Journal of Water Resource Engineering and Management
Research paper
Vol 14, issue 1,2024
Receiving date:02-5-2024
Acceptance- 03-05-2024
Publication -04-05-2024

VALIDATION OF WATERSHED MANAGEMENT PLAN AT TARADGAON REGION USING GEOPHYSICAL & GIS TECHNIQUES

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Abstract:
Water is an essential requirement for the survival of the living organisms on earth planet. Though it seems to be available in sufficient amount, unfortunately its distribution in space and time is highly scattered. Therefore, water resources management practices should be identified using the spatial data set collected through remote sensing and other tools for its optimistic usage and exploration.

This study investigates the utilization of Geophysical and GIS Techniques for validating and managing watershed plans in Taradgaon village, Phaltan taluka of Satara district, Maharashtra. The objective is to facilitate the strategic placement of Water Harvesting Structures such as Check Dams, Percolation Tanks, Farm Ponds, Bore Wells, and Dug Wells. Thematic maps including the base map, geological map, drainage map, and DEM map are prepared to aid in the optimal positioning of these water harvesting structures.

Additionally, subsurface investigations employing geophysical resistivity sounding tests are conducted to obtain information regarding the subsurface rock layers and their individual thicknesses. These findings are then correlated with the local geology of the study area to enhance the understanding of the geological characteristics and inform the placement of water harvesting structures effectively.Using this co-relationship the major structures like check dam or percolation tank or farm ponds or bore-well or open dug wells can be explored with reference to its scientific data.

Keywords- *Watershed Management, Electrical Resistivity, Maps, Water harvesting structures*.

1. Introduction:

Water a natural resource occurring both as surface water and groundwater. It is a basic need of human being which is to be fulfilled on higher priority than any other facilities while considering all human activities. Along with human it is vital for plants, animals on the earth. Development of plant, animals and human is completely dependent on the availability of adequate amount of water. Due to large variation in rainfall, it becomes hard to fulfill the basic need.

Nowadays due to tremendous increase in human population, deforestation and increase in industrialization this basic need become hard to fulfill. Hence consumers are dependent on surface and ground water resource, but all these surface water resource under risk due to changing climate and variation in rainfall. To maintain these ground water resources, it's the need to infiltrate maximum rainfall water directly into the ground. This can be achieved by implementing best watershed management practice.

2. Watershed Management:

3. Watershed management represents a transformative initiative aimed at addressing water scarcity challenges in regions facing acute water shortages. It encompasses the development and execution of comprehensive strategies, initiatives, and interventions to preserve and improve watershed functionality, which in turn impacts the well-being of plants, animals, and human settlements residing within the watershed's confines [1, 2, 3].

4. Objectives of Watershed management:

a. To control damaging runoff.
b. To manage and utilize the excess runoff water.
c. To conserve and improve the valuable land.
d. To reduce the effect of soil erosion.
e. To increase rate of infiltration of rainwater.

5. Ground Water Related Issues and Problems:

a. Whole study area is facing drought in almost each and every location especially in the month of March to May i.e. Aradgaon, Chavanwadi and Saswad village.
b. Due to low and fluctuating rainfall, all streams are observed to be dry throughout the year and ground water scarcity is quite common.
c. Increased demand due to population and industrial growth, it becomes hard to fulfill the water demand.

d. In village Hingangaon, Saswad and Aradgaon deeper water levels more than 12 mbgl observed.
e. Still 100% cultivated land is not coming under irrigation, which will be improved by best watershed management practice.

