	97.14	32.27
		52	284.31	263.83	92.80	95.92	19.83

A30. Tank performance influencing factors of tank cascades in Thoothukudi district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Kayathar cascade	3	1.67	0.00	5.00	0.00	0.00	0.01
2	Marudurkeelakal channel section	16	2.81	2.19	8.13	0.00	9.19	0.04
3	Marudurmelakkal channel section	15	4.67	7.00	6.33	0.00	15.53	0.00
4	Mela arasavaianaicut cascade	11	1.36	0.00	4.09	0.00	4.09	0.00
5	Ottanatham cascade	7	3.57	2.14	5.00	0.00	16.71	0.00
		52	2.82	2.27	5.71	0.00	9.11	0.01

A31.Hydraulic Features of tank cascades in Tirunelveli district

S. No	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Alangulam cascade	3	55.67	49.67	89.22	81.67	3.40
2	Appear pettaikulam cascade	9	54.44	48.44	88.98	97.22	6.01
3	Ayarkulam	7	46.71	42.14	90.21	84.29	4.28
4	Chinnamoolaikarai	4	66.75	64.00	95.88	82.50	6.45
5	Danamkulam	3	61.33	58.33	95.11	91.67	6.66
6	Kadankulam cascade	10	117.20	103.70	88.48	95.50	6.95
7	Kariyandikulam cascade	9	51.00	45.00	88.24	83.89	6.90
8	Ramakrishnapuramkulam cascade	6	58.33	51.50	88.29	86.67	3.88
9	Kadiankulam	4	78.50	75.50	96.18	86.25	7.18
10	Kanganarkulam cascade	13	23.00	19.77	85.95	78.85	1.72
11	Kannankulam	2	124.50	115.00	92.37	100.0	10.84
12	KaruppuKattaiChinnakulam cascade	7	123.68	117.00	94.60	90.71	10.55
13	Kattakaduvettikulam cascade	4	131.00	120.50	91.98	86.25	14.73
14	Kattarimangalamperiyakulam	3	94.00	89.00	94.68	83.33	11.63
15	Kuripankulam	4	81.88	73.75	90.07	93.75	4.98
16	Mallakulam cascade	7	84.96	81.43	95.85	92.86	3.27
17	Manimutharuchannel I	10	29.32	26.70	91.05	85.00	2.53
18	Manimutharu channel III	12	75.00	70.25	93.67	90.00	6.62
19	Manimutharu reach 4	5	100.46	97.40	96.95	86.25	8.83
20	Melamarichikatikulam	5	17.20	14.20	82.56	96.00	4.19
21	Muthudayarkulam	5	35.00	28.40	81.14	95.00	3.12
22	Narayanaperikulam cascade	10	19.30	15.80	81.87	86.50	2.64
23	Pattancherikulam	3	47.67	46.67	97.90	93.33	5.74
24	Ponnankudiperiyakulam cascade	8	98.63	91.88	93.16	85.63	8.87
25	Poolankulam	5	24.40	21.00	86.07	87.00	4.16
26	Pudhukulam cascade	8	72.38	69.50	96.03	91.25	9.55
27	Puliyankulam cascade	5	189.60	177.40	93.57	85.00	12.25
28	Rettaikinarukulam	2	34.00	30.00	88.24	82.50	4.12
29	Sadayamankulam	2	77.50	67.50	87.10	87.50	2.12
30	Sambankulam	6	76.50	70.33	91.94	87.50	6.39
31	Serakulam cascade	7	79.14	75.14	94.95	85.00	5.67
32	Sirusengulam cascade	8	47.13	42.50	90.19	88.13	9.41
33	Solan kulam	7	18.64	15.43	82.76	88.57	1.69
34	Srigovindaperikulam cascade	2	19.00	15.50	81.58	85.00	9.53

