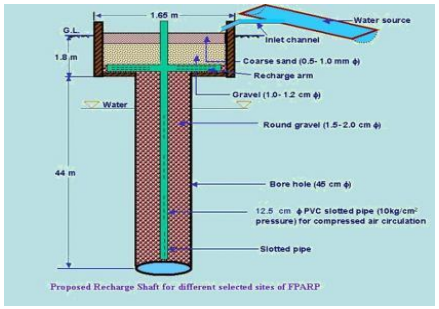
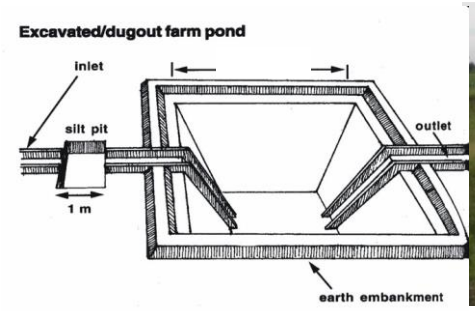
Plan on Artificial Recharge to Groundwater and Water Conservation in Uppuvelur Firka, Vanur Taluk, Villupuram District, Tamil Nadu





By

Central Ground Water Board
South Eastern Coastal Region
Rajaji Bhawan, Besant Nagar
Chennai

AT GLANCE	
Name of Firka	Uppuvelur
Taluk	Vanur
District	Villupuram
State	Tamil Nadu
Total area	113.59
Total suitable area	73.83
Lat. & Lon.	North latitudes 12° 01’ 50.68” to 12° 10’ 57.51” and east longitudes 79° 43’ 34.41”to 79° 51’ 53.19”
Rainfall	824 mm
Monsoon	752 mm
Non- Mon soon	072 mm
Geology	Gneiss complex, clay, shaly lime stone Lime stone, sand stone and conglomerate.
WATER LEVEL	
Pre - Monsoon	5 to 10 m bgl.
Post - Monsoon	5 to 10 m bgl.
GROUND WATER RESOURCES ESTIMATION	
Replenish able ground water resources	21.78 MCM
Net ground water available	19.60 MCM
Ground water draft for irrigation	22.89MCM
Groundwater draft for domestic & industrial water supply	0.49MCM
Total ground water draft	23.37MCM
Stage of ground water development (%)	119.25
Uncommitted surface runoff available for the Firka	12.81 MCM
Total volume of weathered zone	15.402 MCM
Total volume available for recharge (Deepest water level – 3 m)	15.90 MCM
ARTIFICIAL RECHARGE /CONSERVATION MEASURES	
Structures Proposed (tentative) Masonry Check dam Nalla Bund Revival, repair of pond, tanks with recharge shaft	 17 14 21
Improving Water Efficiency /Saving Micro irrigation system for 100 ha	0.7 MCM
Excepted groundwater recharge	2.476 MCM
Total expected groundwater recharge/ saving	3.176 MCM
Tentative total cost of the project	Rs. 7.01 Cr
Expected raise in water level by recharging /saving	4.30 m

Plan on Artificial Recharge to Groundwater and Water Conservation in Uppuvelur, Vanur Taluk, Villupuram district, Tamil Nadu

1. Introduction

India is the largest user of groundwater in the world. Food grain security of the country is largely dependent on water resources and groundwater resources play major role in irrigation sector. Imprints of Over-Exploitation on groundwater resources are being observed as steep deepening of water levels, drying of shallow groundwater abstraction structures, ingress of salinity in fresh aquifers etc. which signal towards taking necessity of emergent action for artificial recharge and rainwater harvesting by utilizing surplus runoff and maintaining groundwater resources at sustainable stage.

In Tamil Nadu dependency on groundwater has increased many folds during the recent years and the groundwater extraction for irrigation, domestic and industries have resulted in lowering of water levels, long-term water level declining trend and even drying up of wells. In order to regulate the groundwater development, Central Ground Water Board in association with State Ground Water Departments has computed Dynamic Groundwater Resources and categorized blocks as Over Exploited, Critical, Semi Critical and Safe.

Out of 1129 firkas (assessment units) in Tamil Nadu the groundwater situation in 374 firkas overexploited, 48 firkas critical, 235 firkassemi-critical, 437 firkas safe and 35 firkas are saline. Various measures such as rainwater harvesting, artificial recharge and water use efficiency are successfully practiced by some NGOs, Central and State Govts., which need replication at larger scale in close coordination with State govt. agencies and stakeholders so that capacity building of state implementing agencies and awareness of stakeholders towards artificial recharge and rainwater harvesting can be made.

2. Objectives of the scheme

Objectives of the proposed scheme are

- To upscale recharge activities, supplement additional groundwater resources by harvesting surplus runoff, sustainability of groundwater resources at shallow depths
- Recovery of over-exploited groundwater areas by implementing artificial recharge measures in groundwater stress areas.
- Conservation, development and sustainable management of natural resources including their use.

3. Study area details

3.1 Location

The total area of Uppuvelur firka is 113.59 sq.km and Uppuvelur firka lies between North latitudes 12° 01’ 50.68” to 12° 10’ 57.51” and east longitudes 79° 43’ 34.41”to 79° 51’ 53.19”. Location map of Uppuvelur firka is given in Figure 1.