6. Study Area:

Study area is around periphery of village Taradgaon in Phaltan tehsil, in the Indian state of Maharashtra. It is situated near the borders of Khandala and Baramati Tehsil. It is located at 20 km. away from Phaltan tehsil city._Tributaries join larger streams at acute angle, less than 900. It lies between North latitude $18^0 1'36.6"$ and $18^0 1' 51.9"$ and East longitude $74^0 14'59"$ and $74^0 13' 7.14"$ located on survey of India, Topo sheet No.47 K/1, 47 J/4, 47 J/8 and 47 K/5on the scale of 1:50000, covering an area 84.27 sq.km. The average rainfall ranging is 492mm. The study area has a partial hilly and flat topography with its elevation varying from 575.9 above mean sea level to 624 above mean sea level. Entire area is covered by undulating flat surfaces. [Fig. 1]

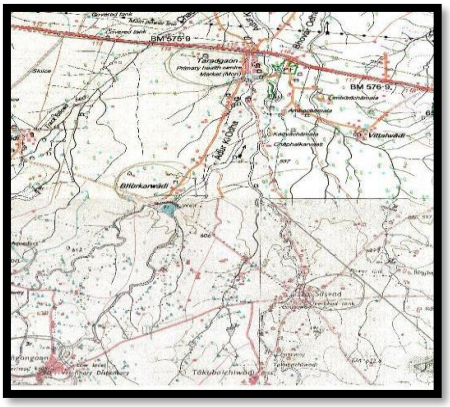

Fig. 1: Toposheet of Study Area.

5.1. Physical Characteristics of Study area:

Physical characteristics of the study area represent the present environmental condition of the place. Some of the useful characteristics in watershed management of study area are:

5.2. Soil:

Soil type usually depends on the type of parent rock and climate. The soils of the study area are generally fall under three categories,

1. Medium black to deep black soil in the plains.
2. Light mineral consisting soil on the slopes of the district.
3. Laterite soils in hilly region of western part and small hillocks in the east region of study area.

5.3. Land Use/Land Cover:

Land cover of area is largely cultivated land. Around 80% of the area covered with cultivated land. Barren land and forest are present in patches. At present cultivated land is been gradually decreasing and converted into barren land due to shortage of irrigation. At the village Hingangaon, Chavanwadi, Aradgaon and Saswad maximum cultivated land remains uncultivated throughout year.

5.4. Agriculture:

Due to adverse climate with unreliable rainfall, unfavorable topography, the total cropping pattern of the study area mainly depend on yearly rainfall as it is main source of surface as well as ground water along with minor and lift irrigation. At present condition Nira right canal lift irrigation scheme in the study area is completely under risk due to high maintenance and improper funding from the concern authority. At the end outcome of these, farmers are completely upset. The farmers at Hingangaon, Chavanwadi and Saswad are dependent on unreliable rainfall.

5.5. Temperature:

Every year April and May is the hottest month with mean daily maximum temperature 33.5^0c and exceeding on several occasions. A mean daily minimum temperature 18.8^0c, goes below during winter. The temperature start increasing from the month of February reached till maximum in the month of May.

5.6. Relative Humidity:

The relative humidity in the study area is moderate in month of March and high in month of June of every year. Mean daily maximum relative humidity recorded 81.6% and mean daily minimum relative humidity 36.7%. The average relative humidity is highest 59.1%.

5.7. Rainfall:

After studying rainfall data (1991-2015) it is observed that, maximum amount of rainfall falls during month June to October, 5 months of every year. Almost whole study area gets most of its rainfall during receding monsoon, accounting for 41% of yearly rainfall in 43 days [10, 15, 16]. Yearly rainfall at study area is 491.42mm which is very low and fluctuating. It is also concluded that after 9 to 10 years, study area facing strong drought condition.

Drainage and Drainage Density:

The study area stream is a 3rd order stream. Tributaries join larger streams at acute angle, less than 90^0. The Drainage map of the study area is prepared with the help of GIS software having flat topography due to which drainage density is very poor. [Fig. No. 2]

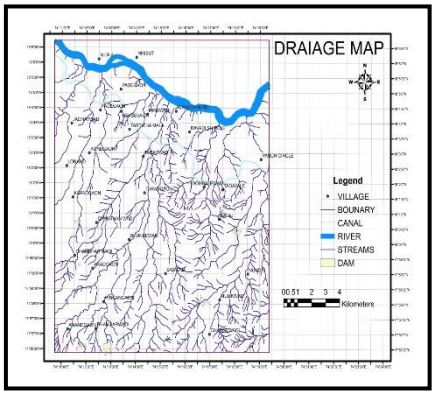

Fig. 2: Drainage map of the study area.