35	ThanthoniKulam cascade	2	78.00	72.50	92.95	87.50	4.16
36	Thattankulam	3	76.67	68.33	89.13	81.67	6.92
37	Therkkuvalimarichankulam cascade	7	29.57	25.86	87.44	92.86	3.30
38	TherkkupathiniParaikulam cascade	7	65.57	58.57	89.32	67.86	19.27
39	Thiruvarulaneri cascade	6	125.17	118.83	94.94	87.50	11.32
40	Thiruvarulnerikulam cascade	3	69.67	63.33	90.91	83.33	2.79
41	Unnankulam	3	115.00	106.67	92.75	78.33	8.87
42	Uthayanerikulam cascade	2	85.00	80.00	94.12	72.50	5.56
43	Vadakupathiniparaikulam cascade	2	218.50	200.00	91.53	87.50	2.30
44	Vagaikulam cascade	4	44.25	37.00	83.62	83.75	6.55
45	Vasapanerikulam cascade	2	64.00	59.50	92.97	90.00	10.59
46	Veeralaperunselvi tank cascade	6	49.01	42.83	87.40	91.67	4.65
47	Veppankulam	8	51.56	46.25	89.69	83.13	2.76
48	Vettarankulam	4	57.50	53.25	92.61	86.25	6.03
49	Sathanerikulam cascade	4	28.00	25.25	90.18	68.75	3.56
50	Vadakkuvagaikulam cascade	5	29.40	26.80	91.16	95.00	3.86
51	Marudhakulam cascade	15	98.27	89.00	90.57	85.00	59.03
52	Viralancherikulam cascade	3	105.65	98.33	93.07	85.00	6.25
53	Udaviyarkulam	5	37.30	34.60	92.75	87.00	2.69
54	Perumal Kulamkeela and Mela kulam cascade	12	289.07	272.50	94.27	83.75	13.16
55	Kadambankulam cascade	2	1177.67	1090.0	92.56	90.00	177.30
56	Thiruvaranganerimelakulam cascade	9	36.89	32.71	88.69	87.78	8.13
57	Sundanparaikulam	2	21.50	19.00	88.37	90.00	3.41
58	Therkkankulam	2	76.27	70.00	91.78	90.00	1.00
59	Siru Udayar kulam cascade	4	27.87	23.00	82.54	82.50	2.69
60	Sankarankulam cascade	5	90.60	87.60	96.69	94.00	6.01
61	Kodagan channel cascade	17	167.41	160.53	95.89	100.0	2.45
62	Nainarkulam cascade	9	116.32	111.78	96.10	100.0	0.38
63	Palayankal channel cascade	43	94.97	89.51	94.25	69.76	2.32
64	Tirunelveli channel cascade	14	197.22	192.57	97.64	100.0	1.38
		415	94.34	87.29	92.53	87.23	9.46

A32. Tank performance influencing factors of tank cascades in Tirunelveli district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Alangulam cascade	3	6.67	1.67	6.67	0.00	16.67	0.11
2	Appear pettaikulam cascade	9	3.89	3.33	9.44	0.00	8.33	0.15
3	Ayarkulam	7	7.86	2.86	0.00	0.00	13.57	0.13
4	Chinnamoolaikarai	4	5.00	2.50	3.75	0.00	20.50	0.13
5	Danamkulam	3	5.00	3.33	6.67	0.00	21.00	0.15
6	Kadankulam cascade	10	2.00	3.50	7.00	0.00	10.40	0.09
7	Kariyandikulam cascade	9	3.89	5.00	18.33	0.00	12.22	0.15
8	Ramakrishnapuramkulam cascade	6	3.33	4.17	10.83	0.00	7.83	0.16
9	Kadiankulam	4	6.25	8.33	15.00	0.00	18.50	0.18
10	Kanganarkulam cascade	13	2.31	5.15	12.69	0.00	7.46	0.21
11	Kannankulam	2	5.00	2.50	5.00	0.00	5.00	0.15
12	KaruppuKattaiChinnakulam cascade	7	5.00	6.43	7.86	0.00	11.43	0.04
13	Kattakaduvettikulam cascade	4	3.75	3.75	13.75	0.00	11.25	0.11
14	Kattarimangalamperiyakulam	3	15.00	12.50	30.00	0.00	9.00	0.08
15	Kuripankulam	4	8.33	5.00		0.00	15.00	0.09
16	Mallakulam cascade	7	0.00	0.00	1.67	0.00	20.00	0.10
17	Manimutharuchannel I	10	12.50	5.00	6.67	0.00	22.30	0.20
18	Manimutharu channel III	12	6.55	6.50	8.17	0.00	12.92	0.11
19	Manimutharu reach 4	5	5.00	5.00		0.00	18.40	0.12
20	Melamarichikatikulam	5	2.00	8.40	2.00	0.00	12.40	0.12
21	Muthudayarkulam	5	2.00	0.00	5.00	0.00	5.00	0.21
22	Narayanaperikulam cascade	10	2.50	3.40	8.60	0.00	11.00	0.18
23	Pattancherikulam	3	3.33	5.67	7.33	0.00	13.00	0.10
24	Ponnankudiperiyakulam cascade	8	5.00	3.75	12.50	0.00	9.88	0.09
25	Poolankulam	5	5.00	6.40	6.00	0.00	22.80	0.20
26	Pudhukulam cascade	8	6.25	6.75	5.50	0.00	13.88	0.13
27	Puliyankulam cascade	5	5.00	7.00	14.00	0.00	9.00	0.09
28	Rettaikinarukulam	2	7.50	7.50	7.50	0.00	11.50	0.13
29	Sadayamankulam	2	2.50	7.50	15.00	0.00	11.00	0.12
30	Sambankulam	6	5.83	5.33	5.00	0.00	12.50	0.15
31	Serakulam cascade	7	5.00	3.86	13.14	0.00	13.71	0.27