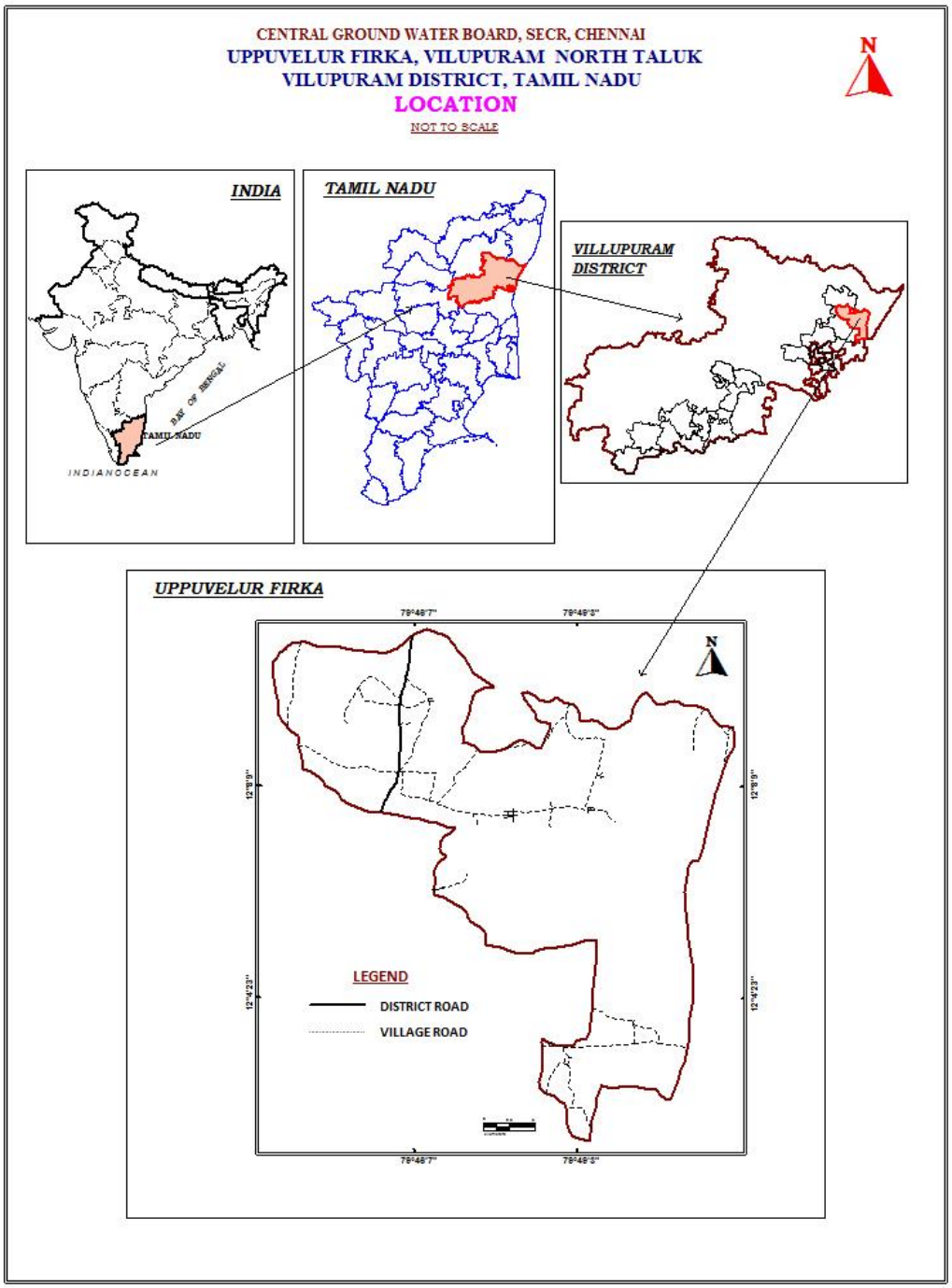


Figure 1. Location map of Uppuvelur firka

3.2 Geomorphological Set up

Geomorphologically, the area is covered by dissected /undissected pediment, buried pediment moderate and shallow, tertiary upland, Marsh, lagoon back water and sedimentary paln. Tertiary upland occupying North and south of middle portion and eastern portion of the firka is covered by lagoon back water & marsh units. Central and southern portion of the firka is covered by the Sedimentary plan. These landforms are influencing the ground water recharge. (*Source: IRS, Anna university, Chennai Tamil Nadu). Geomorphological map prepared using IRS- 1D data on 1: 50,000 scale and units are as per NNRMS standard*s. The various Geomorphological units in the firka is given in table 1.

Table 1. Various geomorphological units with its % of coverage area in Uppuvelur firka

LANDFORMS
Sedimentary plan
Pediment DISSECTED/UNDISSECTED
Buried pediment - moderate
Marsh
Buried pediment - Shallow
Lagoon back water
Tertiary

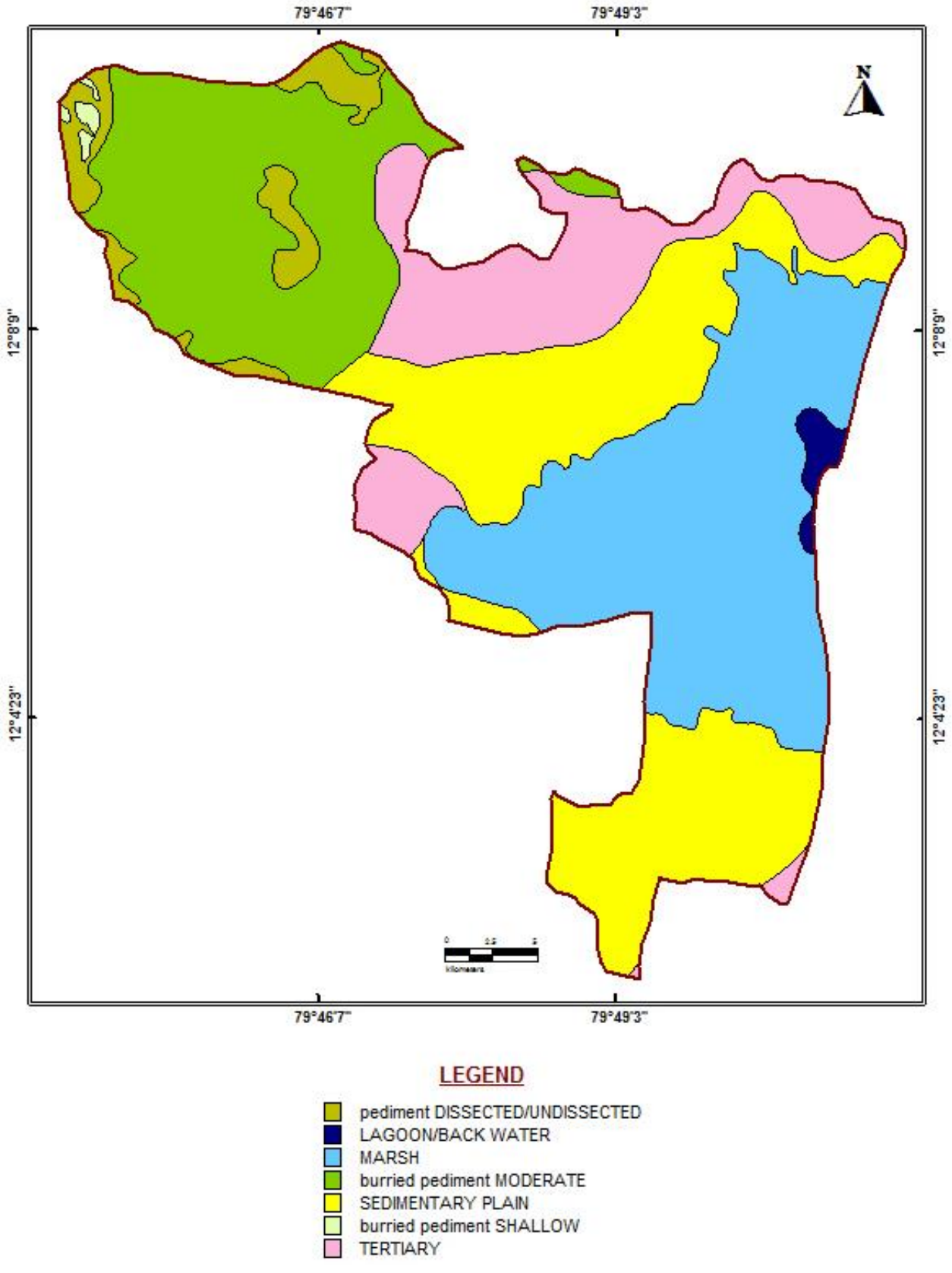


Figure 2. Geomorphology of Uppuvelur Firka

3.3 Land use and soil

The land use pattern of the Uppuvelur Firka is given in figure 3. Predominantly the most of the area is characterised by the wet crop, plantation and dry crop (i.,e agricultural field)and accounts for 50 % of the total area of the firka. Northwest part of firka is covered with small pockets of salt affected units and central and east part of the firka is covered by the reservoir/lake/tank (Source: IRS, Anna University, Chennai Tamil Nadu).