Specific Yield:

Yield refers to the volume of groundwater extracted via gravity drainage from a saturated water-bearing material. When expressed as a ratio relative to the volume of the drained material, it is termed as specific yield.

Hydrogeology:

The geological composition of the region predominantly consists of Deccan Trap basaltic lava flows, spanning from the Upper Cretaceous to Lower Eocene age [10, 12, 15].There is predominance of clay in study area which is found mixed with kankar and low percentage of gravels. In the study area favorable mode of extraction of ground water are through hand pumps, Bore wells and dug wells. Depth to water table survey in the study area shows wide variations and fluctuations of ground water level. In and around Taradgaon village water is very shallow i.e. 5-6 m below ground level but in and around village Hingangaon and Saswad it is 12 m below ground level. In summer season most of well in village Saswad, Aradgaon and Chavanwadi are reportedly dry; hence no accurate assessment could be made on the fluctuation of the water table.

Canal irrigation is confined to a limited area in the north and north east side. Remaining irrigation is done through dug wells resulting in over exploitation of aquifers.

Ground Water Level Fluctuation:

In order to study and observe the depth to water level, data are collected from 28 observation wells from study area. In study area the depth to water level varies widely because topography, drainage system and geological set up. During the Nov. 2014 and May 2015 Pre and Post monsoon water levels were recorded. The dominant range of water level is followed in Taradgaon village range within 5 m bgl, remaining area follow range within or more than 12 m bgl. Apart from this patch in between village Hingangaon and Saswad, Aradgaon and Chavanwadi deeper depth to water levels are observed.

7. Objectives of the paper work:

a. To identify the provision of Water Harvesting Structures made by Irrigation Department, Govt. of Maharashtra.
b. To validate these structures with the present condition for scientific study.
c. Use of Electric Resistivity Sounding for identification of sub-surface formation of the study area.

8. Geology of the Area:

In the present paper work Geophysical survey and survey of various wells have thrown focus on geological characters of the rocks present in the study area. Two lava flows of upper cretaceous to lower Eocene age belonging to Deccan trap formation, Sahyadri group and Indrayani Stratigraphic units are exposed in the study area. The flows are exposed accordingly to their mode or formation from SE to North portion. The area being studied as micro watershed region falls in DTB, where the exposed rocks are compact Basalt (CB), Amygdaloidal Basalt (AB) and some lava matrix (RTB). In the study area, numerous flow formations are discernible, demarcated by ancient buried soils known as red bole. These flows exhibit varying thicknesses, ranging from less than 1 meter to 35 meters, with an average thickness of approximately 15 meters per individual flow unit.

The geohydrological characterization of the area is delineated as follows [Fig. 3]:

a. In the vicinity of Chavanwadi village, closely spaced jointed compact basalt formations with a moderate stage of weathering are prevalent, facilitating percolation.

b. Amygdaloidal basalt formations, along with the contact zones of columnar basalt, exhibit a distinctive jointing pattern conducive to water percolation to shallow depths.

c. Within the villages, a combination of broadly spaced jointed compact basalt flows, unjointed amygdaloidal basalt flows, and the upper sections of freshly hydrothermally altered unjointed basalts are identified. These formations demonstrate poor permeability characteristics.

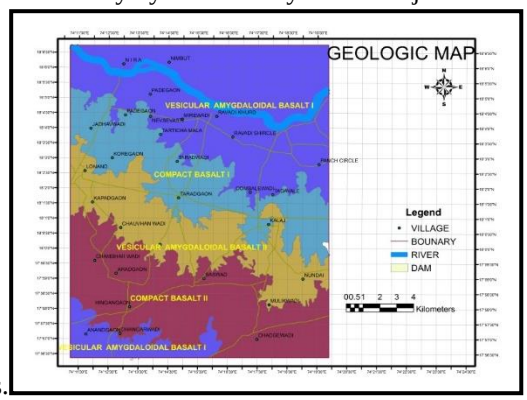

Fig. 3: Geological Map of study area.