32	Sirusengulam cascade	8	6.25	4.38	11.25	0.00	6.25	0.12
33	Solan kulam	7	11.43	9.57	5.00	0.00	10.83	0.28
34	Srigovindaperikulam cascade	2	2.50	0.00	10.00	0.00	8.50	0.29
35	ThanthoniKulam cascade	2	5.00	7.50	7.50	0.00	0.00	0.13
36	Thattankulam	3	10.00	8.33	3.33	0.00	12.33	0.08
37	Therkkuvalimarichankulam cascade	7	4.57	5.00	10.71	0.00	11.43	0.15
38	TherkkupathiniParaikulam cascade	7	7.86	4.29	5.71	3.57	14.57	0.09
39	Thiruvarulaneri cascade	6	3.33	3.33	5.83	0.00	3.33	0.05
40	Thiruvarulnerikulam cascade	3	1.67	0.00	3.33	0.00	15.00	0.15
41	Unnankulam	3	6.67	3.33	5.00	0.00	15.00	0.06
42	Uthayanerikulam cascade	2	7.50	7.50	10.00	0.00	15.00	0.09
43	Vadakupathiniparaikulam cascade	2	5.00	10.00	12.50	0.00	7.50	0.08
44	Vagaikulam cascade	4	6.25	2.50	3.75	0.00	16.25	0.23
45	Vasapanerikulam cascade	2	5.00	2.50	5.00	0.00	16.00	0.18
46	Veeralaperunselvi tank cascade	6	4.17	3.33	4.17	0.00	9.17	0.14
47	Veppankulam	8	4.38	0.63	5.00	0.00	6.25	0.21
48	Vettarankulam	4	2.50	6.25	0.00	0.00	11.00	0.09
49	Sathanerikulam cascade	4	2.50	5.00	5.00	0.00	5.00	0.25
50	Vadakkuvagaikulam cascade	5	5.00	2.00	14.00	0.00	8.00	0.14
51	Marudhakulam cascade	15	2.33	2.67	2.67	1.79	14.33	0.07
52	Viralancherikulam cascade	3	0.00	0.00	0.00	1.67	13.33	0.04
53	Udaviyarkulam	5	6.00	7.50	6.67	0.00	18.80	0.25
54	Perumal Kulamkeela and Mela kulam cascade	12	6.50	9.00	10.00	1.67	8.00	0.02
55	Kadambankulam cascade	2	0.00	0.00	0.00	0.00	5.00	0.02
56	Thiruvaranganerimelakulam	9	1.88	1.88	1.88	1.11		0.18
57	Sundanparaikulam	2			10.00	0.00	13.50	0.19
58	Therkkankulam	2			4.00	0.00	0.00	0.15
59	Siru Udayar kulam cascade	4	1.25	1.25	0.00	0.00	8.75	0.14
60	Sankarankulam cascade	5	5.00	6.00	5.00	0.00	7.00	0.17
61	Kodagan channel cascade	17	9.81	5.00	10.42		13.93	0.04
62	Nainarkulam cascade	9	9.17	15.83	8.33		33.75	0.15
63	Palayankal channel cascade	43	7.78	1.88	7.62		16.25	0.04
64	Tirunelveli channel cascade	14	7.80	10.83	10.63		19.70	0.09
		415	5.13	4.83	7.57	0.16	12.24	0.09