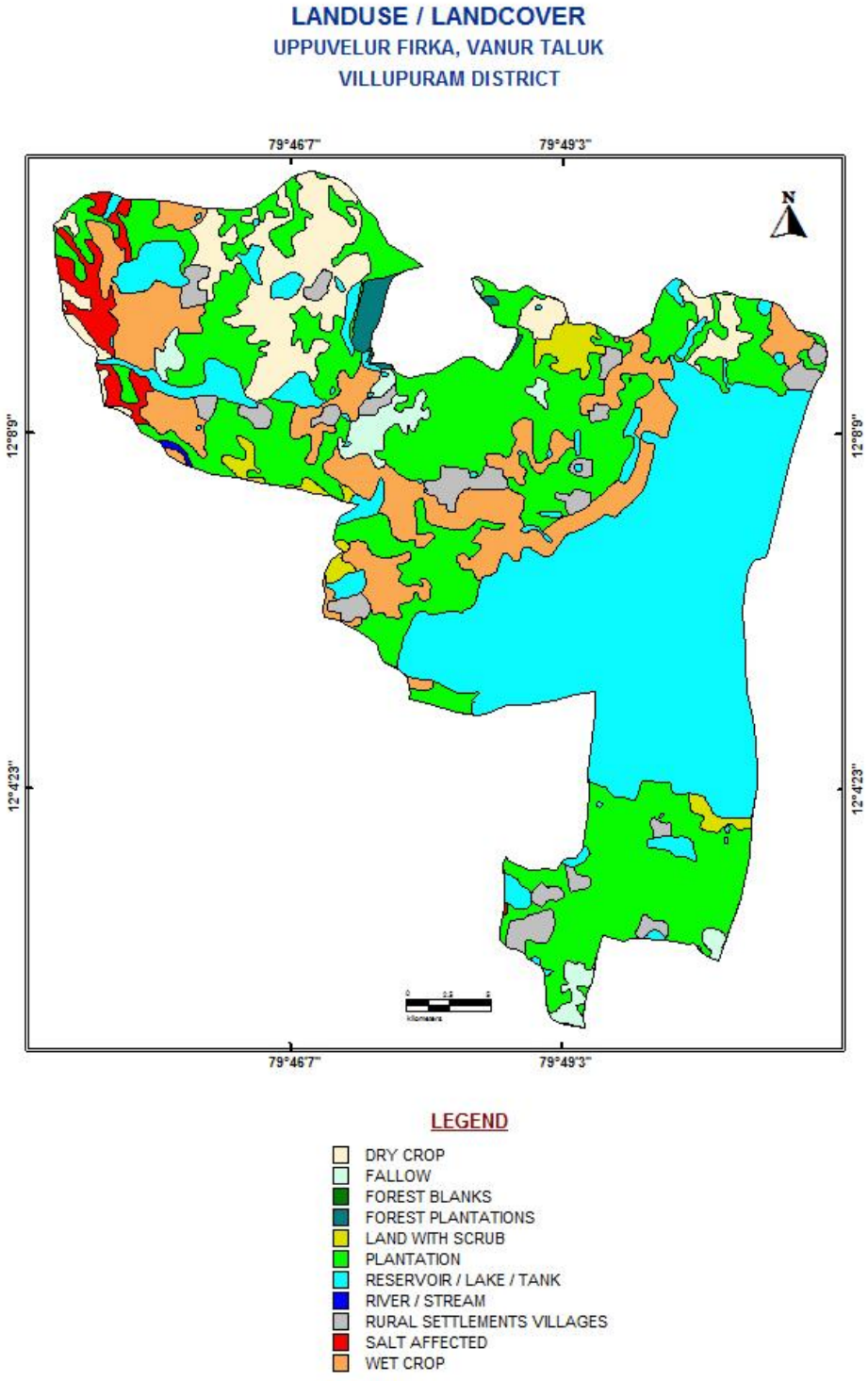


Figure 3. Land use map of Uppuvelur **Firka**

3.4 Drainage

The entire Firka area is within the Varahanadhi basin Numbers of small streams originate from the hills located in the Uppuvelur firka. Only seasonal floods inundate lower parts of the basins. Basin sub soil water is used to irrigate the lands. Tanks and surface water bodies are spread over the entire firka. The drainage pattern is the dendritic and sub- dendritic. The drainage map of Uppuvelur firka is given in Fig 4.

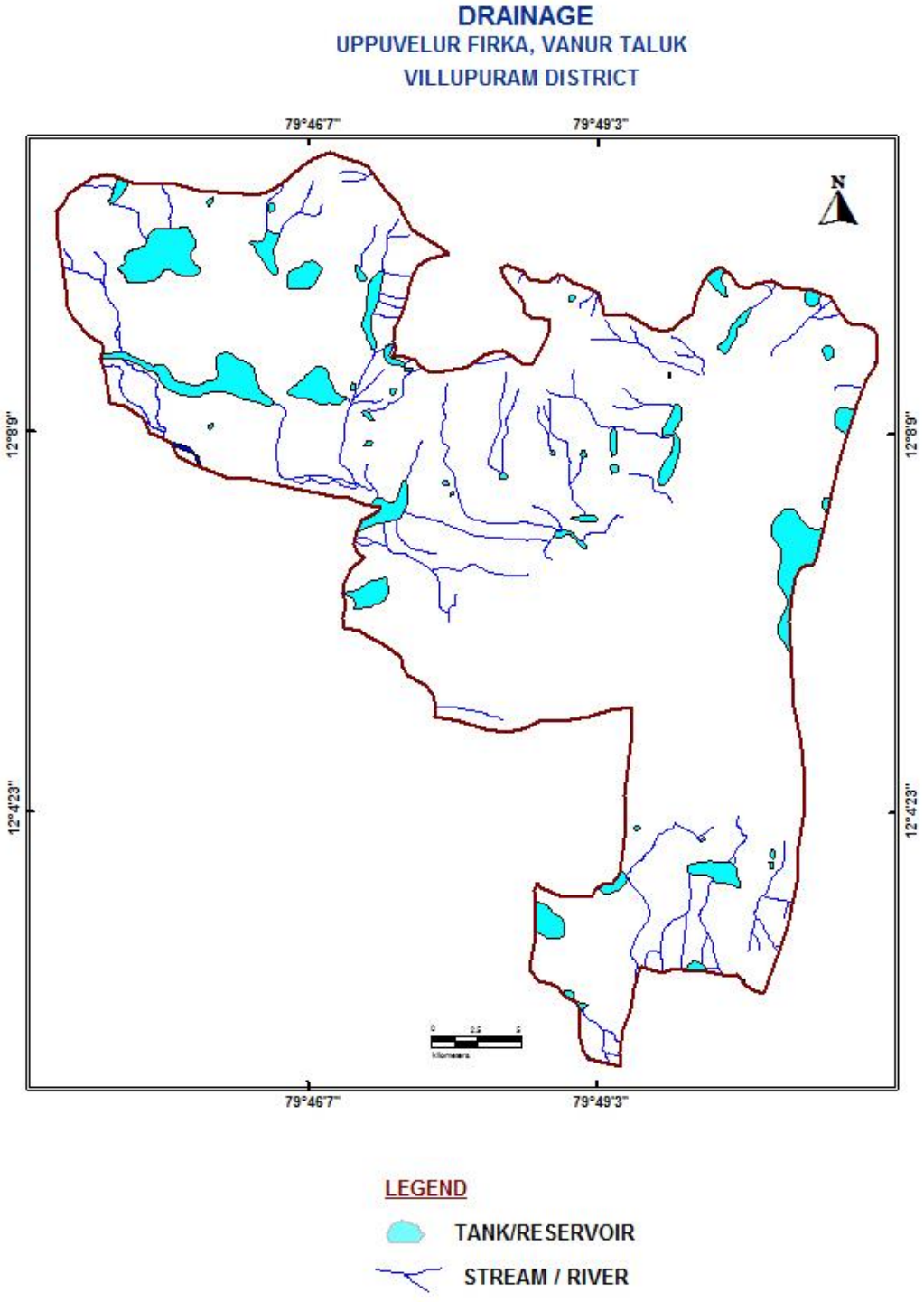


Figure 4.Drainage map of Uppuvelur Firka

3.5 Rainfall

Uppuvelur area falls under tropical climate with temperature in the summer months of March to May. The average temperature varies from 26 to 41° C. The humidity is also high in the order of 80%. The wind speed is high during the months of July and August. The wind speed ranges from 7.4 to 12.6 km/hr, which increases from 100 to 120 km/hr during cyclone period. Uppuvelur Firka receives rainfall from southwest monsoon (June – September), northeast monsoon (October – December) and non-monsoon periods (January – May). The area receives the major rainfall from northeast monsoon. Rainfall is generally heavy during low-pressure depressions and cyclones during the northeast monsoon period. The normal annual rainfall is 824 mm and the higher is towards coast i.e, east part of the firka.