9. Methodology:

GIS, Geomorphology and Geophysical studies plays an important role to identify the suitable sites for WHS (water harvesting structures). To identify the artificial recharge zone and suitable sites for water harvesting structures, various thematic maps are prepared like contour map, drainage map, etc. Remote Sensing is used to acquire satellite data [2, 3, 4, 5, 6]. After analyzing the satellite data, DEM i.e. Digital Elevation Model is prepared. To prepare the base map, study of topographical map has been carried out. To create the shape files, first scanning of Topo sheet is done and then Geo-referencing of the toposheet is carried out [Fig. 4]. After digitization of different features like drainage line, water bodies, the base map is prepared which showing settlement, contour line, water body, etc.

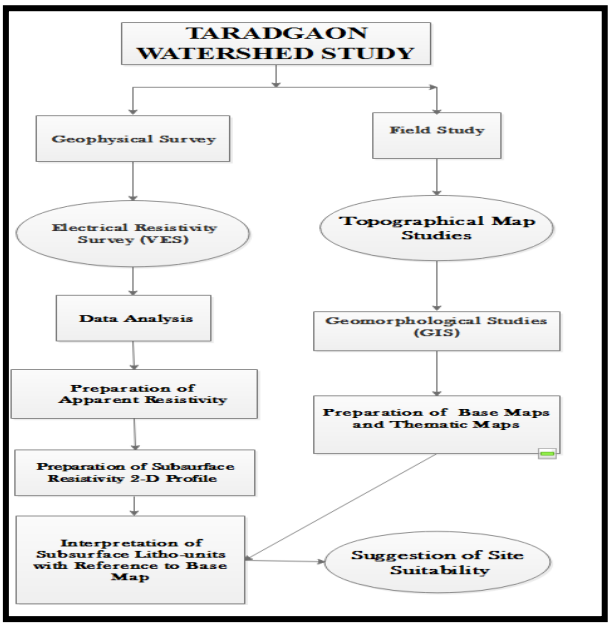

Fig. 4: Flow chart of Methodology.

Electric resistivity is carried out to identify the artificial recharge zone which is favorable for ground water potential development [7-16]. To suggest the suitable sites for water harvesting structures geophysical survey is carried out. Wenner's sounding method is adopted to take the electric sounding readings. [Fig. 5(a,b), Fig. 6(a,b), Fig. 7(a,b), Fig. 8(a,b), Fig. 9(a,b) and Fig. 10(a,b)]

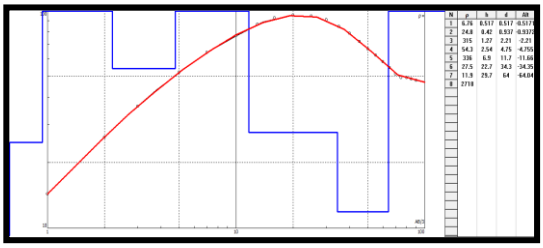

Fig. 5a: Graphical representation of curve matching.

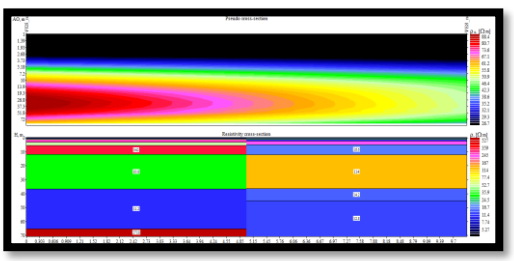

Fig. 5b: 2 D section of Tardgaon & Tardgaon2 area.

