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Influence of Minor Irrigation Tanks Storage Water on Ground Water Recharge over Lateritic, Basaltic and Granitic Formations of Gangakatwa Stream Basin-Telangana - India. A Case Study

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ABSTRACT: *In order to investigate the Influence of Minor Irrigation Tanks (Cheruvu), three tanks located in distinct geological formations Lateritic, Basaltic and Granitic, are chosen. Geophysical Resistivity surveys are conducted difference distance parallel to bund, to determine the soil resistivity. Remote sensing images are acquired pre and post monsoon for interpretation of dry and wet area of the tanks its surroundings. Subsequently the collected water samples underwent laboratory for EC analysis. The relationship between the M.I Tanks and Electrical Conductivity (EC) (mS/cm) are established based on the distance of ground water recharge.*

The ground water recharge increases from M.I Tanks storage water up to influence zone due to hydro chemical interaction with geological formations. This phenomenon contributes to the replenishment of groundwater in areas characterized by different geological formations. Based on the interpretation data, strategic plans can be developed, such as desilting of the tanks, percolation tanks, Farm ponds, cheek dams, to enhance their storage capacity. This, in turn, facilitates the optimization of irrigation methods within the region.

KEYWORDS - *Electrical Conductivity, Soil Resistivity, Distance, Variations, Influence Zone, Geological Formations, Minor Irrigation Tanks, Recharge and Remote Sensing.*

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I. INTRODUCTION

Electrical conductivity refers to the ability of water to conduct an electrical current in a solution over a certain distance, usually measured in Siemens (S) per distance. The power for water to conduct electricity comes from the ion concentration within the water, which comes from dissolved solids and inorganic materials like carbonate compounds, chlorides, and sulfides. The conductance level also depends on the ion's potential to bind with water, (Atlas scientific environmental robotics). The E.C of M.I tank water and ground water of the catchment area measured at locations spread all over the study area.

The EC of water is influenced by various factors, including temperature, such as the geology of the watershed, the relative size of the watershed compared to the tank, like human Induced anthropogenic, runoff, atmospheric inputs, evaporation rates, and certain types of bacterial metabolism. Conductivity increases with higher concentrations of chemical ions or dissolved salts in water. The correlation factor between conductivity and ion concentration typically ranges from 0.55 to 0.8 (E.A. Atekwana et al., 2004). Significant changes in conductivity can occur naturally due to factors like flooding or evaporation, as well as due to human-induced pollution, which can have adverse effects on water quality. A sudden increase or decrease in conductivity in a water body may indicate pollution. For example, agricultural runoff or sewage leakage can contribute to an increase in conductivity due to the presence of additional chloride, phosphate, nitrate ions and movement of recharge front over lateritic, basaltic and granitic formations

II. STUDY AREA

The subject of the study Fig 1 is the drainage section of the Gangakatwa basin, a tributary of River Manjera, situated in parts of Vikarabad and Sangareddy Districts in Telangana State, India. The study area as shown in Fig. 1 is bounded by North Latitude170 6' 40"- 170 10' 0" and East Longitude 790 35' 50" - 790 39' 10", and falls within Survey of India Toposheet No. 56G/14 and 56G/15. The area covers approximately 318 Square Kilometers. Elevation ranges between 680 and 540 MSL meters. The average annual rainfall of the

Sangareddy and Vikarabad districts are 910 mm and 833 mm respectively. Water levels vary from 1.0 to 10 m in post monsoon and 5 to 30 m in pre monsoon seasons. Average temperature is 15 to 40 degrees Celsius. In the basin 16 Minor Irrigation Tanks are identified of which three M.I tanks covering one from each terrain such as Lateritic, Basaltic and Granitic respectively are selected for study.

III. METHODOLOGY

In the study area water samples are collected to study the influence of storage water and correlated it with geophysical and remote sensing data. This information is then employed to estimate the variations in water tank areas between dry and wet conditions and brief methodology is shown in Fig. 2.