Taluk	Name of Firkas	Area in sq.km	Monsoon rainfall (Jun to Dec) In m	Non monsoon rainfall (Jan – May) In m	Total Rainfall In m
Vanur	Uppuvelur	113.59	0.752	0.072	0.824

3.6 Hydrogeology

Uppuvelur firka is underlain by the gneissic complex and in south-eastern portion of the firka is covered by of limestone, sand stone and conglomerate formation. Ground water is occurring in Pheratic conditions in weathered and fractured Charnokite rock formation. The weathering is highly erratic and the depth of abstraction structures is controlled by the intensity of weathering and fracturing. Large diameter dug well is more common ground water abstraction structures in the area. The diameter of the dug well is in the range of 7 to 10 m and depth of dug wells range from 15 to 18 m bgl. The dug wells yield up to 1 lps in summer months and few wells remains dry. The yield is adequate for irrigation for one or two crops in monsoon period.

The cretaceous formations are very compact and yield prospects are low. The dug wells of 6 m diameter and 10 m bgl depth in sandy tracts give about 3.5 lps. The yield of tube wells in the sedimentary formation ranges from 2.4 to 37 lps. The diameter of the dug well in hard rock formation is in the range of 7 to 10 m and depth of dug wells range from 15 to 18 m bgl. The dug wells yield up to 1 lps in summer months and few wells remains dry. The yield is adequate for irrigation for one or two crops in monsoon period.

The depth of wells varies from 6.64 to 17 m bgl. The hydrogeological map of Uppuvelur firka is given in Figure 5. Decadal mean water level of pre-monsoon and post monsoon are given in fig 6 a & b. In Pre and post monsoon, majority area is having ground water level in the range of 5-10 m bgl. The present water level in the firka is in the range of 5.00 to 10.00 m bgl.

