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GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES,
RIVER DEVELOPMENT & GANGA REJUVENATION
CENTRAL GROUND WATER BOARD

PLAN ON
ARTIFICIAL RECHARGE TO GROUNDWATER AND WATER CONSERVATION IN TIRUPATI RURAL MANDAL, CHITTOOR DISTRICT, ANDHRA PRADESH STATE

SOUTHERN REGION
HYDERABAD
AUGUST 2016

PLAN ON
ARTIFICIAL RECHARGE TO GROUNDWATER AND WATER CONSERVATION IN TIRUPATI RURAL MANDAL, CHITTOOR DISTRICT, ANDHRA PRADESH STATE

CONTENTS

AT A GLANCE

Name of the Mandal	TIRUPATHI
District	CHITTOOR
State	ANDHRA PRADESH
Total Area(sq. km)	112
Area suitable for Artificial Recharge (sq.km.)	108
Latitude and Longitude	13.592490 to 13.764520 and 79.243580 to 79.464110.
Average Annual Rainfall (mm)	977
Geology	BGC and Quartzites
Average Depth To Water Level (Decadal) (Pre Monsoon)	6.40
Average Depth To Water Level (Decadal) (Post Monsoon)	4.10
Ground Water Resources (2011)	
Annual Replenishable Ground Water Resources (MCM/yr)	12.99
Net Annual Ground Water Availability(MCM)/yr	11.93
Net Annual Ground Water Draft(MCM)/yr	16.94
Projected Demand for Domestic and Industrial Use(MCM)/yr	3.56
Stage of Ground Water Development (%)	140
Surface runoff available (MCM)/yr	28.02
Total Storage Created in the Mandal by Various Agencies (MCM)/yr	0.16
Artificial Recharge/Conservation Measures	
Recharge Structures Proposed (No.s)	Check Dams: 50 Farm ponds: 580, Recharge Shafts: 12
Improving Water use Efficiency	Micro Irrigation System: 2900 ha
Tentative Total Cost in Lakhs (Rs.)	2266.845
Expected Recharge/Savings (MCM)/yr	9.957

1. INTRODUCTION

Tirupati Rural Mandal is one of over-exploited Mandal in Chittor district, Andhra Pradesh State, which is economically backward and chronically drought affected. The Mandal has 29 inhabited villages and with 28 gram panchayats.

2. LOCATION

The Mandal lies between north latitudes 13.592490 to 13.764520 and between east longitudes 79.243580 to 79.464110. The Mandal occupies the eastern part of the Chittoor district and is bounded on the north by Renigunta Mandal, on the east by Yerpedu Mandal, on the south by Ramachandrapuram Mandal and west by Chandragiri Mandal. (Fig.1) The geographical area of the Mandal is 112 sq.km.

3. PHYSIOGRAPHY AND DRAINAGE:

The area is drained by streams which are tributaries of Palar River. The streams are mostly ephemeral in nature. The drainage pattern is dendritic, rectangular to sub rectangular due to the influence of geological structures. (Fig.2)

4. RAINFALL

The average rainfall in the Mandal is 977 mm. The rainfall during the South-west monsoon season i.e., June-September accounts for about 85% of the total rainfall.

5. LAND USE PATTERN

Out of the total geographical area of 112 sq.km, the area covered by forest is 20.19 sq.km and the net area sown is 12.99 sq.km. Barren and uncultivable land is 9.79 sq.km. The land for non agricultural use accounts for 21.63 sq.km.(Fig.3)

6. HYDROGEOLOGY

The area is underlain by granites and granitic gneisses of Archaean age (Fig.4). Ground water occurs in weathered and fractured zones under water table and semi- confined conditions. The weathered zone thickness as per the GEC report is 12 m. The weathered zone has been extensively tapped by dug and dug cum bore wells upto20 m depth, which are mostly dry now. Ground water occurs in the fractured granites up to 200 m bgl. However, the potential fractures are encountered between 50-100 m bgl. The cumulative yield varies from 2-5 lps.

7. GROUND WATER LEVEL SCENARIO

The depth to water level during the pre-monsoon and post-monsoon varies from 10 to 20m. The depth to water levels maps for pre and post monsoon period (2014) are shown in Fig 5 & 6 respectively. The decadal mean water level trend during post monsoon is depicted in the Fig.7.

8. DYNAMIC GROUND WATER RESOURCES

The Ground water availability, Utilization and stage of Development in Tirupati Rural Mandal Chittoor District is given in Table-1.

Table-1: Ground water resources of Tirupati Rural mandal, Chittoor district.

Annual Replenishable Ground water resources (MCM)	12.99
Net Annual Ground Water Availability(MCM)/yr	11.93
Net Annual Ground Water Draft(MCM)/yr	16.94
Projected Demand for Domestic and Industrial use up to 2025. (MCM)	3.56
Stage of Ground water development (%).	140
Whether notified or not with year of notification.	Yes, 2005

9. NEED FOR ARTIFICIAL RECHARGE AND CONSERVATION METHODS

The ground water withdrawal is more than the recharge with a stage of development above hundred percent. The long term water level trend mostly shows a declining trend and the water levels are very deep ranging upto20 m. The sustainability of bore wells has become questionable as many bore wells are either drying up or have recorded reduced yields. There is no surface water irrigation facility in the area. All these factors indicate that there is an urgent need for artificial recharge and water conservation in the Mandal.