Water Analysis

20 water samples are collected during pre and post monsoon periods in three Minor Irrigation Tanks, and their downstream catchment areas, formations like Granitic, Basaltic, and Lateritic respectively from study

Fig. 3. In each tank contributed a minimum of 6 to 8 water samples, and the distances ranged from 0 to 1000 meters from the tanks. The water samples are analyzed in laboratory.

The main parameters studied are Electrical Conductivity (E.C) and Distance from the M.I tanks, is analyzed and plotted in Graph.1-3. E.C is a measure of the ability of water to conduct an electric current and is often used as an indicator of the water's salinity or Total Dissolved Solids content. The variations in E.C at distances from the M.I tanks are given in Table. 1. It can provide insights about how storage structures impact the movement of ground water

The Collected Water sample shows many variations Table.1. & Graph 1-3. At Gundam cheruvu, Panchalingala village, the area influence by the water storage up to a distance of 400 meters from the M.I tank during the pre-monsoon season. This influence zone expands to approximately 750 meters from the M.I tank during the post-monsoon season.

At Patha cheruvu, located in Komsetypally village, the area influence by the water storage up to a distance of 100 meters from the M.I tank during the pre-monsoon season. This influence zone expands to approximately 300 meters from the M.I tank during the post-monsoon season.

Where as in Pedda cheruvu village Munipally, the area influence by the water storage up to a distance of 150 meters from the M.I tank during the pre-monsoon season. This influence zone expands to approximately 250 meters from the M.I tank during the Post monsoon season.

Geophysical Surveys:

In the Geophysical Resistivity method involves the generation of an artificial electric field within the Earth's subsurface using either a galvanic battery (DC) or a low-frequency AC generator. This electric current is introduced into the ground through two specific points referred to as the current electrodes, denoted as 'A' and 'B.' Simultaneously, the potential in the area is measured using two additional grounded electrodes known as potential electrodes, labeled as 'M' and 'N.' Electrical resistivity is a measure of the resistance encountered by a unit cube of material to the flow of current across its surface. If 'L' represents the length of the conductor 'A' is its cross-sectional area, the resistance (R) can be defined as:

$R = \rho * (L / A)$

Resistivity (ρa) is calculated using the formula:

$\rho a = \rho * K * (\Delta V / I)$

In this equation, 'ΔV' denotes the potential difference, and 'I' represents the current.

$ar= \rho L/A$

Schlumberger Array Description

The Schlumberger array employs four co-linear point electrodes for assessing the potential gradient at the midpoint. In this array, the spacing between the current electrodes and the potential electrodes follows as 1:5 ratios. The geometric factor 'K' for this specific array can be determined as:

$K = \{(AB/2) - (MN/2)\} / MN$

Alternatively, K can be computed using the following formula:

$K = (a - b) / 2b$

Here, 'a' represents half the spacing between the current electrodes, while 'b' signifies half the spacing between the potential electrodes. The apparent resistivity (ρa) can be calculated as:

$\rho a = \rho * K * (\Delta V / I)$

The Resistivity sounding with Schlumberger array Fig.4 is employed for detection of soils Properties .The survey is carried out parallel to bund in three Minor Irrigation Tank beds, in different Geological formations, like Lateritic, Basalt and Granite. VES data is interpreted by using IPI2 Win Software, Mostly three /four layer curves are opted Table. 2

Remote Sensing:

Maximal definition: Remote Sensing is the acquiring of data about an object without touching it. India's National Remote Sensing Agency defined it as: Remote Sensing is the technique of deriving information about objects on the surface of the earth without physically coming in to contact with them (June 1995).