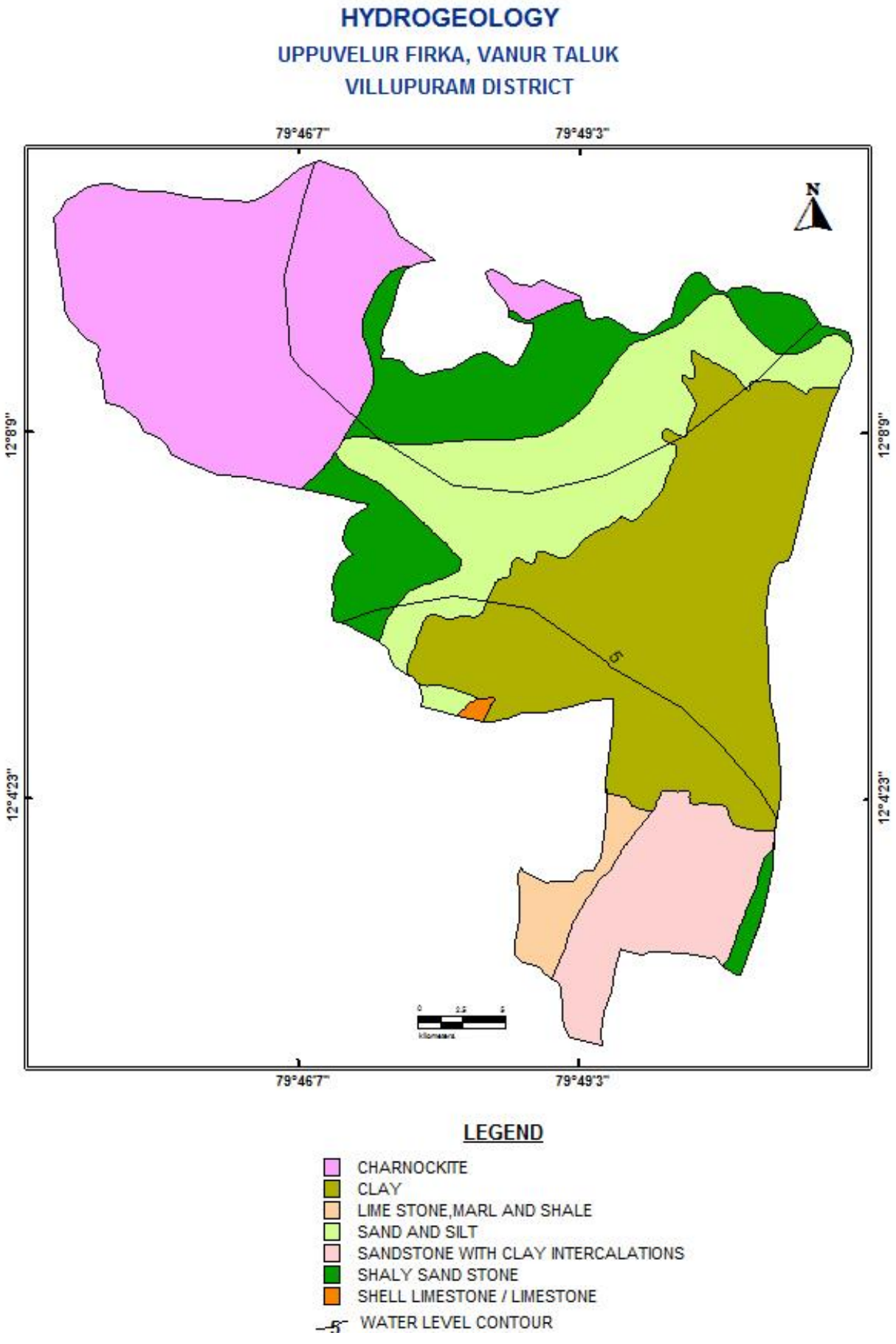


Figure 5. Hydrogeological Map of Uppuvelur Firka

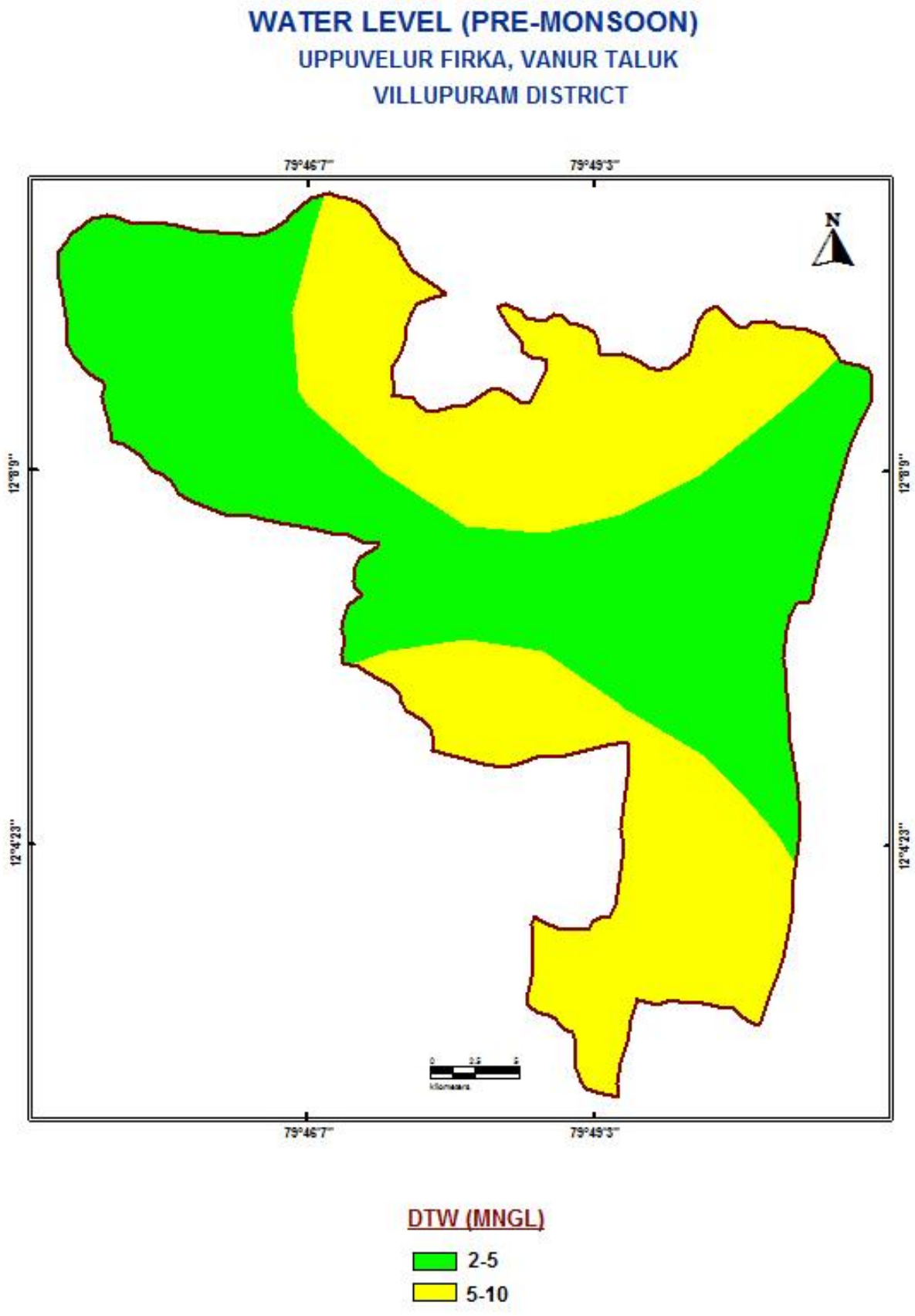


Figure 6a. Pre -monsoon water level in Uppuvelur firka **(Decadal)**

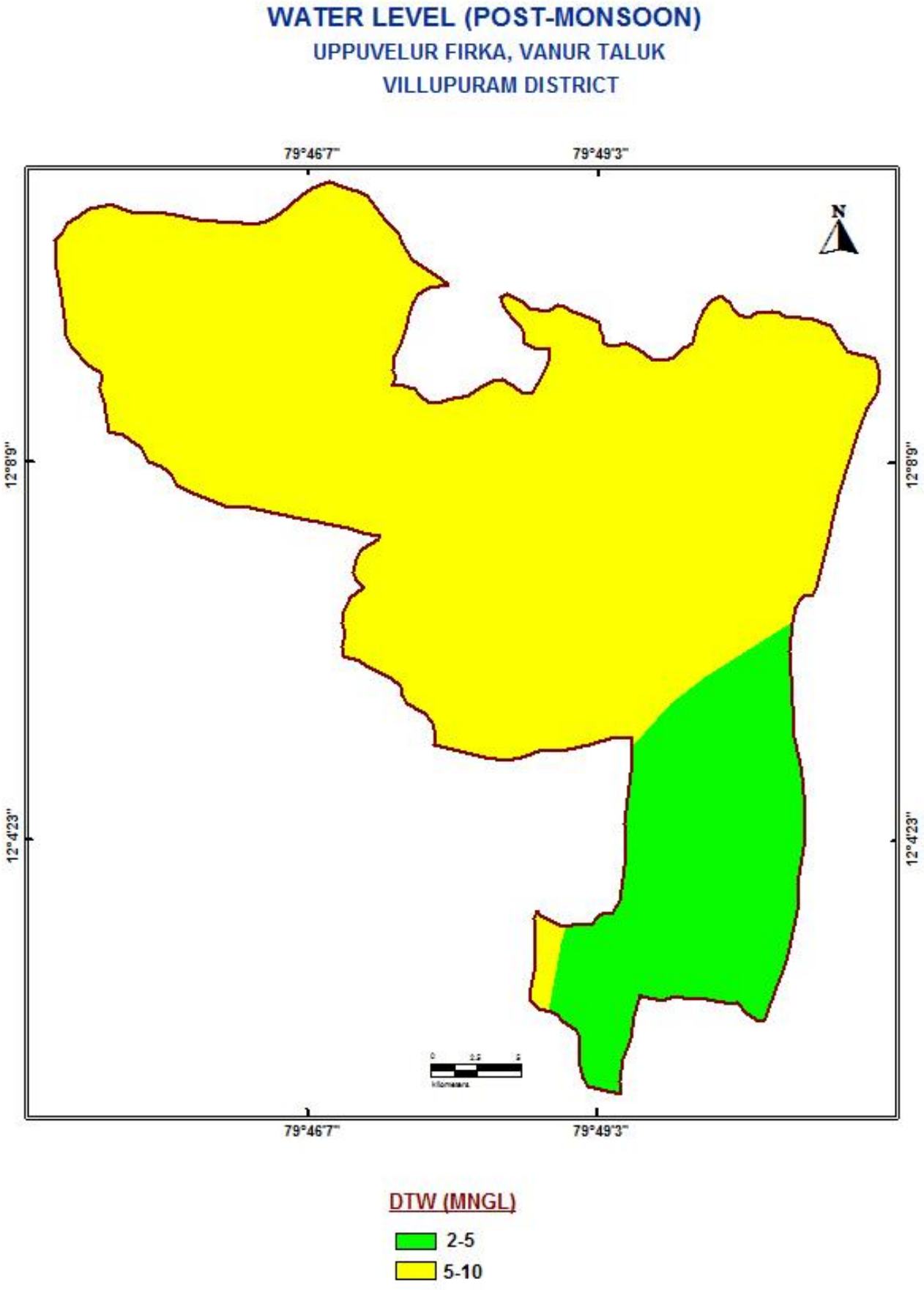


Figure 6 b. Post-monsoon water level in Uppuvelur firka **(Decadal)**

3.7 Dynamic Ground water Resources

The ground water resources have been computed jointly by Central Ground Water Board and State Ground Water Resources Data Centre (PWD, WRO, Govt. of Tamil Nadu) as on 31st March 2011. The computation has been done using GEC1997 methodology. The salient features of the computations are furnished in table 2.

Table 2. Dynamic Ground water resources estimation of Uppuvelur firka

Firka	GW WORTHY AREA	REPLENISHABLE GROUND WATER RESOURCES	NET GROUND WATER AVAILABLE	GROUND WATER DRAFT FOR IRRIGATION	GROUNDWATER DRAFT FOR DOMESTIC & INDUSTRIAL WATER SUPPLY	TOTAL GROUND WATER DRAFT	STAGE OF GROUND WATER DEVELOPMENT (%)	CATEGORY
	(Sq.Km)	(In MCM)					%	
Uppuvelur	113.59	21.78	19.60	22.89	0.48	23.37	119.25	OVER EXPLOITED

4. Spatial Data Integration

The potential area for groundwater recharge is highly influenced by Geology, Geomorphology, Land use /land cover, Drainage, Surface Water Body, Weathered Thickness and first fractured Depth in the area. In order to ascertain the suitable area for groundwater recharge in firka, spatial data integration of have been attempted using index overlay model in GIS environ. In this model, above seven layers have been integrated by assigning weightage for the theme having scale of 1-100 and sub-classes of the theme between 1 & 10 scales. The resultant map has been reclassified into four classes(High-low integrated values) indicating the suitable area for artificial recharge and given in fig-7 and described below.