10. JUSTIFICATION OF THE ARTIFICIAL RECHARGE PROJECT

Tirupati Rural Mandal falls under high stage of ground water development i.e., 140 % and with sufficient amount of uncommitted surface runoff. The area is completely dependent on ground water for domestic, industrial and irrigation purposes. During the monsoons runoff quickly flows out of the area without natural recharge to ground water. It is necessary to apply artificial recharge techniques to allow more and more recharge through check dams, PTs, MPTs, farm ponds, recharge shafts to cope up with the withdrawal pattern and also to improve ground water situation through various interventions including on farm activities and micro irrigation systems (Sprinkler-Drip-HDPE).

11. AVAILABILITY OF SURPLUS, SURFACE WATER FOR ARTIFICIAL RECAHRGE OR CONSERVATION

The runoff was calculated by taking into account of normal rainfall of the mandal and corresponding runoff yield from Strangers table. The existing storage created by various artificial recharge structures constructed by the State Government, if any, was deducted for calculating the runoff yield to recommend new AR structures.

Total Geographical area (Sq.kms)	112
Hilly Area (Sq.kms)	4
Area suitable for Artificial Recharge (sq.km.)	108
Runoff Yield in MCM/yr.	28.02
Existing No. of Check Dams	21
Storage created MCM/yr.	0.149
Existing No. of Percolation Tanks	1
Storage created MCM/yr.	0.01
Total Existing Storage Created	0.16

12. FEASIBLE ARTIFICIAL RECHARGE STRUCTURES

Since the mandal is categorized as over exploited, there is an immediate need for improving ground water scenario and to ensure sustainability of ground water sources. It is also suggested to create additional storage capacity of surface water bodies which would result in supplementing irrigation thereby reducing the ground water draft. The run off available in the mandal has been assessed as 27.86 MCM/yr, which could be considered for further planning of artificial recharge. However, the number of artificial recharge structures feasible has been recommended in areas, by considering the utilizable yield, number of existing structures, land use, drainage pattern and also where the post monsoon water levels (decadal mean) are more than 5 m bgl., and or decadal trends are either falling or showing insignificant raising trend.

A) Check dams and Percolation Tanks

The area is covered by seasonal nalas – drains, which carry discharge during monsoon period debauched into the water bodies within a short duration. It is proposed to identify such nalas for construction of check dams/Percolation tank with recharge shafts, so as to harness ground water and to increase soil moisture content.

- The site selected for check dam/Percolation Tank should have sufficient thickness of permeable soils or weathered material to facilitate recharge of stored water within a short span of time. The water stored in these structures is mostly confined to the stream course and height is normally less than 2m.

- These are designed based on stream width and excess water is allowed to flow over the crest wall. In order to avoid scouring from excess runoff water cushions are provided on the downstream side. To harness maximum runoff in the stream, a series of such check dams can be constructed to have recharge on a regional scale.

- Considering the annual monsoon rainfall of 977 mm, sufficient rain water can be harnessed. This will improve ground water regime as well as delaying the instant flow into the main river.

- The flow in these seasonal rivers can be sustained up to about 2 to 3 months after monsoon.

- Recharge trenches can also be constructed along upstream side of the check dam/Percolation Tank in the impoundment area for enhancing the ground water recharge rate.

Thus, a total of 50 **Check dams** are recommended.

B). Recharge Shafts

The existing check dams and percolation tanks lose their storage capacity as well as recharge capacity due to siltation. Hence, Recharge shafts are recommended in the existing Check dams and Percolation tanks to enhance the ground water recharge. During the heavy downpours, there will be sufficient accumulation of runoff, which can also effectively be utilized for recharge by constructing recharge shafts. Hence, it is proposed to construct 11 and 1 recharge shafts of 165 mm dia with 30 m depth in the existing check dams and percolation tanks respectively.

C). Farm Ponds

A farm pond is a large dug out in the earth, usually square or rectangular in shape, which harvests rain water 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 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, majority of the area is covered by the agricultural field. Hence, it is proposed to construct580 farm ponds in 29 villages of the Mandal @ 20 farm ponds in each village.

D). 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 wastages 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 2900 ha @ 100 ha per village.

13. TENTATIVE COST ESTIMATES (TIRUPATI RURAL MANDAL)

S.No.	Feasible Artificial Recharge & Water Conservation structures/	No. of Structures/ Quantity	Total Volume (MCM)	Tentative unit cost (in Rs lakh)	Total tentative cost (in Rs Lakh)	Expected Annual GW recharge/savings (MCM)
1	Proposed Masonry Check dams Crest Length -10-15 m, Height-1-2 m) (0.007 MCM*4 fillings)	50	1.4	5	250	1.05
2	Recharge shaft in Check dam (50% of the existing Check dams)	11	0.121	0.5	5.5	0.121
3	Proposed Percolation Tanks (100*100*2.5)* 4 fillings)	0	0	15	0	0
4	Renovation Desilting, Repairs and installation of Recharge Shafts in existing PTS (50% of the existing PTS)	1	0.011	1	1	0.011
5	Proposed Farm Pond (6 filling) 5*5*1.5 dimension @ 20 farm ponds per each village	580	0.08352	0.25	145	0.075168
6	Proposed Sprinkler/drip/HDPE pipes for 100 ha in each village	2900	17.4	0.6	1740	8.7
7	Proposed Piezometers up to 50 mbgl @ one PZ per Village	29	0	0.6	17.4	0
8 (i)	Total (No. of AR Structures)	671	1.62		418.9	1.257
8 (ii)	Total (ha)	2900			1740	8.7
	Total (8(i) + 8 (ii))				**2158.9**	**9.957**
9	Impact Assessment & O & M -5 % of Total cost of the Scheme				**107.945**	
	Grand Total				**2266.845**	

*(Expected annual GW Recharge/Savings MCM - CDS& PTS: 75%, Farm ponds - 90%, Sprinklers-50%, Recharge shafts in existing CDS and PTS-100%)

Note: The type, number and cost of structure may vary according to site, after the ground truth verification.