A33. Hydraulic Features of tank cascades in Virudhunagar district

S. No	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Aathiyur cascade	8	188.19	161.13	85.62	91.25	20.11
2	ChettikurichiPeriyaKanmai cascade	4	146.33	133.25	91.06	95.00	16.80
3	Kollapatti cascade	3	379.36	303.00	79.87	86.67	81.00
4	Maravankulam cascade	3	184.28	166.67	90.44	86.67	12.92
5	NathampattiPeriyakulamkanmai cascade	5	131.73	115.80	87.91	100.0	23.94
6	Periyapuliyampatti cascade	9	241.09	201.33	83.51	97.78	19.77
7	Rengappayakankulam cascade	14	258.10	219.07	84.88	92.07	18.54
8	Vetrilaikanmai cascade	5	200.53	162.40	80.99	100.0	23.94
9	Viragasamuthiramkanmai cascade	6	255.72	238.00	93.07	98.33	242.11
10	Watrapperiyakulam cascade	9	222.01	186.11	83.83	100.0	20.14
		66	220.73	188.68	85.48	94.78	47.93

A34. Tank performance influencing factors of tank cascades in Virudhunagar district

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry	% area under Prosophis tree in tank waterspread	no.of wells / ac
1	Aathiyur cascade	8	17.50	5.63	6.88		23.13	0.16
2	ChettikurichiPeriya Kanmai cascade	4	11.25	1.25	3.75		21.25	0.12
3	Kollapatti cascade	3	20.00	5.00	6.67		18.33	0.04
4	Maravankulam cascade	3	15.00	1.67	0.00		43.33	0.19
5	Nathampattiperiya kulamkanmai cascade	5	9.00	2.50	8.00		37.00	0.14
6	Periyapuliyampatti cascade	9	16.11	3.13	5.56		35.56	0.13
7	Rengappayakankulam cascade	14	13.93	7.14	9.64		17.86	0.39
8	Vetrilaikanmai cascade	5	8.75	6.25	17.00		41.00	0.06
9	Viragasamuthiram kanmai cascade	6	18.33	5.00	5.00		34.17	0.17
10	Watrapperiyakulam cascade	9	24.44	6.11	5.56		34.44	0.25
		66	15.43	4.37	6.80		30.61	0.16

A35. Hydraulic Features of tank cascades in Kanyakumari District

S. No	Name of the tank cascade	No. of Tanks Surveyed	Registered Ayacut area (ac)	Actual area cultivated (ac) 2020-21	% area irrigated to registered area	Tank filling %	Tank Storage capacity (Mcft)
1	Thovalai channel	16	53.05	51.56	97.20	100.00	0.54
2	Kothayar channel cascade(keelanarasinganeri)	17	51.22	50.29	98.18	100.00	2.40
3	Koyhayar channel(sambakulam)	17	209.94	188.71	89.89	95.29	31.87
4	Kothayar channel	9	18.23	15.56	85.33	98.89	2.71
5	Sooravalianaicut	8	29.81	25.88	86.79	93.13	1.59
6	Parivarisooriyankulam	6	114.71	105.00	91.53	89.17	5.81
7	Kokkurunikulam	2	13.48	11.50	85.30	75.00	0.65
8	Senjetty	10	54.91	49.20	89.60	100.00	8.44
9	Pottakulam cascade	2	6.84	5.50	80.41	92.50	0.18
10	Thamaraikulam	4	28.50	25.00	87.71	95.00	0.60
11	Chemmankulam cascade	2	7.54	7.00	92.90	92.50	0.09
12	Vallotukulam cascade	4	27.27	24.00	88.00	100.00	1.01
13	Pulavankulam	3	5.59	4.67	83.48	96.67	0.31
14	Pullonguzhikulam	5	11.30	9.80	86.69	100.00	0.31
15	Chemparuthiluam cascade	4	37.72	33.75	89.48	97.50	7.13
16	Perunjiraikulam cascade	7	6.83	6.00	87.88	98.57	1.46
17	Paraikulam	4	5.51	5.00	90.72	96.25	0.29
18	Perumanguli cascade	8	5.65	4.88	86.33	96.25	0.89
19	Kattankulam cascade	2	3.10	2.50	80.65	92.50	0.14
20	Aanuvathikulam	4	2.74	2.50	91.12	96.25	0.10
21	Kavukulam	4	5.26	4.75	90.37	93.75	0.29
22	Kackulam	3	3.87	3.33	86.21	91.67	0.42
23	Isakkikulam cascade	5	2.60	2.00	76.83	97.00	0.14
24	Pidarikulam cascade	3	21.01	18.67	88.86	96.67	0.88
25	Pipinikulam cascade	4	15.85	15.25	96.23	100.00	0.81
26	Paduvakulam cascade	6	14.75	13.00	88.17	98.33	1.03
27	Kankeyankonathukulam	4	2.09	2.00	95.81	93.75	0.79
28	Allangulam cascade	6	9.37	8.50	90.76	100.00	0.35
29	Annuvathikulam cascade	3	19.91	18.00	90.41	91.67	1.29
30	Chettikulam cascade	3	15.75	15.00	95.24	96.67	0.59
31	Senthilkathananaicut	7	59.51	51.71	86.90	92.14	3.18
32	Kothayar channel	14	54.70	48.07	87.88	99.29	8.70
33	Nanjilnaaduputhanadu channel	9	75.50	75.00	99.34	93.89	0.60
		205	30.12	27.38	90.89	95.46	2.59