ZONE	% OF AREA COVERAGE	SIGNIFICANCE*
Very high	5	Suitable for all major recharge structures like Percolation pond and stop dam, check dam etc.,
High	19	Suitable for all major recharge structures like stop dam, check dam etc.,
Moderate	41	Suitable for all major recharge structures like earthen check dam, Boulder check dam and Nala bund etc.,
Poor	35	Hilly/Forest /Catchment area

*However, the filed verification is required to confirm above potential area for groundwater recharge.

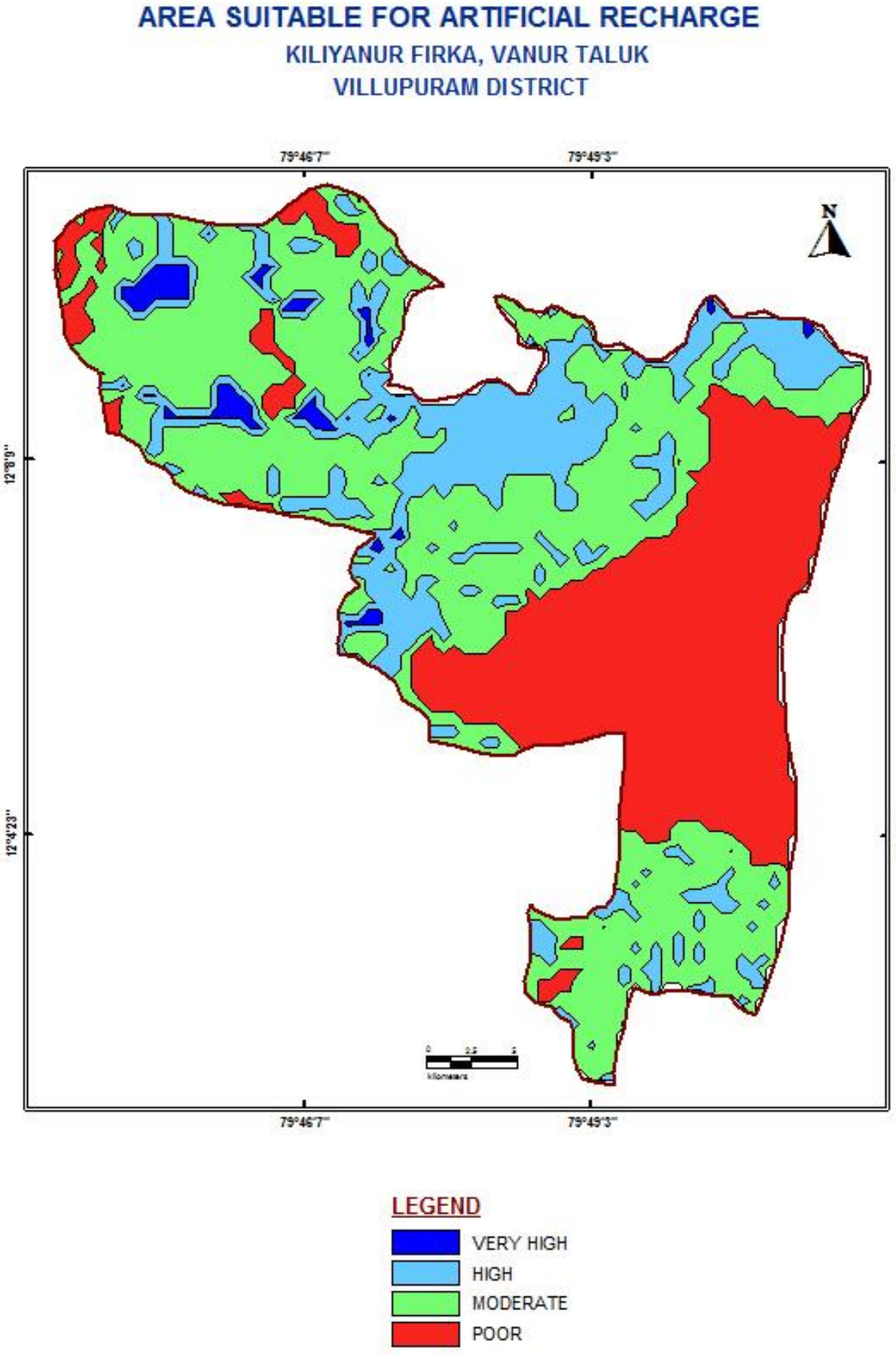


Figure 7. Showing the recharge worthy area Uppuvelur firka

5. Planning for groundwater recharge /conservation

5.1 Justification of the artificial recharge & conservation measures

- The Uppuvelur firkas is with high stage of groundwater development i.e, 119.254 % and with sufficient amount of uncommitted surface runoff/flow of 12.813 MCM.
- The total weathered zone available beneath the ground in the firka is 15.402 MCM. Out of these total volume available for recharge considering water level from 3 m) is 15.9 MCM.
- The Uppuvelur firka consists of number of surface water bodies /lakes which are well connected by the drainage. Revival and Recharge of these ponds will enhance the sustainability of the ground water abstraction structures.
- However, most of the ground water developments for agricultural purposes are met through dug-cum bore well and bore wells only. Hence, there is sufficient scope of recharge.
- Model generated in the Uppuvelur areas reveals that more than 60 % of areas are suitable for recharge.
- In Uppuvelur firka more than 50 % area is characterised by the agricultural activities, there is sufficient scope for the water conservation measures for enhance the crop production and better ground water development.

5.2 Availability of surplus surface water for artificial recharge or conservation

The uncommitted surface flow for Uppuvelur firka is estimated as per the norms followed by State Ground & Surface Water Resources data centre, PWD, Taramani, Chennai (Aug 2015). The available of surplus surface water for Uppuvelur firka is 12.81 MCM.

5.3 Proposed interventions including tentative location of artificial recharge /conservation measures

On basis of above description the following three type of approach have been made to propose artificial recharge or conservation structures.

a. Artificial recharge
b. Water conservation measure
c. Water Efficiency

5.3.1 Artificial recharge

The details of artificial recharge structure proposed along with justification are given below.

5.3.1.1 Check dam/Nala bund

Uppuvelur firka area is covered by the seasonal nallahs/drains which carry heavy discharge during monsoon period is debauched into the water bodies within a short duration. It is proposed that such seasonal nala will be identified and the rain water will be harnessed through construction of series of check dams, nala bund and gabion structures so as to harness this water thereby increasing the resident period of the water in these channels and to increase the soil moisture

content. As per the integrated model prediction around 25 % of the firkas areas are suitable for these structures. It is proposed to construct 17 Check dam and 14 Nala bunds. The tentative location of these 31 ARs are given below and shown in Plate 1. The size and location of these structures are tentative and details field survey is essential to ascertain the exact size and location.