14. TIME SCHEDULE

Steps	Quarters							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Identification of line department/implementing agency and preparation of DPR								
Approval of Scheme and releases of sanction of funds								
Implementation of ARS								

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

A). Operation and Maintenance

In all projects impact assessment has to be carried out to ensure that project 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 as well as operation & Maintenance at the rate of 5% of the total cost of the project for 5 years from the completion of artificial recharge project.

B). Expected Benefits

The benefits of the project are:

1. The implementation of the project would result in additional recharge/Ground water savings to the tune of 9.957 MCM.
2. Ground water recharge will help in arresting the rapid decline in ground water resources and will also ensure improvement in quality of ground water by dilution.
3. Proposed structures and measures will also enhance the ground water potential and would ensure sustainability of ground water resources. It is estimated that the stage of ground water development may likely to be reduced from the present 140% to 77% (63%)
4. It will also help in controlling soil erosion.

Acknowledgements

The data received from the Director Ground Water Department Andhra Pradesh in respect of the basic inputs is duly acknowledged. The information on existing Artificial Recharge Structures have been taken from the EMUSTER, Department of Rural Development, Government of AP.

EXISTING ARTIFICIAL RECHARGE STRUCTURES
TIRUPATI RURAL MANDAL, CHITTOOR DISTRICT, AP

S.no	Gram Panchayat	Habitation	Structure Type	Longitude	Latitude	Scheme
1	Mundlapudi	Agraharam	Check Dam	79.4600	13.5956	NREGS
2	Mundlapudi	Harijanawada	Check Dam	79.4534	13.5908	NREGS
3	Mundlapudi	Harijanawada	Check Dam	79.4461	13.5848	NREGS
4	Perumalpalle	Kopparavandlapalle	Check Dam	79.3417	13.6106	NREGS
5	Perumalpalle	Laxmipuram	Check Dam	79.3448	13.6115	NREGS
6	Perumalpalle	Laxmipuram	Check Dam	79.3476	13.6101	NREGS
7	Perumalpalle	Sv Nagar	Check Dam	79.3522	13.6093	NREGS
8	Perumalpalle	Sv Nagar	Check Dam	79.3516	13.6150	NREGS
9	Cherlopalle	Cherlopalle	Check Dam	79.3624	13.6050	NREGS
10	Cherlopalle	Cherlopalle	Check Dam	79.3685	13.6113	NREGS
11	Durgasamudram	DurgaSamudram	Check Dam	79.3926	13.5658	NREGS
12	Durgasamudram	Harijanawada	Check Dam	79.3905	13.5584	NREGS
13	Pudipatla	Chaitanyapuram	Check Dam	79.3564	13.6052	NREGS
14	Mallavaram	Gandhinagar	Check Dam	79.3606	13.5997	NREGS
15	Mallavaram	Kalur	Check Dam	79.3427	13.5968	NREGS
16	Mallavaram	MallavaramHw	Check Dam	79.3575	13.5985	NREGS
17	Perur	Staff Quarters	Check Dam	79.3794	13.6254	NREGS
18	Perur	Staff Quarters	Check Dam	79.3780	13.6263	NREGS
19	Perur	Staff Quarters	Check Dam	79.3800	13.6261	NREGS
20	Perur	Staff Quarters	Check Dam	79.3813	13.6243	NREGS
21	Chiguruwada	Chiguruwada (S)	Check Wall	79.3891	13.5896	NREGS
22	Perumalpalle	Chandamamapalli	PT	79.3444	13.6147	NREGS

PROPOSED ARTIFICIAL RECHARGE STRUCTURES
TIRUPATI RURAL MANDAL, CHITTOOR DISTRICT, AP.

S.No.	Mandal	Lattitude	Longitude	Structure_Type
1	Tirupathi Rural	13.5972	79.4654	Check Dam
2	Tirupathi Rural	13.5746	79.4438	Check Dam
3	Tirupathi Rural	13.5702	79.4398	Check Dam
4	Tirupathi Rural	13.5850	79.4618	Check Dam
5	Tirupathi Rural	13.5732	79.3934	Check Dam
6	Tirupathi Rural	13.5817	79.3963	Check Dam
7	Tirupathi Rural	13.5870	79.4061	Check Dam
8	Tirupathi Rural	13.5977	79.4196	Check Dam
9	Tirupathi Rural	13.6082	79.4645	Check Dam
10	Tirupathi Rural	13.6193	79.3638	Check Dam
11	Tirupathi Rural	13.6193	79.3765	Check Dam
12	Tirupathi Rural	13.5907	79.3738	Check Dam
13	Tirupathi Rural	13.6172	79.3463	Check Dam
14	Tirupathi Rural	13.6179	79.3820	Check Dam
15	Tirupathi Rural	13.5698	79.4530	Check Dam
16	Tirupathi Rural	13.5771	79.4759	Check Dam
17	Tirupathi Rural	13.5760	79.4848	Check Dam
18	Tirupathi Rural	13.5686	79.4772	Check Dam
19	Tirupathi Rural	13.5675	79.4669	Check Dam
20	Tirupathi Rural	13.5767	79.4607	Check Dam
21	Tirupathi Rural	13.5884	79.4270	Check Dam
22	Tirupathi Rural	13.5850	79.4172	Check Dam
23	Tirupathi Rural	13.5919	79.3927	Check Dam
24	Tirupathi Rural	13.5997	79.3841	Check Dam
25	Tirupathi Rural	13.5914	79.3607	Check Dam
26	Tirupathi Rural	13.5848	79.3658	Check Dam
27	Tirupathi Rural	13.6018	79.3460	Check Dam
28	Tirupathi Rural	13.6069	79.3367	Check Dam
29	Tirupathi Rural	13.6138	79.3572	Check Dam
30	Tirupathi Rural	13.6066	79.3834	Check Dam
31	Tirupathi Rural	13.6112	79.3989	Check Dam
32	Tirupathi Rural	13.5963	79.4010	Check Dam
33	Tirupathi Rural	13.6060	79.4218	Check Dam
34	Tirupathi Rural	13.6140	79.4209	Check Dam
35	Tirupathi Rural	13.6159	79.4483	Check Dam
36	Tirupathi Rural	13.6097	79.4559	Check Dam
37	Tirupathi Rural	13.5972	79.4550	Check Dam
38	Tirupathi Rural	13.5938	79.4409	Check Dam
39	Tirupathi Rural	13.5958	79.4327	Check Dam
40	Tirupathi Rural	13.5779	79.4263	Check Dam