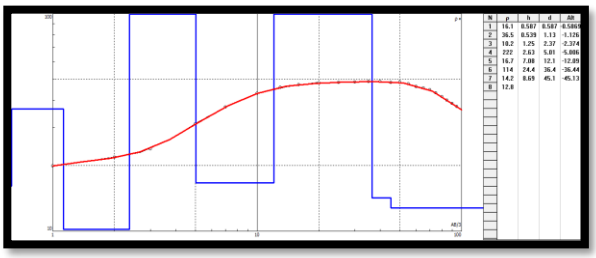

Fig. 6a: Graphical representation of Curve Matching

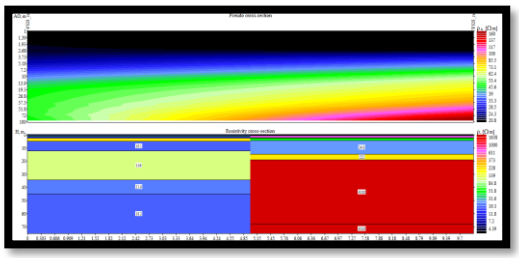

Fig. 6b: 2 D section of Tardgaon & Saswad area

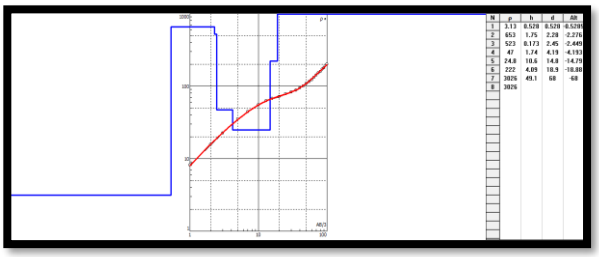

Fig. 7a: Graphical representation of curve matching.

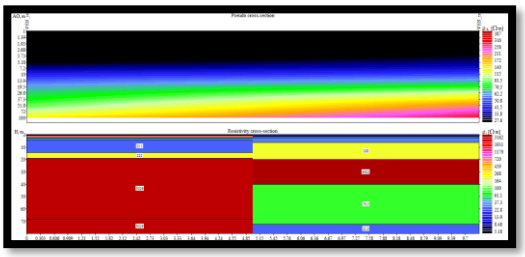

Fig. 7b: 2 D section of Saswad & Hingangaon area.

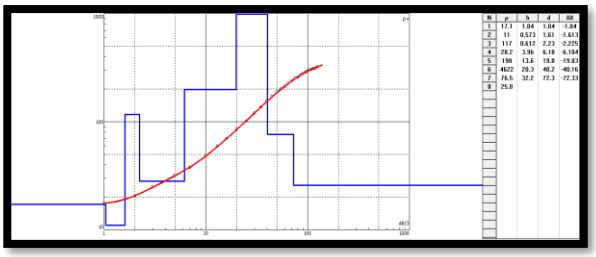

Fig. 8a: Graphical representation of curve matching

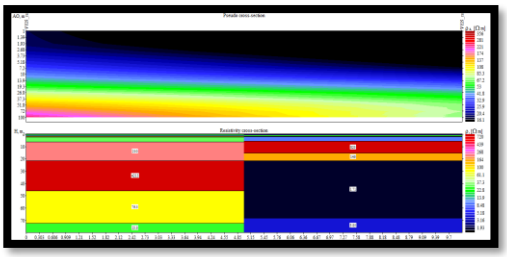

Fig. 8b: 2 D section of Hingangaon & Hingangaon2 area.