Tentative location of proposed 17 Check dam in Uppuvelur firka

S. NO.	LONGITUDE	LATITUDE	TYPE OF ARS
1	79.767	12.172	Check Dam
2	79.781	12.165	Check Dam
3	79.776	12.142	Check Dam
4	79.743	12.137	Check Dam
5	79.734	12.159	Check Dam
6	79.775	12.131	Check Dam
7	79.811	12.135	Check Dam
8	79.816	12.140	Check Dam
9	79.830	12.140	Check Dam
10	79.834	12.149	Check Dam
11	79.826	12.150	Check Dam
12	79.846	12.159	Check Dam
13	79.851	12.154	Check Dam
14	79.833	12.057	Check Dam
15	79.835	12.054	Check Dam
16	79.844	12.058	Check Dam
17	79.815	12.040	Check Dam

Tentative location of proposed 14 Nalla bund in Uppuvelur firka

SL.NO	LONGITUDE(DD)	LATITUDE (DD)	TYPE OF ARS
1	79.744	12.176	Nala Bund
2	79.780	12.150	Nala Bund
3	79.780	12.170	Nala Bund
4	79.784	12.169	Nala Bund
5	79.785	12.146	Nala Bund
6	79.801	12.144	Nala Bund
7	79.809	12.143	Nala Bund
8	79.818	12.152	Nala Bund
9	79.855	12.155	Nala Bund
10	79.781	12.119	Nala Bund
11	79.828	12.048	Nala Bund
12	79.838	12.047	Nala Bund
13	79.845	12.050	Nala Bund
14	79.800	12.089	Nala Bund

5.3.1.3. Revival, repair of water bodies

The existing ponds and tanks in loose their storage capacity as well as the natural ground water recharge through these water bodies has also become negligible due to siltation and encroachment by farmers for agriculture purposes. There are several such villages where ponds/ tanks are in dilapidated condition. These existing village tanks which are normally silted and damaged can be modified to serve as recharge structure in case these are suitably located to serve as percolation tanks. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structure. Several such tanks are available in the area which can be modified for enhancing ground water recharge. Studies, however, are needed to ascertain whether the village tanks are suitably located to serve as recharge structures. The locations of about 21 existing ponds/tanks have been identified with latitude and longitude given below and marked on Plate 1. The above 21 tanks/ponds could be taken up for the renovation with recharge shaft.

Tentative location of proposed de-siltation of pond/tanks with recharge shaft Uppuvelur firka.

Sl. No.	LONGITUDE	LATITUDE	STRUCTURE	ACTION
1	79.752	12.174	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
2	79.762	12.173	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
3	79.813	12.158	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
4	79.785	12.147	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
5	79.830	12.146	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
6	79.776	12.144	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
7	79.783	12.143	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
8	79.779	12.139	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
9	79.752	12.137	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
10	79.779	12.134	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
11	79.815	12.132	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
12	79.810	12.133	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
13	79.820	12.130	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
14	79.801	12.129	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
15	79.792	12.128	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
16	79.793	12.126	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
17	79.824	12.070	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
18	79.835	12.068	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
19	79.847	12.066	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
20	79.847	12.064	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
21	79.842	12.045	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT

5.3.2 Water conservation measure

5.3.2.1 Farm Pond

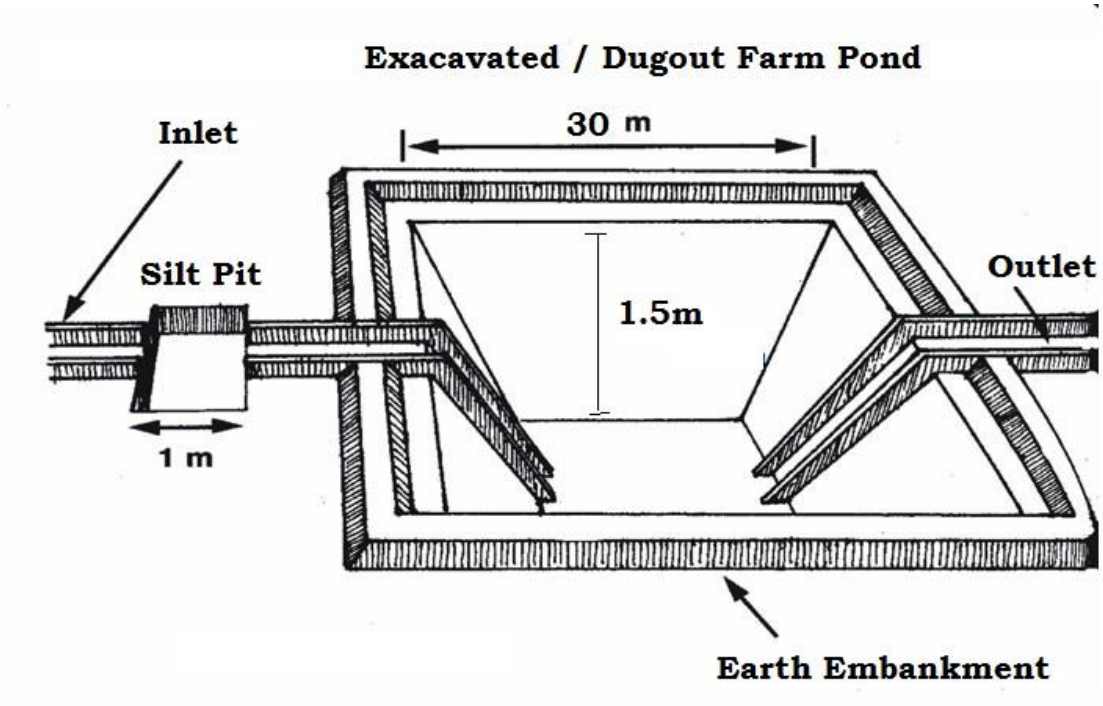
A farm pond is a large dug out in the earth, usually square or rectangular in shape, which harvests rainwater and stores it for future use. It has an inlet to regulate inflow and an outlet to discharge excess water. The pond is surrounded by a small bund, which prevents erosion on the banks of the pond. The size and depth depend on the amount of land available, the type of soil,

the farmer's water requirements, the cost of excavation, and the possible uses of the excavated earth. Water from the farm pond is conveyed to the fields manually, by pumping, or by both methods.

Advantages of Farm Ponds

- They provide water to start growing crops, without waiting for rain to fall.
- They provide irrigation water during dry spells between rainfalls. This increases the yield, the number of crops in one year, and the diversity of crops that can be grown.
- Bunds can be used to raise vegetables and fruit trees, thus supplying the farm household with an additional source of income and of nutritious food.
- Farmers are able to apply adequate farm inputs and perform farming operations at the appropriate time, thus increasing their productivity and their confidence in farming.
- They check soil erosion and minimize siltation of waterways and reservoirs.
- They supplies water for domestic purposes and livestock
- They promote fish rearing.
- They recharge the ground water.
- They improve drainage.
- The excavated earth has a very high value and can be used to enrich soil in the fields, levelling land, and constructing farm roads

As per the Land use classification of the firka, majority of the area is covered by the agricultural field. Hence it is proposed to construct 100 farm ponds as per the specification of AED, Govt. of Tamil Nadu (30 x 30 x 1.5 m).



5.3.2.2. Micro Irrigation System (Sprinkler/ drip/ HDPE pipes)

Micro irrigation is defined as the frequent application of small quantities of water directly above and below the soil surface; usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line

In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant. While through drip & sprinkler irrigation wastage of irrigational water could be minimized. The studies on different crops, has revealed that irrigation water is saved drastically. The conveyance losses (mainly seepage & evaporation) can be saved up to 25 to 40% through utilization of HDPE pipes. Initially the scheme is proposed to be implemented in worst affected areas showing deepest water levels and significant declining trends.