41	Tirupathi Rural	13.5880	79.4383	Check Dam
42	Tirupathi Rural	13.5933	79.4741	Check Dam
43	Tirupathi Rural	13.5728	79.4716	Check Dam
44	Tirupathi Rural	13.5965	79.4092	Check Dam
45	Tirupathi Rural	13.5983	79.3756	Check Dam
46	Tirupathi Rural	13.6181	79.3578	Check Dam
47	Tirupathi Rural	13.6209	79.3830	Check Dam
48	Tirupathi Rural	13.6048	79.4027	Check Dam
49	Tirupathi Rural	13.6131	79.3827	Check Dam
50	Tirupathi Rural	13.6175	79.3876	Check Dam

Fig.1

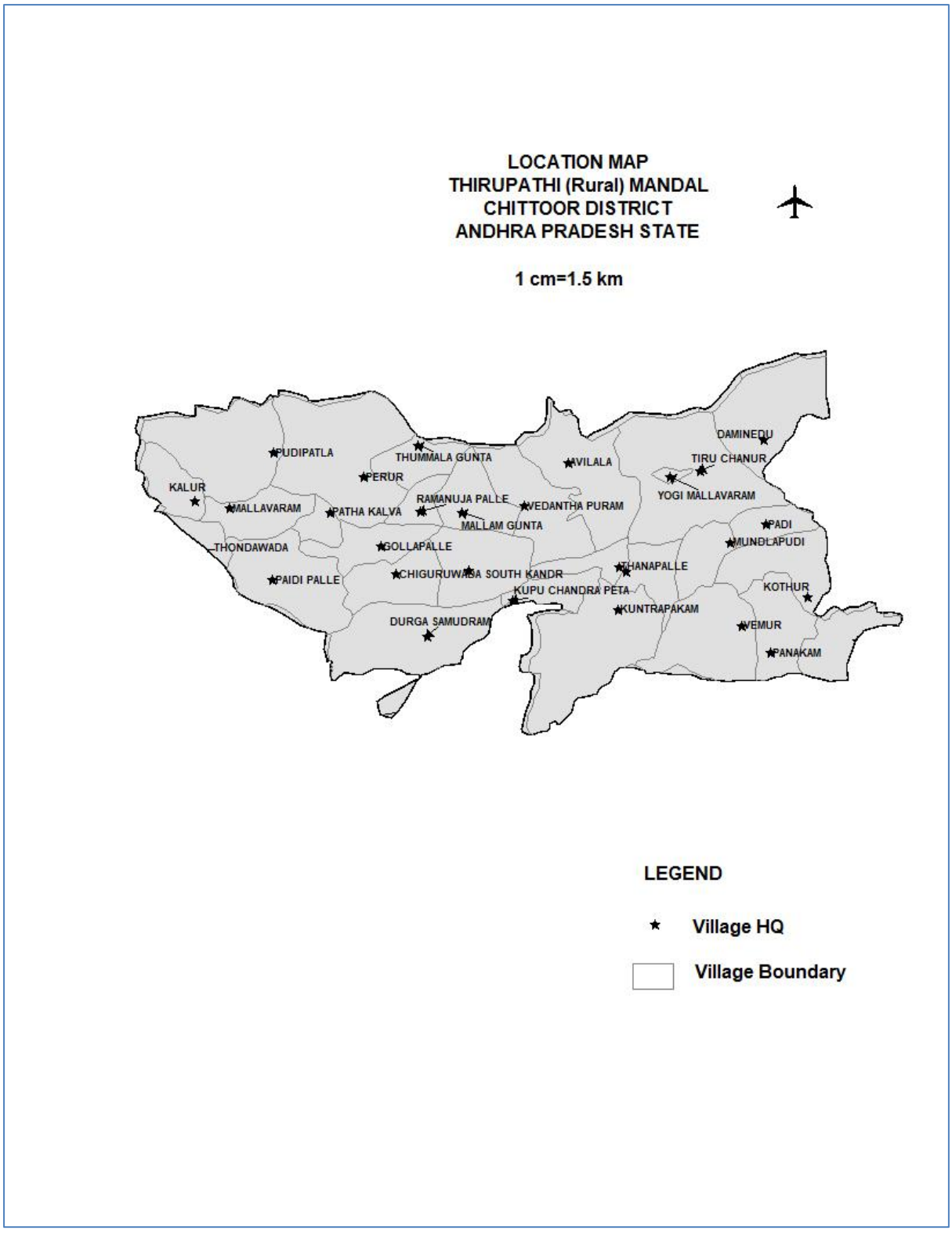

LOCATION MAP
THIRUPATHI (Rural) MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
1 cm=1.5 km
PUDIPATLA