A36. Tank performance influencing factors of tank cascades in Kanyakumari District

S. No	Name of the tank cascade	No. of Tanks Surveyed	% encroachments in tank catchment	% encroachments in tank foreshore	% encroachment in supply channel	% Social forestry (acacia trees)	% area under Prosophis tree in tank water spread	no.of wells / ac
1	Thovalai channel	16	2.81	0.00				0.00
2	Kothayar channel (keelanarasinganeri)	17	2.53	0.00				0.00
3	Koyhayar channel(sambakulam)	17	8.82	1.18	8.33	15.00		0.00
4	Kothayar channel	9	15.56	1.11	5.00			0.01
5	Sooravalianaicut	8	5.00	0.00	5.00		10.00	0.35
6	Parivarisooriyankulam	6	2.50	0.00	8.33		5.00	0.21
7	Kokkurunikulam	2	0.00	7.50	10.00		0.50	0.00
8	Senjetty	10	1.50	0.00				0.54
9	Pottakulam cascade	2	0.00	2.50	0.00		0.00	0.00
10	Thamaraikulam	4	0.00	1.25	2.50		0.00	0.00
11	Chemmankulam	2	0.00	0.00	5.00			0.00
12	Vallotukulam cascade	4	0.00	0.00				0.00
13	Pulavankulam	3	0.00	1.67	5.00			0.00
14	Pullonguzhikulam	5	0.00	0.00				0.00
15	Chemparuthiluam	4	0.00	0.00	1.25		0.00	0.00
16	Perunjiraikulam	7	0.00	0.00	5.00			0.00
17	Paraikulam	4	0.00	0.00	5.00			0.00
18	Perumanguli cascade	8	0.00	1.25	1.25		0.00	0.00
19	Kattankulam cascade	2	0.00	0.00	2.50		0.00	0.00
20	Aanuvathikulam	4	0.00	0.00	5.00			0.00
21	Kavukulam	4	0.00	0.00	5.00			0.00
22	Kackulam	3	0.00	0.00	5.00			0.00
23	Isakkikulam cascade	5	0.00	0.00	1.00		0.00	0.00
24	Pidarikulam cascade	3	0.00	0.00	1.67		0.00	0.00
25	Pipinikulam cascade	4	0.00	0.00	0.00		0.00	0.00
26	Paduvakulam cascade	6	0.00	0.00	0.83		0.00	0.00
27	Kankeyankonathukulam	4	0.00	0.00	2.50		0.00	0.00
28	Allangulam cascade	6	0.00	0.00	0.00		0.00	0.00
29	Annuvathikulam	3	0.00	0.00	5.00			0.00
30	Chettikulam cascade	3	0.00	0.00	1.67		0.00	0.00
31	Senthilkathananaicut	7	1.43	1.43	15.00			0.72
32	Kothayar channel	14	7.14	6.50	5.00			0.00
33	Nanjilnaaduputhanadu channel	9	0.56	18.00	17.50			0.00
		205	1.45	1.28	4.62	15.00	1.03	0.11