The Remote Sensing data of the study area are collected from Sentinel Satellite data from European Space Agency Copernicus Program. For the present study, 10 m high-resolution bands of Band 8 (Visible and Near Infrared), Band 4 (Red) and Band 3 (Green) are used to map the water spread areas during pre and post monsoon seasons for the year 20212. The data is interpreted and analyzed statistics of the water spread area (Dry/Wet) is depicted Fig.5 & Table.3

IV. FIGURES AND TABLES

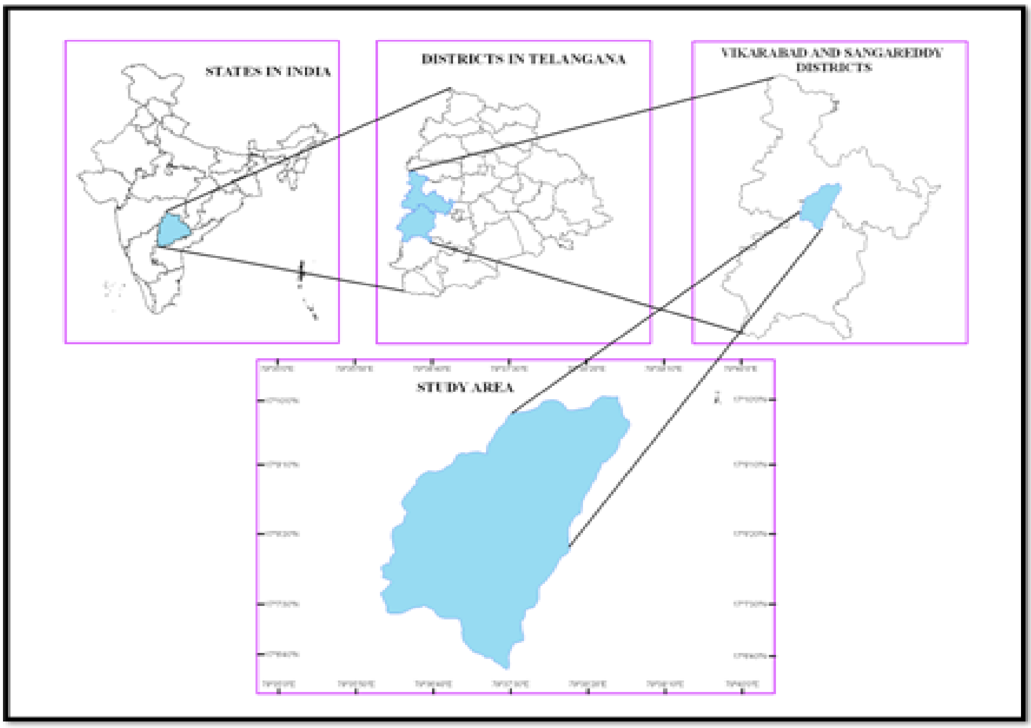


fig. 1 - location map of the study area

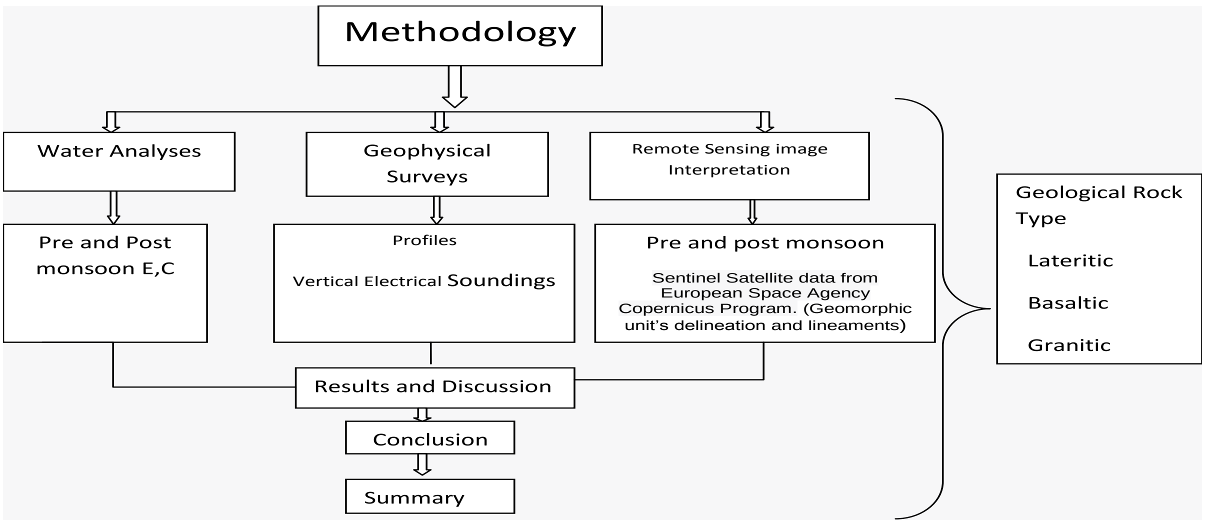


Fig. 2 - Methodology carried out in the study area

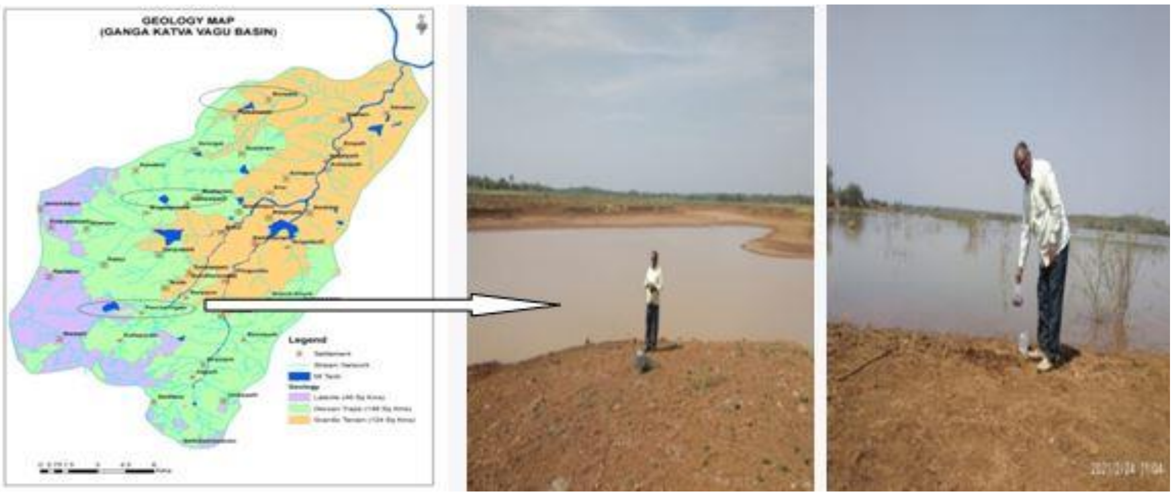
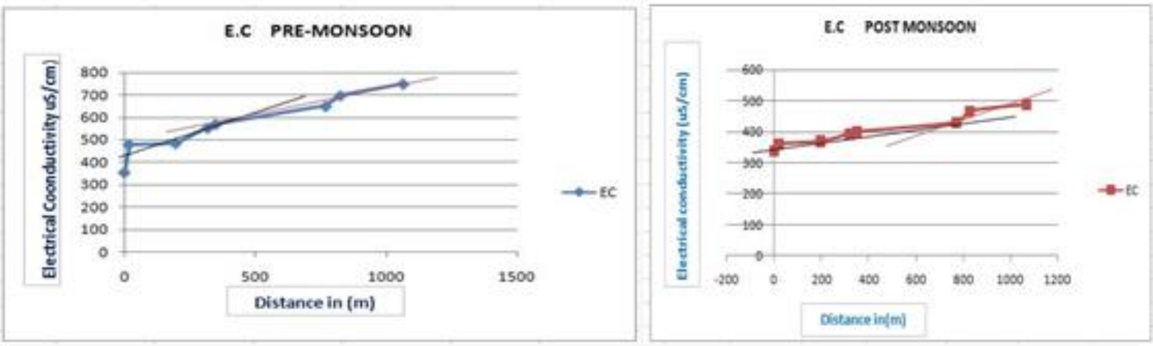
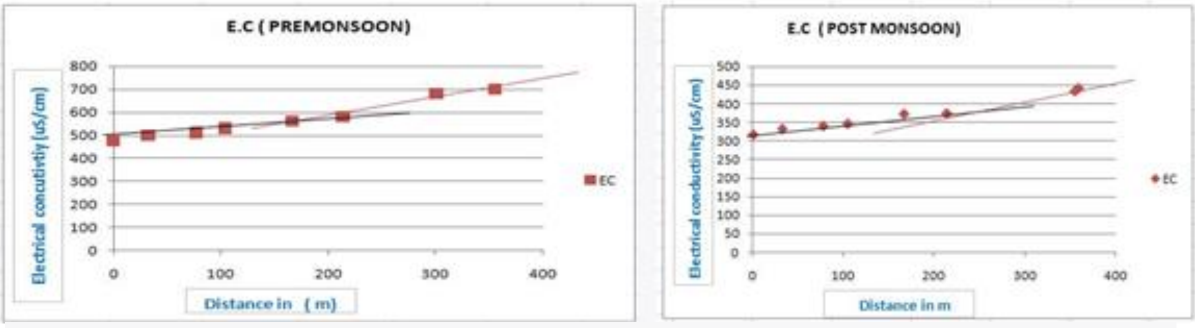