THUMMALA GUNTA
AVILALA
DAMINEDU
TIRU CHANUR
PERUR
KALUR
YOGI MALLAVARAM
RAMANUJA PALLE
VEDANTHA PURAM
MALLAVARAM
PATHA KALVA
MALLAM GUNTA
PADI
MUNDLAPUDI
THONDAWADA
GOLLAPALLE
THANAPALLE
PAIDI PALLE
CHIGURUWADA SOUTH KANDR
KUPU CHANDRA PETA
KOTHUR
KUNTRAPAKAM
DURGA SAMUDRAM
VEMUR
PANAKAM
LEGEND
Village HQ
Village Boundary

Fig.2

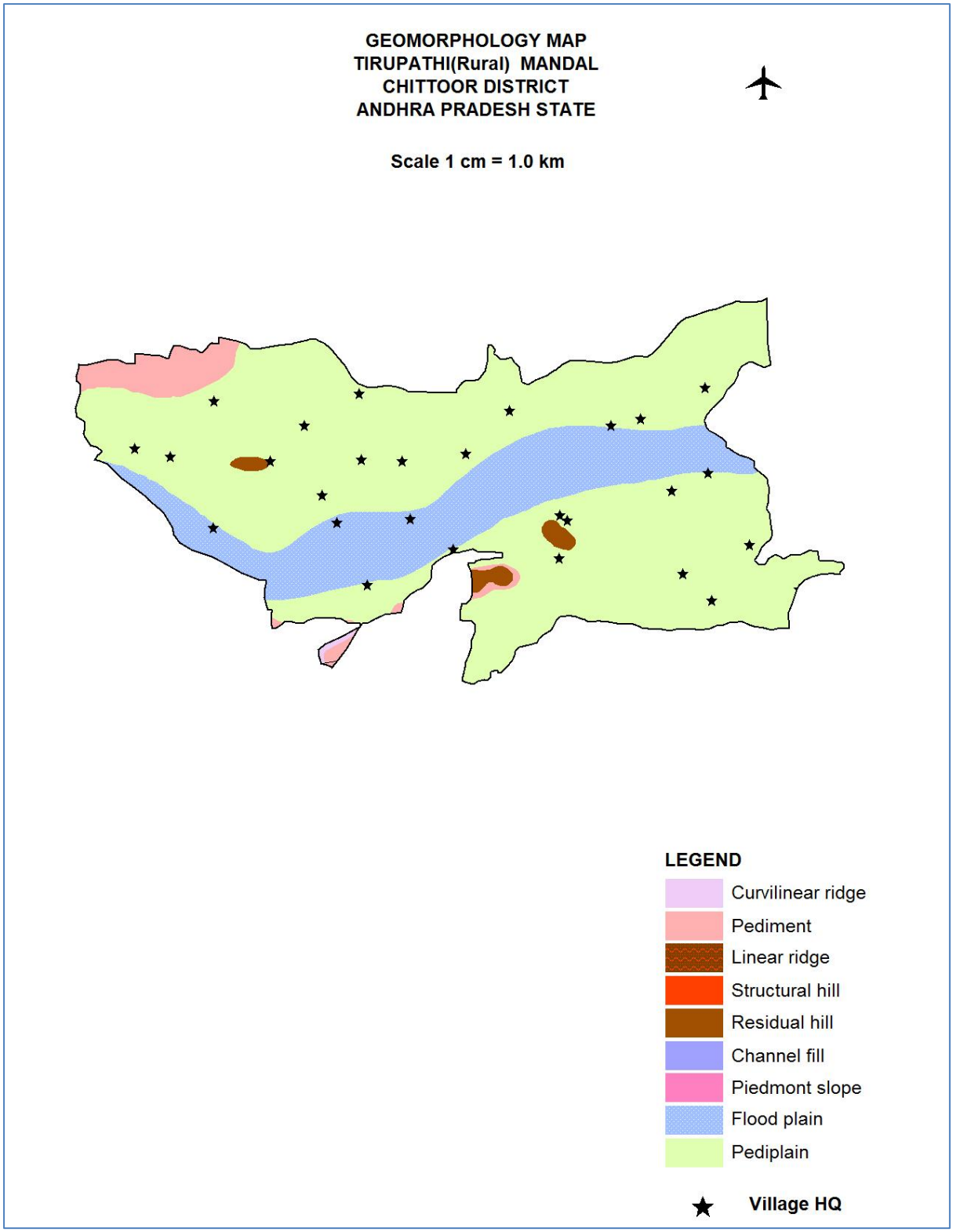

GEOMORPHOLOGY MAP
TIRUPATHI(Rural) MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
Scale 1 cm = 1.0 km
LEGEND
Curvilinear ridge
Pediment
Linear ridge
Structural hill
Residual hill
Channel fill
Piedmont slope
Flood plain
Pediplain
Village HQ