It is proposed to take up micro irrigation system in 100 ha. The cost estimation for this component has been taken from SOR of Agricultural Engineering Department (AED), Govt. of Tamil Nadu. Tentative locations of proposed micro irrigation are shown in Plate 1.

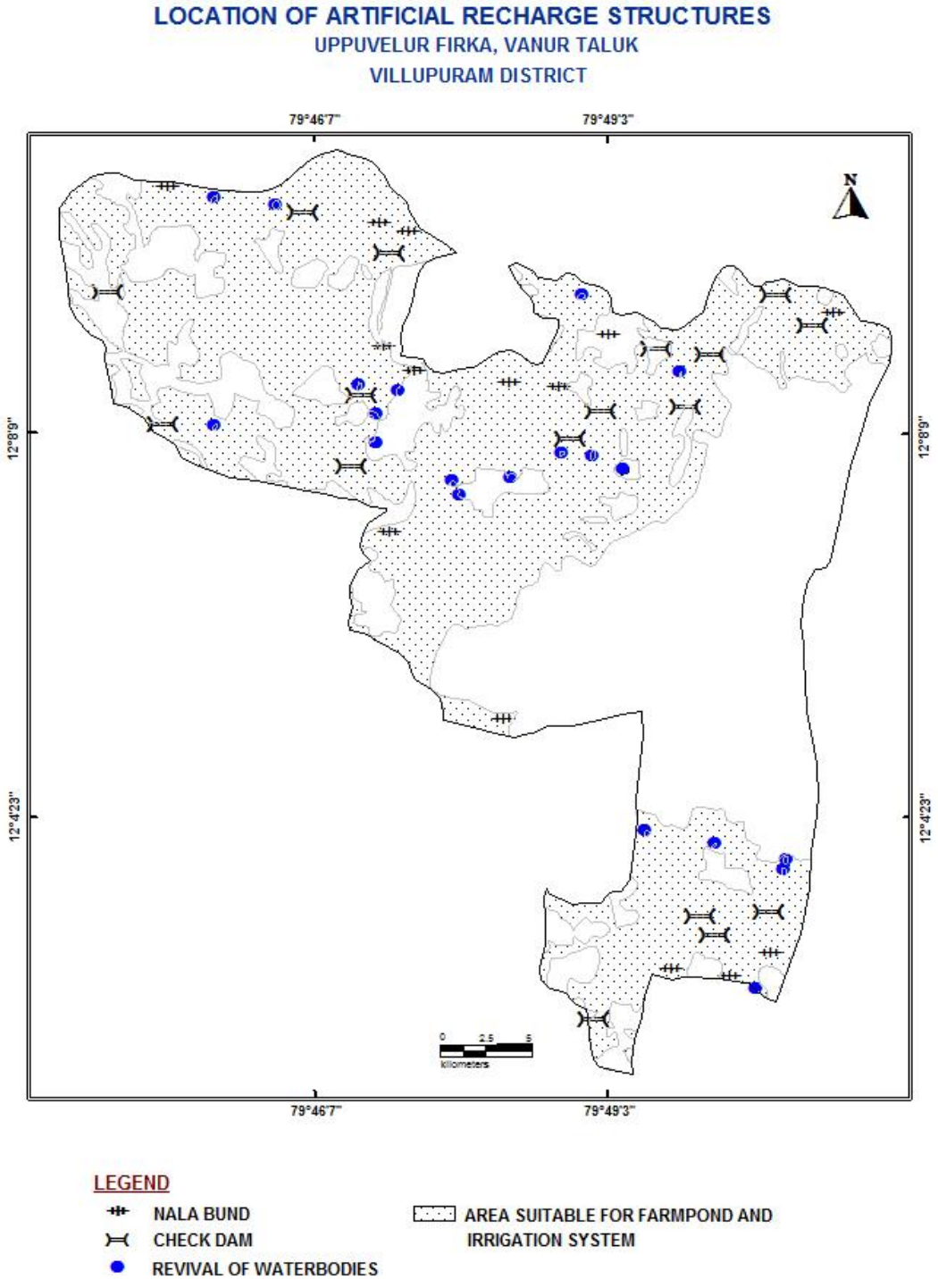


Plate 1. Location map showing the proposed AR Structures in Uppuvelur firka

6. Tentative Cost Estimation

A tentative number of feasible structures, its cost and expected annual groundwater recharge / water saving is given in the table 7.The unit rates are as followed by the PWD, Govt.of Tamil Nadu (Sources : Schedule of rates, Govt.of Tamil Nadu 2015).

Table 7. Showing the Cost Estimation of proposed Artificial Recharge Structures

Feasible Artificial Recharge & Water Conservation structures/ activities	Tentative Design	quantity (in nos. or area in sq. m)	Total volume (cu.m)	Tentative unit cost (in Rs. lakh)	Total tentative cost (in Rs. lakh)	Expected Annual GW recharge /saving(cu.m)
Recharge Structures/ Activities						
Masonry Check dams (5 Fillings)	Crest- 10 -15 m; Height- 1 m to 1.5 m	17	289000	9	153	231200
Nala bunds/ Gabion (4 Fillings)	Width: 5 to 15 m	14	42000	2.0	28	33600
Revival, repair of water bodies (3 fillings)	(~150mx150mx1.5m)	21	2126250	12	252	1701000
Recharge shaft with the pond /tanks	Recharge shaft of 1.5m dia with 2m depth with filter media in lower 1m, Bore dia 10" Casing 6" Depth 30m	21		2	42	
Water Conservation Activities						
Farm Pond (in ha) (5 filling)	(30 m x 30m x 1.5 m)	100 unit	600000	1	100	510000
Sprinkler/ drip/ HDPE pipes	For 1 ha with 5 m interval HDPE pipe	100 ha	1000000	0.6 /ha	60	700000
				Sub total	**635**	**3175800**
Impact assessment and O & M						
Piezometers Up to 50 m bgl – 3 nos. @ 0.6 lakh					**1.8**	
Total cost of the project					**636.8**	
O & M - 5 % of total cost of the scheme					**31.84**	
Impact assessment to be carried out by the implementing agencies @ 5 % of total cost					**31.84**	
				GRAND TOTAL	**700.48**	

Note:

- The type, number and cost of structure may vary according to site, after the ground truth verification
- CD, PC – the storage of Check dams and percolation ponds is also proposed for irrigating the surrounding areas for enhancing the ground water recharge as well as effective utilisation of the artificial recharge structures.

7. Implication modalities

The implementation of the scheme will be done by the line department of the state selected by the respective State authority. Further, it is to add that more than 50 % MGNREGA works related to water conservation/sustainable management, accordingly a convergence guideline has been made between National Rural Employment Guarantee Act (NREGA) (Ministry of Rural Development) & Programmes of Water Resources (MoWR , RD & GR). The district Villupuram is one among the list of districts identified for Convergence between NREGS and schemes of MoWR. The details of permissible works under convergence are envisaged in the Joint Convergence Guideline.

a.) Time schedule

Steps	1st Quarter	2th Quarter	3rd Quarter	4th Quarter	5th Quarter	6th Quarter	7th Quarter	8th Quarter
❖ Identification of line department /implementing agency and preparation of DPR								
❖ Approval of scheme and release of sanction of funds								
❖ Implementation of ARS								

Phase = one quarter or 3 months or equivalent to financial quarter

b.) Operation and maintenance

In all projects Impact assessment has to be carried out to ensure that projects is economically viable, socially equitable and environmentally sustainable by inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. Accordingly it is proposed to have impact assessment at the rate of 5 % of the total cost of the project for 5 years from the completion of artificial recharge.