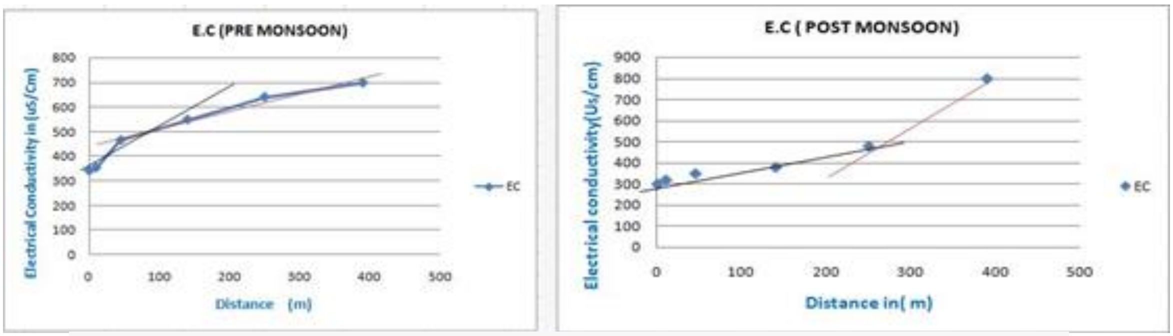
Fig. 3. Collection of Water Sample from Minor Irrigation Tank during Pre and Post monsoon at Gundam Cheruvu, Panchalingala Village.



Graph.1. Gundam cheruvu at Panchalingala village, Pre-and Post Monsoon E.C Variation (mS/cm) VS Distance (in m).



Graph.2. Patha cheruvu Komsetypally village Pre and Post monsoon E.C (mS/cm Variation) VS Distance (in m).



Graph.3 Pedda Cheruvu village Munipally Pre and Post Monsoon E.C (mS/cm Variation) VS Distance (in m).

Table 1. Pre and Post Monsoon E.C Variation (mS/cm) VS Distance (in m)

S.No	Name of the Tank	Location	Geology	Pre Monsoon Distance (in m)	Post Monsoon Distance (in m)
1	Gundam cheruvu	Panchalinga	Lateritic	400	750
2	Patha cheruvu	Komsetypally	Basaltic	100	300
3	Pedda cheruvu	Munipally	Granitic	150	250