Fig.3

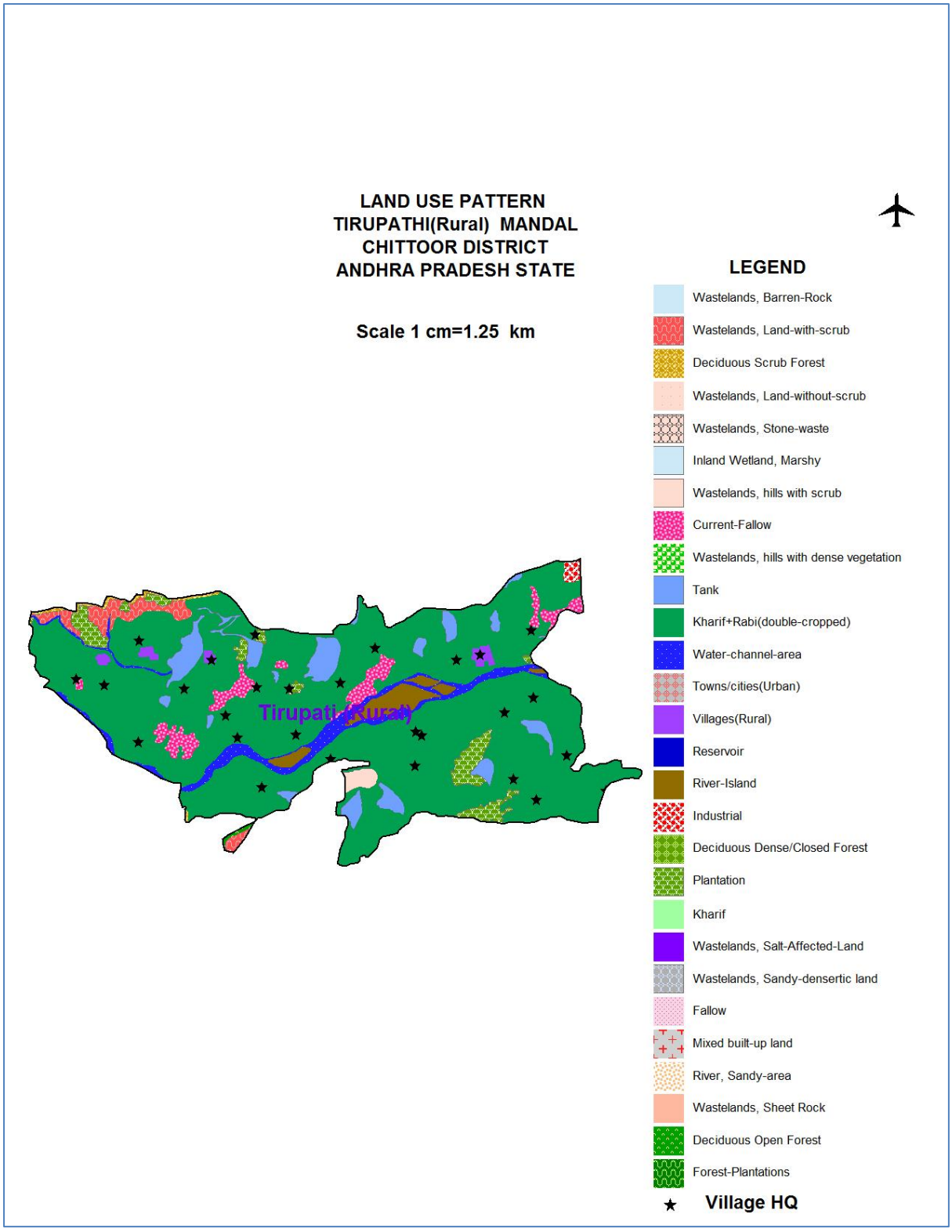

LAND USE PATTERN
TIRUPATHI(Rural) MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
Scale 1 cm=1.25 km
Tirupati (Rural)
LEGEND
Wastelands, Barren-Rock
Wastelands, Land-with-scrub
Deciduous Scrub Forest
Wastelands, Land-without-scrub
Wastelands, Stone-waste
Inland Wetland, Marshy
Wastelands, hills with scrub
Current-Fallow
Wastelands, hills with dense vegetation
Tank
Kharif+Rabi(double-cropped)
Water-channel-area
Towns/cities(Urban)
Villages(Rural)
Reservoir
River-Island
Industrial
Deciduous Dense/Closed Forest
Plantation
Kharif
Wastelands, Salt-Affected-Land
Wastelands, Sandy-densertic land
Fallow
Mixed built-up land
River, Sandy-area
Wastelands, Sheet Rock
Deciduous Open Forest
Forest-Plantations
Village HQ