A37. Activeness OF WUA

S. No	District	No. of Tanks							Percentage of Tanks						
		WUA				WUA			WUA				WUA		
		Active		Not Active					Active		Not Active				
		PU	PWD	PU	PWD	PU	PWD	Total	PU	PWD	PU	PWD	PU	PWD	Total
	Northern Districts														
1	Chengalpattu	3	106	3	19	6	125	131	2.29	80.92	2.29	14.50	4.58	95.42	100.00
2	Kallakurichi	0	62	0	0	0	62	62		100.00				100.00	100.00
3	kancheepuram	5	31	11	57	16	88	104	4.81	29.81	10.58	54.81	15.38	84.62	100.00
4	Krishnagiri	4	2	23	24	27	26	53	7.55	3.77	43.40	45.28	50.94	49.06	100.00
5	Thiruvallur	2	80	0	8	2	88	90	2.13	88.89		8.89	2.22	97.78	100.00
6	Villupuram	13	50	5	21	18	71	89	14.61	56.18	5.62	23.60	20.22	79.78	100.00
Sum		27	331	42	129	69	460	529	6.28	59.93	15.47	29.42	18.67	84.44	100.00
	Southern Districts														
7	Madurai	0	2	47	70	47	72	119		1.68	39.50	58.82	39.496	60.504	100.00
8	Pudukottai	1	15	10	259	11	274	285	0.35	5.26	3.51	90.88	3.860	96.140	100.00
9	Ramanathapuram	16	18	24	78	40	96	136	11.76	13.24	17.65	57.35	29.412	70.588	100.00
10	Sivagangai	11	28	49	100	60	128	188	5.85	14.89	26.06	53.19	31.915	68.085	100.00
11	Tenkasi	0	0	8	10	8	10	18			44.44	55.56	44.444	55.556	100.00
12	Thoothukudi	2	14	11	25	13	39	52	3.85	26.92	21.15	48.08	25.000	75.000	100.00
13	Tirunelveli	70	37	238	70	308	107	415	16.87	8.92	57.35	16.87	74.217	25.783	100.00
14	Virudhunagar	10	48	0	8	10	56	66	15.15	72.73		12.12	15.152	84.848	100.00
15	Kanyakumari	1	0	181	23	182	23	205	0.49		88.29	11.22	88.780	11.220	100.00
Sum		111	162	568	643	679	805	1484	7.76	20.52	37.24	44.90	39.142	60.858	100.00

A38. District wise List of Tank Cascades selected for Modernization

Name of the District	Name of the tank cascade	No. of Tanks	Highly Potential	Medium Potential	Less Potential
Chengalpattu	Acharavakkam	5	5	0	0
Chengalpattu	adavilagam	3	2	1	0
Chengalpattu	Anumanthapuram	3	3	0	0
Chengalpattu	Kaatoor	3	3	0	0
Chengalpattu	Kaatrampalli cascade	2	2	0	0
Chengalpattu	Kalanipakkam tank cascade	2	2	0	0
Chengalpattu	karumbakkam	2	2	0	0
Chengalpattu	kothimangalam	5	4	1	0
Chengalpattu	lower palar basin	7	3	4	0
Chengalpattu	mambakkam	2	2	0	0
Chengalpattu	marutheri	6	5	1	0
Chengalpattu	nallanpillaipetralperiyaeri	2	1	1	0
Chengalpattu	Narapakkam tank cascade	4	4	0	0
Chengalpattu	Nenmeliperiyaeri	10	9	1	0
Chengalpattu	orakadam	2	2	0	0
Chengalpattu	periyairumbedu	2	2	0	0
Chengalpattu	Porunthavakkam cascade	2	2	0	0
Chengalpattu	pulikundram tank	3	3	0	0
Chengalpattu	Sembakkam	5	4	1	0
Chengalpattu	Sooradimangalam cascade	5	3	2	0
Chengalpattu	Thirukalukundram tank cascade	10	10	0	0
Chengalpattu	Kayaru cascade	4	4	0	0
Chengalpattu	Venbedu cascade	7	4	3	0
Chengalpattu	karumarapakkamperiyaeri	3	3	0	0
Chengalpattu	Kadumbadi	5	5	0	0
Chengalpattu	Salur thangal	5	4	1	0
Chengalpattu	Mannivakkam cascade	2	1	1	0
Chengalpattu	Thalambedu tank cascade	3	3	0	0
kallakurichi	nagalur cascade	3	2	1	0
kancheepuram	Kambakal channel cascade	10	4	6	0
kancheepuram	Ekanapuramkadappanthangal cascade	4	2	2	0
kancheepuram	Mambakkam section (Kambakal)	6	3	3	0
kancheepuram	MelkathirpurHissa cascade	3	2	1	0
kancheepuram	Singalpadi section (Kambakkal channel)	3	3	0	0
kancheepuram	thenneri cascade	11	5	6	0
Krishnagiri	Pennaiyar river (RMC) IV	5	4	1	0
Thiruvallur	adigathur cascade	4	2	2	0
Thiruvallur	Ekkadu cascade	8	8	0	0
Thiruvallur	Govindamedu tank cascade	11	10	1	0
Thiruvallur	Kakkalur cascade	5	5	0	0
Thiruvallur	Koramangalam cascade	10	4	6	0