Table. 2. Vertical Electrical Sounding Interpretation Data

Vertical Electical Sounding Interpretation Results in (M.I Tank beds)																Analysis			
S.No	Name of the M.I Tank	VES NO	ρ1	h1	ρ2	h2	ρ3	h3	ρ4	h4	ρ5	h5	ρ6	H	Total Avarage Thickness in m)	Top soils Avarage Thickness in (m)	wethered soils Avarage Thickness in (m)	Geology
1	Panchalingala M.I Tank	1	126.0	1.0	9.4	8.0	24.3	23.3	195.0					32	34	1.4	32.6	clay loam Latritic soils /basalts
		6	10.6	1.5	53.0	3.1	6.8	15.0	2332.0	16.8	11.3			36				
		11	10.6	1.6	8.5	7.0	40.7	20.7	25.6	3.2				33				
2	Komsetypally M.I Tank	3	3.5	1.0	5.3	4.3	188.0	6.4	6.0	3.8	1.1			16	16	1.3	14.7	Clay soils /basalts
		6	2.8	1.8	5.7	1.2	2.3	1.8	67.7	1.1	247.0	10.0	531.0	16				
		16	2.2	1.2	5.4	2.9	20.4	7.1	53.1	6.0				17				
3	Munipally M.I Tank	1	8.4	1.6	5.0	3.4	202.0	16.0	9.0					21	24	2	22	clay Sandysoils /granites
		6	4.5	1.2	5.2	5.3	984.0	15.0	22.6					22				
		13	4.6	2.8	6.2	12.0	69.8	8.0	258.0	5.9	340.0			29				