Fig.4

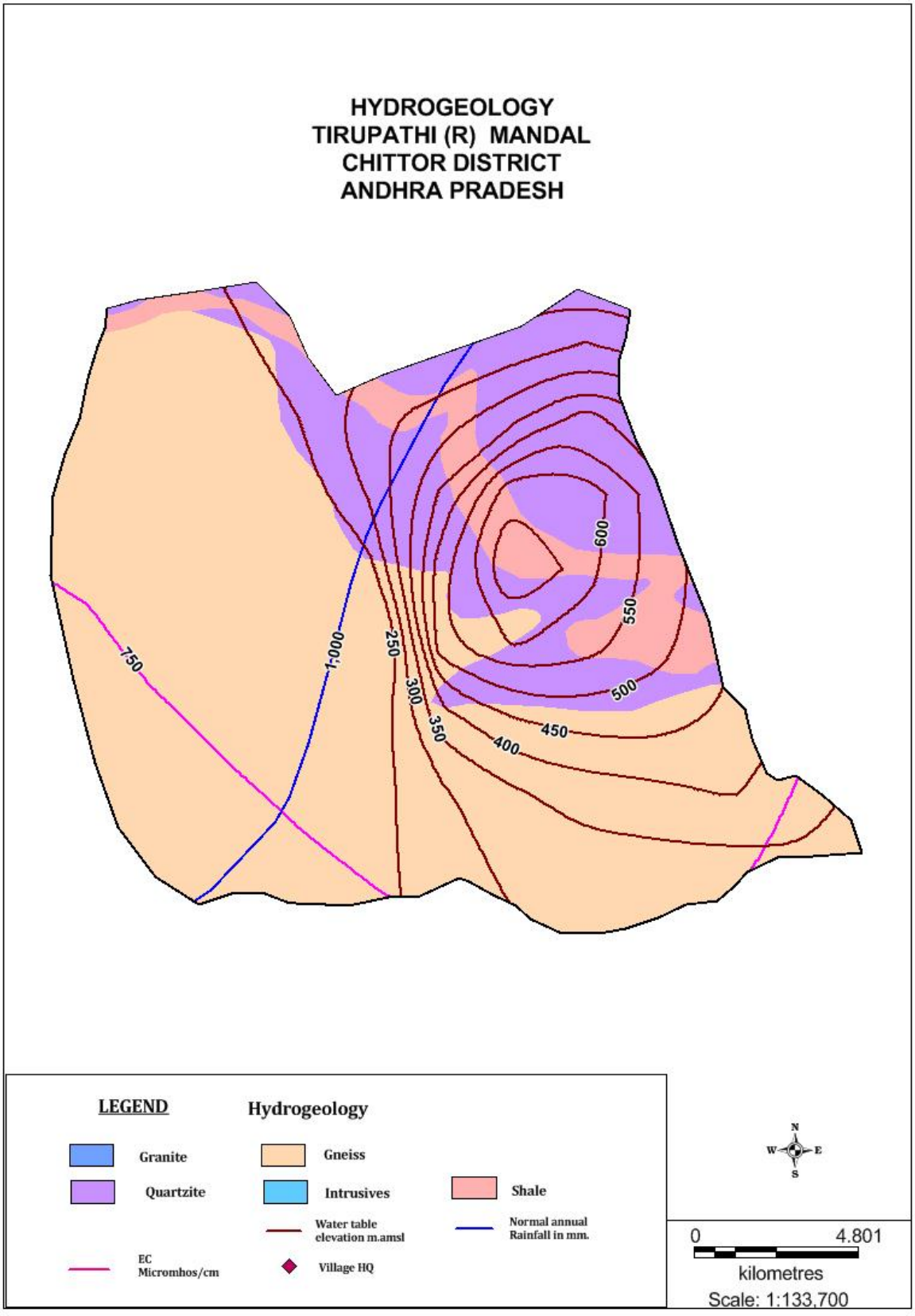

HYDROGEOLOGY
TIRUPATHI (R) MANDAL
CHITTOR DISTRICT
ANDHRA PRADESH
600
550
500
450
400
350
300
250
1,000
750
LEGEND
Hydrogeology
Granite
Gneiss
Quartzite
Intrusives
Shale
Water table elevation m.amsl
Normal annual Rainfall in mm.
EC Micromhos/cm
Village HQ
N
W
E
S
0
4.801
kilometres
Scale: 1:133,700