Thiruvallur	pudhumavilangai cascade	9	7	2	0
Thiruvallur	Putlur cascade	4	3	1	0
Thiruvallur	selai cascade	4	3	1	0
Thiruvallur	sirugumi cascade	4	3	1	0
Thiruvallur	keelanur	2	1	1	0
Thiruvallur	Keelmuthalambedu	9	7	2	0
Thiruvallur	vanjivakkam cascade	7	6	1	0
Thiruvallur	Kooduvanjeri	7	6	1	0
Villuppuram	Alangal cascade	7	5	2	0
Villuppuram	Gangavaram cascade	15	12	3	0
Villuppuram	Nannadu cascade	5	3	1	1
Villuppuram	Palliyandur cascade	8	5	3	0
Villuppuram	Pamboondi cascade	7	4	2	1
Villuppuram	Radhapuramlyyanar cascade	13	8	5	0
Villuppuram	Tirukoilur tank cascade	8	7	0	1
Madurai	Ayanarkulam tank cascade	13	12	1	0
Madurai	kallanai cascade	21	19	2	0
Madurai	Melakkal Cascade	10	4	6	0
Madurai	periyarvaigai basin	12	10	2	0
Madurai	PMC main canel cascade	15	10	5	0
Madurai	Valandur tank cascade	18	14	4	0
Madurai	Vikkramangalam cascade	15	15	0	0
Pudukottai	Veeramangalamanaicut cascade	15	10	5	0
Ramanathapuram	Paranur cascade - I	10	9	1	0
Ramanathapuram	Paranur cascade - II	8	8	0	0
Ramanathapuram	RS Managalam big tank -II	8	7	1	0
Ramanathapuram	RS Managalam big tank-I	9	9	0	0
Sivagangai	Rajagampiram cascade	6	3	3	0
Sivagangai	Siriyur cascade	4	2	2	0
Thoothukudi	kayathar cascade	3	2	1	0
Thoothukudi	Mela arasavaianaicut cascade	11	11	0	0
Tirunelveli	KaruppuKattai Chinna kulam cascade	7	6	1	0
Tirunelveli	Puliyankulam cascade	5	3	2	0
Tirunelveli	Thanthoni Kulam cascade	2	1	1	0
Tirunelveli	Therkkuvalimarichankulam cascade	7	3	4	0
Tirunelveli	TherkkupathiniParaikulam cascade	7	5	2	0
Tirunelveli	Uthayanerikulam cascade	2	1	1	0
Tirunelveli	Veeralaperunselvi tank cascade	6	6	0	0
Tirunelveli	Viralancherikulam cascade	3	3	0	0
Tuticorin	Kadamban kulam cascade	2	2	0	0
Tuticorin	Thiruvaranganerimelakulam cascade	9	5	4	0
Tuticorin	therkkankulam	2	2	0	0
Tuticorin	Siru Udayar kulam cascade	4	4	0	0

Tirunelveli	Sankarankulam cascade	5	5	0	0
Virudhunagar	ChettikurichiPeriyaKanmai cascade	4	3	1	0
Virudhunagar	Rengappayakankulam cascade	14	8	5	1
Virudhunagar	Watrapperiyakulam cascade	9	4	5	0
	Total	572	437	131	4

राष्ट्रीय कृषि और ग्रामीण विकास बैंक, मुंबई

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