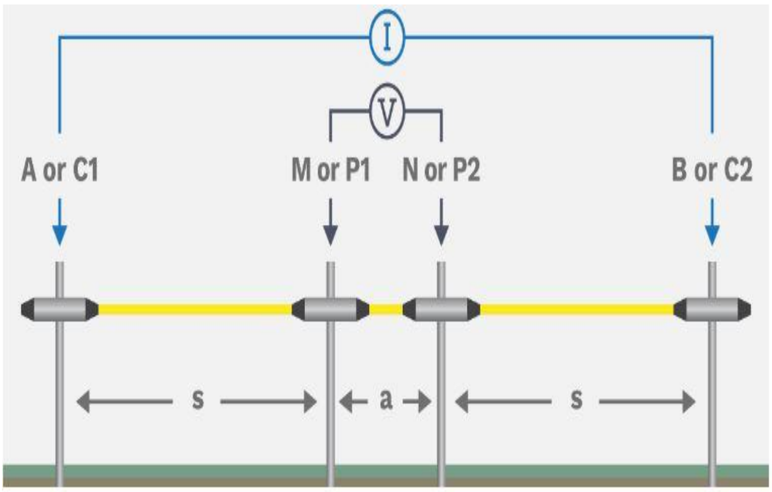


Fig. 4. Schlumberger array

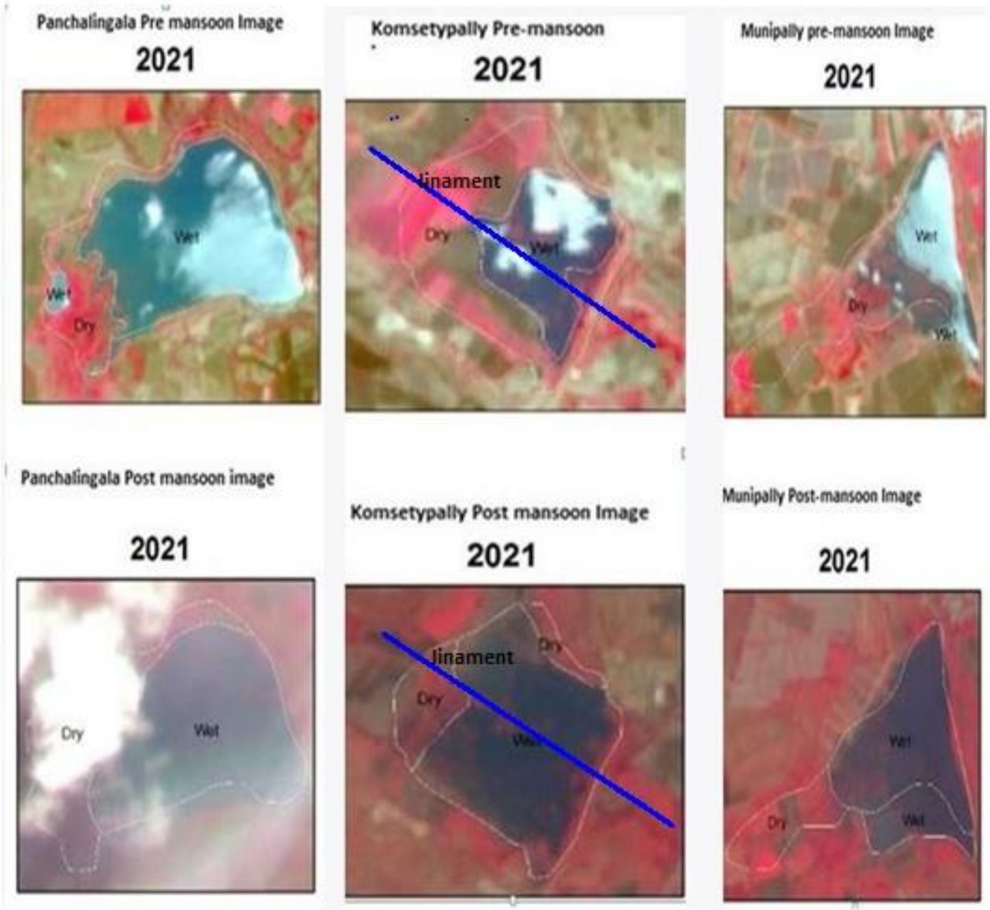


Fig. 5. Pre & Post- Monsoon Images May and November – 2021

Table.3. Statistics of the water spread (Dry/Wet) 2021 Pre and Post Monsoon of the study area

Name of Minor Irrigation Tank	Pre Monsoon (Cu m) 2021		Post Monsoon (Cu m) 2021		Grand Total (Cu m)
	Dry	Wet	Dry	Wet	
Komsetypally (Patha cheruvu)	130,756	80,769	40,586	170,939	2,11,525
Munipally (Pedda cheruvu)	131,172	85,788	14,855	2,02,105	2,16,960
Panchalingala (Gundam cheruvu)	99,904	298,784	145,165	253,523	3,98,688

V. RESULTS AND DISCUSSION

Water samples collected from different geological formations in various locations display significant variations

In Gundam cheruvu , Panchalingala village, located in a lateritic formation the area influence by the water storage up to a distance of 400 meters from the M.I tank during the pre-monsoon season. This influence zone expands to approximately 750 meters

In Patha cheruvu , Komsetypally village, situated in a basaltic formation, the area influence by the water storage up to a distance of 100 meters from the M.I tank during the pre-monsoon season. This influence zone expands to approximately 300 meters

In Pedda cheruvu village, Munipally, located in a granitic formation, the area influence by the water storage up to a distance of 150 meters from the M.I tank during the pre-monsoon season. This influence zone expands to approximately 250 meters from the M.I tank during the Post monsoon season

Geophysical studies

At Gundam chervu tank bed in Panchalinga village revealed specific geological characteristics through Vertical Electrical Sounding (VES) data. The uppermost soil layer lateritic soils having high porosity are a result of leaching and weathering processes over a period of time. It is rich in iron and aluminum. Resistivity ranging from 10.6 ohm m to 126 ohm m, with an average thickness of 1.4 meters, composed of clay loam lateritic soils. The second layer showed signs of weathering, with resistivity varying from 8.5 ohm m to 195 ohm m, spanning a thickness of 34 meters. Below this weathered layer, a third layer of massive basalts was identified. The fourth layer represented the contact zone between basalts and granites, situated at a depth of 34 meters below ground level (bgl).

Similarly, in Komsetypally village's Patha cheruvu tank bed, VES data unveiled the following geological features. The top soil is weathering of basaltic rock dark in colour due to iron and magnesium and low silica. The top layer had a resistivity range of 2.2 ohm m to 3.5 ohm m, consisting of black cotton clay soils with a fine-grained texture and an average thickness of 1.3 meters. The second layer displayed signs of weathering with resistivity varying from 5 ohm m to 240 ohm m, spanning a thickness of 10 meters. Below the weathered layer, a third layer of massive basalts was encountered. The fourth layer, representing the contact zone between basalts and granites, was found at a depth ranging from 10 to 16 meters bgl

Finally, at Munipally village's Pedda cheruvu tank bed, VES data provided information about the geological composition. The top soil layer showed a resistivity range of 4.5 ohm m to 8.4 ohm m, characterized by clay sandy soils of granitic origin with a coarse-grained texture and an average thickness of 2 meters. The second layer exhibited signs of weathering with resistivity varying from 5 ohm m to 984 ohm m and had a thickness of 22 meters. Beneath the weathered layer, a third layer consisting of massive granitic rock was encountered.