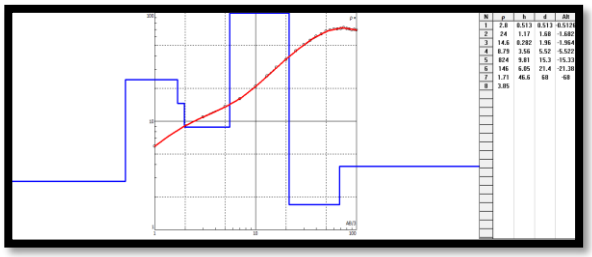

Fig. 9a: Graphical representation of Curve matching

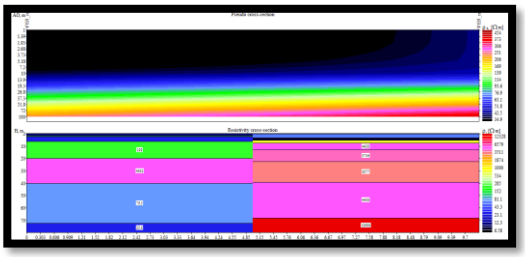

Fig. 9b: 2 D section of Hingangaon & Aradgaon area.

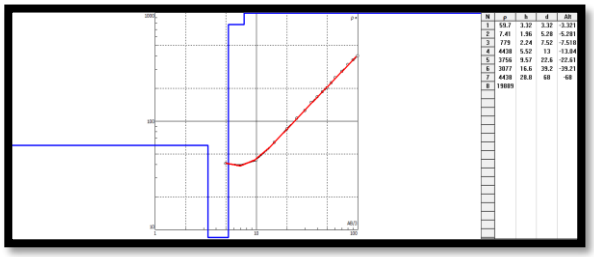

Fig. 10a: Graphical representation of curve matching.

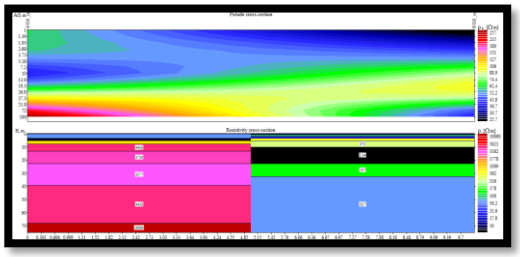

Fig. 10b: 2 D section of Aradgaon & Chavanwadi area.

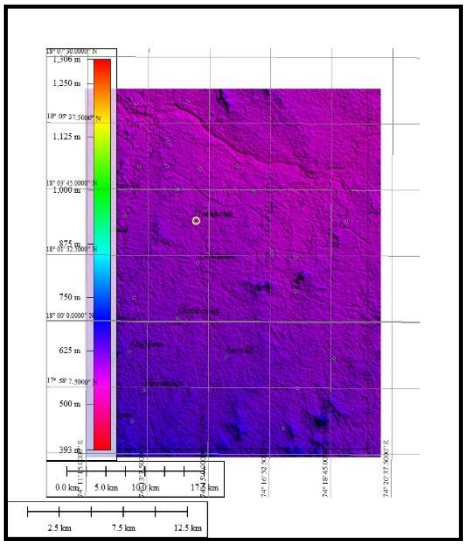

Fig. 11: Digital Elevated Model of Taradgaon Region.

10. Conclusion:

Conclusions from all the above has been predicted by placing it in a model form [Fig. 11] and the same as been derived and listed below as,

a. The geomorphometric analysis helps in understanding the trend of the streams to define the surface water movement. The Third and Fourth order streams will definitely improve the surface movement and if at all small bands are constructed in these regions where the channels have been eroding its own bed can improve the storage capacity.
b. The Bhovar and Adhurki odhas needs to divert towards the western part of the region due to which the Chavanwadi and Aradgaon region will be well recharged by groundwater.
c. The present existing structures needs to be improved as they are being constructed at various locations.
d. The use of GIS and geophysical survey are helpful to prepare 2 D maps and Digital Elevated Model which elaborates the solution for Taradgaon Micro watershed region.

Acknowledgement:

The author[1] express their gratitude towards Dr G. K. Deshmukh, Chairman, VVPIET, Solapur and Mr. Amol (Nana) Chavan, Secretary, Solapur for supporting and providing the necessary facility during the research work. Also author[2] express her gratitude towards the tehsil office of Phaltan for providing the required data during her research work.

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