Fig.5

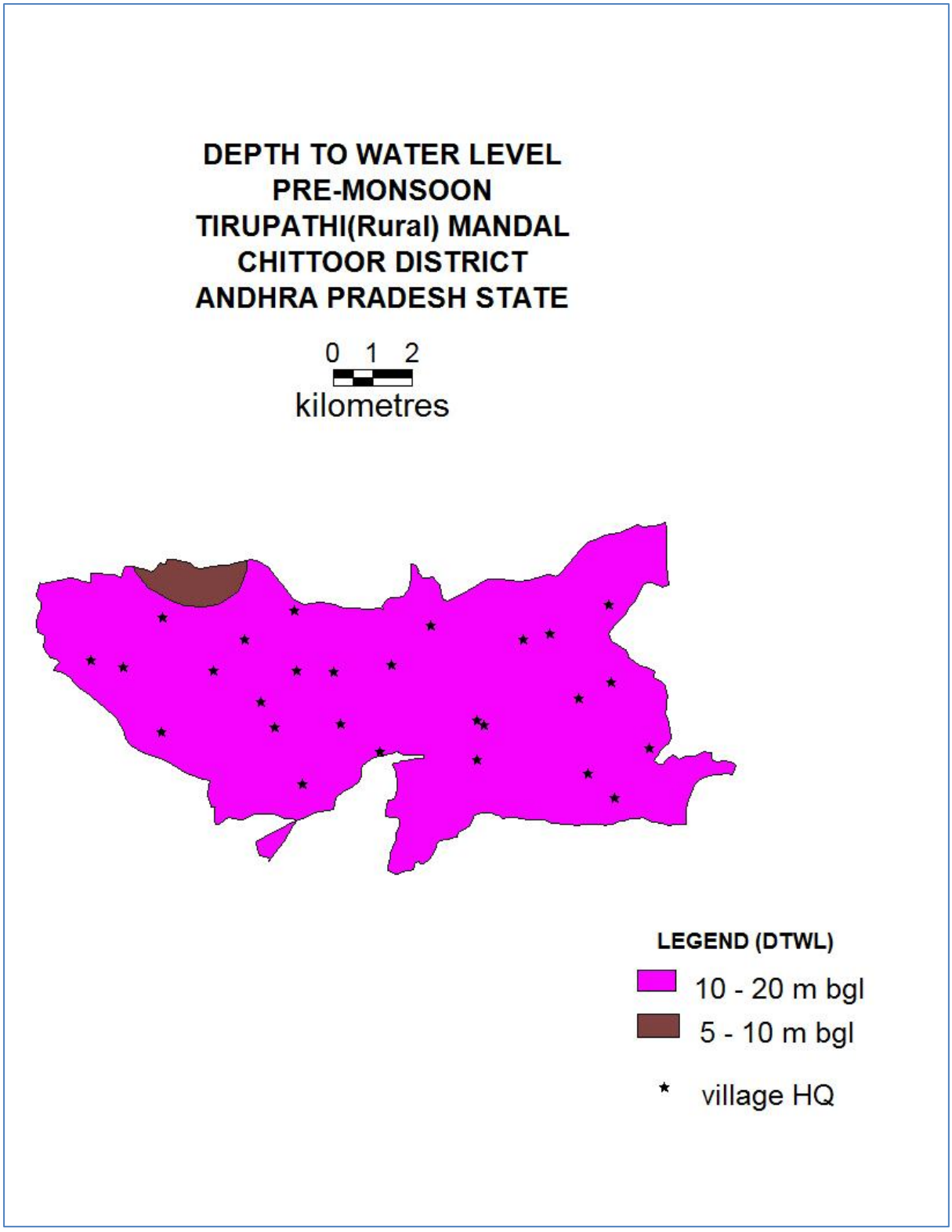

DEPTH TO WATER LEVEL
PRE-MONSOON
TIRUPATHI(Rural) MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
0 1 2
kilometres
LEGEND (DTWL)
10 - 20 m bgl
5 - 10 m bgl
village HQ

Fig.6

DEPTH TO WATER LEVEL
NOVEMBER 2014
TIRUPATHI(Rural) MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE

1 cm=1.5 km

LEGEND

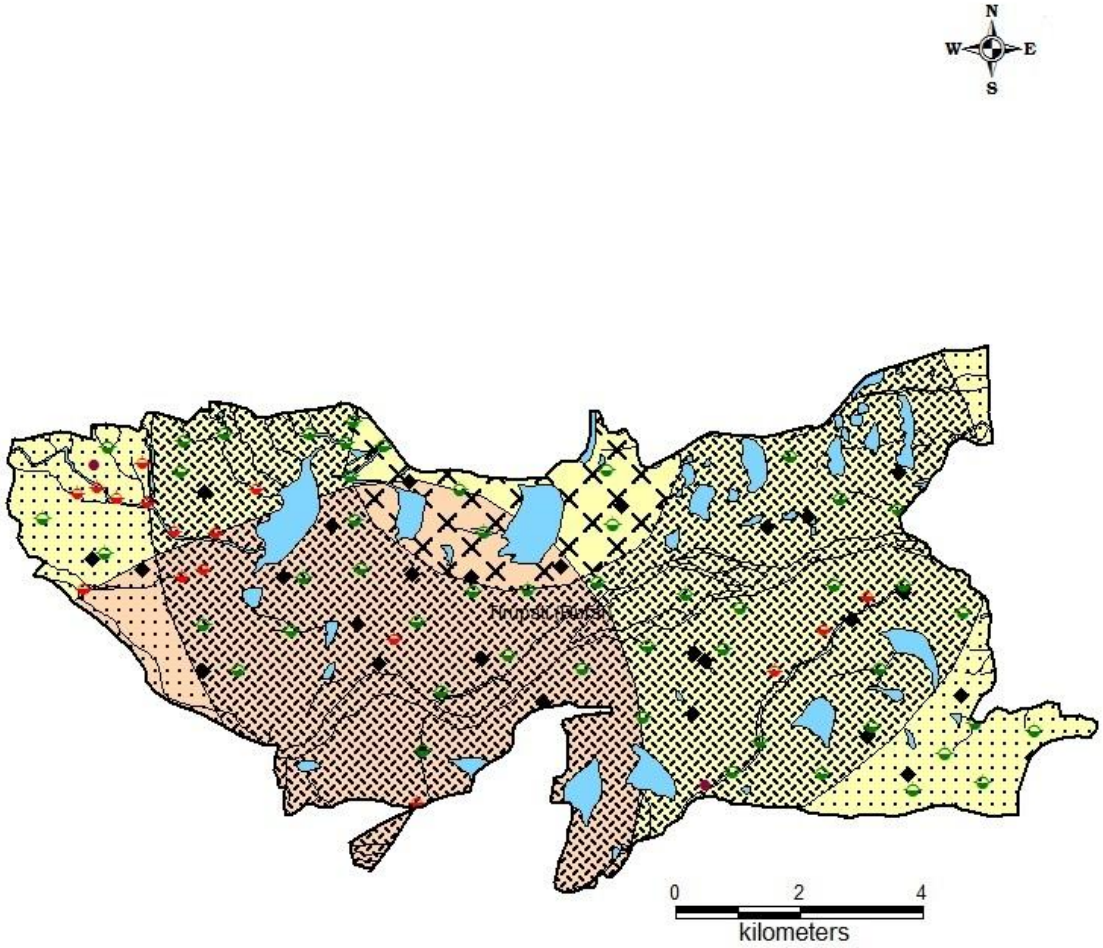
5 - 10 m bgl

10 - 20 m bgl

Village HQ

Fig.7

Post Monsoon Water Level and Trend (Decadal Mean) along with
Existing and Proposed Artificial Recharge Structures in
Tirupathi (Rural) Mandal, Chittoor District, Andhra Pradesh



LEGEND

Post Monsoon Water Level (m) (Decadal Mean)

- 10 - 15
- 15 - 20
- 20 - 25

Post Monsoon Water Level Trend (m/yr)

- -1 to 0.1 (Rising to Falling)
- 0.1 to 1 (Falling)

- Village HQ
- Drainage
- Tanks
- Existing CD
- Proposed CD
- Existing PT