Remote Sensing

Regarding Panchalinga village's Gundam cheruvu tank bed, the pre-monsoon and post-monsoon images for 2021 depict the following data. The dry area during the pre-monsoon season covered approximately 99,904 cubic meters, while the wet area amounted to 298,784 cubic meters. In the post-monsoon season, the dry area reduced to 145,165 cubic meters, and the wet area measured 253,523 cubic meters, resulting in a total water storage volume of 398,688 cubic meters. The geomorphic unit is PLS (2) Massive flow 620-600 M lateritic MSL

Similarly, in Komsetypally village's Patha cheruvu tank bed, the pre-monsoon dry area covered about 130,756 cubic meters, with a wet area of 80,769 cubic meters. In the post-monsoon season, the dry area decreased to 40,586 cubic meters, while the wet area expanded to 170,939 cubic meters, leading to a total water storage capacity of 211,525 cubic meters. In The image a lineament is identified NW-SE direction, due that recharge is more comparatively in post monsoon The geomorphic unit is PLS (3) vesicular flow 620-600M basaltic MSL

Lastly, at Munipally village's Peddacheruvu tank bed, the pre-monsoon dry area covered approximately 131,172 cubic meters, with a wet area of 85,788 cubic meters. In the post-monsoon season, the dry area reduced to 14,855 cubic meters, while the wet area increased to 2,02,105 cubic meters, resulting in a total water storage capacity of 216,960 cubic meters. Even though the proportionate water level is more or less same for 3 tanks, the zone of influence is fluctuating due to changes in geological characteristics. The geomorphic unit is BPS -81 pediplain shallow buried granitic MSL

VI. CONCLUSION

The analysis of water samples, geophysical and remote sensing studies conducted in the regions of Gundamcheru, Pathacheru, and Peddacheruvu has provided valuable insights into the diverse geological formations and their impact on groundwater. The study has revealed significant variations in the influence of pre and post monsoon storage on groundwater in these areas.

In Gundamcheruvu , located in a lateritic formation, the groundwater's influence extends to 400 meters distance from M.I Tank in Pre-Monsoon and 750 meters post-monsoon, highlighting the unique characteristics of this geological setting. The Vertical Electrical Sounding (VES) data in this area further confirmed the presence of clay loam lateritic soils and massive basalts at various depths, shaping the hydro geological landform.

Pathacheruvu , situated in a basaltic formation, the influence zone, with 100 meters distance from M.I Tank in pre monsoon and 300 meters post monsoon. The VES data in this region unveiled the presence of black cotton clay soils and the contact zone between basalts and granites. In post-monsoon influence is increasing due to presents of lineament conformed by remote sensing data.

Peddacheruvu located in a granitic formation. The topsoil is the product of weathering, transportation, and deposition processes. It is characterized by its light color, primarily owing to the abundance of feldspar and quartz minerals. These soils exhibit low silica content hard and durable in nature. This Tank displays an intermediate influence zone, with a range of 150 meters before the monsoon season and up to 250 meters after the monsoon distance from M.I Tank. The VES data collected in this region has provided confirmation about the layer parameters and its thickness.

Additionally, the study of tank bed areas in these regions provided data on pre-monsoon and post-monsoon water storage volumes, showing fluctuations in the dry and wet areas. These fluctuations are influenced by rock type.

Overall, the research paper highlights the importance of understanding the geological features of an area when assessing groundwater dynamics and storage influence in different geological formations. This information can be impartment for sustainable water resource management and land use planning in these regions.

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