ISSN 2229-5518

Soil texture analysis of Katepurna river basin, Akola District, Maharashtra with reference to water resource management

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Abstract

In this study an attempt has been made to understand the hydrogeomorphological regime of the Katepurna river basin by utilizing soil texture qualitative classification tool through both the field and laboratory analysis to determine the classes for agricultural soils based on their physical texture. The classes are distinguished in the field by the 'textural feel' which can be further clarified by separating the relative proportions of sand, silt and clay using grading sieves, the particle size distribution. The class is then used to determine crop suitability and to approximate the soils responses to environmental and management conditions such as drought or calcium (lime) requirements.

Geomorphologic studies have demonstrated the presence of five distinct landforms namely shallow dissected plateau, moderately dissected plateau, highly dissected plateau, undulations and valley fills. The shallow dissected plateau is characterized by the presence of thick weathered mantle ranging from 4 to 8 m with less dissection, and intersecting lineaments indicating a potential storage zone. The depth to water level ranges from 5- 10 m bgl during post monsoon and 12 – 18 m bgl in pre monsoon. The safe yield in the open dug wells various from 45 – 70 m/d with sustained discharge of over 3-5 hours indicating phreatic and confined to semi confined aquifer conditions. The moderately dissected plateau occurs along the fringes of steep scarps indicating moderate thickness of the weathered horizons showing 3-5m. The bed rock is shallow and depth to water level various from 3-8 m bgl with moderate water bearing horizons depending upon the placement of interflow zone suggesting the recharge nature and higher hydraulic potential. The highly dissected plateau is characterized by the presence of compact and massive lava flows showing intricate network of dissection. The availability of groundwater is scare due to negligible weathered mantle except where the top portion is either altered or due to the presence of vesicular horizon, which may retain some groundwater. The undulating plains represent potential groundwater horizons due to the availability of aquifer zones. The depth to water levels in highly dissected area various from 15-18 m. The area can be divided into low lying plains towards the Northern side along Purna river valley and abrupt vertical cliffs made up of horizontal basalt flows with multiple scraps towards the southern side.

Key Words: Geomorphology, Soil Texture, weathered horizon, safe yield, groundwater

ISSN 2229-5518

Introduction

Water is the most vital, natural resource for living and is the backbone of the socio economic development of the country. The absence of water results in the absence of life on the Moon. The planet Earth has approximately 71% of this area covered with water contained in the oceans. Water is a natural and basic essential need for survival of human beings and for other living beings including plants and animals. Groundwater has been in use in India from the time of Vedas, which mentions that irrigation was being practiced from the wells in addition to surface water resources. Water is the form of precipitation which terminates into rainfall, river water, surface ponds, and lakes which partly infiltrates into ground in the form of groundwater. Beside that water is one of the main resources essential for the overall socio-economic development of any region and it requires careful planning and appropriate exploration for its sustainable management. Water plays a vital role in the development of any activity in the area. Thus the availability of surface and ground water governs the process of planning and development. The surface water resources are inadequate to fulfill the water demand. Productivity through groundwater is quite high as compared to surface water, but groundwater resources have not yet been properly developed through exploration. Keeping this in view, the present study attempts to select suitable locations for groundwater exploration in hard rock areas using an integrated approach through field investigations, geomorphologic, petrographic, geochemical, stratigraphic, remote sensing, geoelectrical soundings and GIS techniques. Watershed management is the process of creating and implementing plans, programs, and projects to sustain and enhance watershed function that affect the plant, animal, and human communities within a watershed boundary. Features of a watershed that agencies seek to manage include water supply, water quality, drainage, storm water runoff, water rights and the overall planning and utilization of watersheds. Landowners, land use agencies, storm water management experts, environmental specialists, water use surveyors and communities all play an integral part in the management of a watershed. Ground water has and would continue to pay a crucial role for food and fodder production, drinking water supply, drought mitigation and economic development of the country. The ground water being relating to subterranean resource, it needs to be explored through sub surface techniques of ground water exploration.

Integrated watershed development is a multidisciplinary work for overall improvement, conservation and augmentation of land, and water resources. Studies of various disciplines, such as field geology, stratigraphy, petrography, geochemistry, hydro-geology, remotesensing and GIS techniques will certainly aid in the water resource management of any region in addition to hydrogeochemical and geophysical investigations which deal with the above multi disciplinary work. Groundwater bodies and aquifers in hard rocks are mainly

ISSN 2229-5518

considered in its vertical and lateral extent to weathered mantle. The most important factor which control groundwater resources is rainfall and subsequently other hydrological parameters like soil cover, topography, vegetation, type of rocks etc. play an important role. The water resources produced by run-off are estimated on the basis of drainage catchments of watershed. The management and conservation should be planned on watershed basis laying emphasis on capturing the water in-sit for its optimum use in the watershed itself. Watershed of a river basin in the rock formation therefore makes an independent ground water reservoir.

The development of water resources of a basin in an integrated manner, a number of development scenarios have to be copiously considered further more. The statistics nature of water resources adds another new dimension of complexity to the planning process, which is therefore complex undertaking to undergo. Most of the land surface of Maharashtra State is underlain by the Deccan Traps Basalt including the entire highly drought-prone central area with an average rainfall of less than 750 (and locally 500) mm/a. This formation gives rise to a complex low-storage weathered hard-rock aquifer system and in the very extensive rural areas outside the command of (the few) major and minor irrigation canals, it is vital to human survival and livelihoods. But the total available storage of groundwater in hard rock aquifers is strictly limited by their weathering characteristics and water-bearing properties. There is one part of Maharashtra State which possesses a major alluvial aquifer – this is the Tapi – Purna. Groundwater resource depletion has had a series of impacts – spiraling costs for water well and/or pump set deepening, escalating energy consumption and losses in water pumping, serious operating and financial problems for state electricity company (since rural energy is highly subsidized), reduced availability of electricity and/or groundwater supply for irrigation with damage to dry season crops, and problems with provision of drinking water. In this study an attempt has been made to understand the water resource management of the Katepurna River basin, Akola District, MS with special emphasis on soil texture analysis (Fig.1).

ISSN 2229-5518

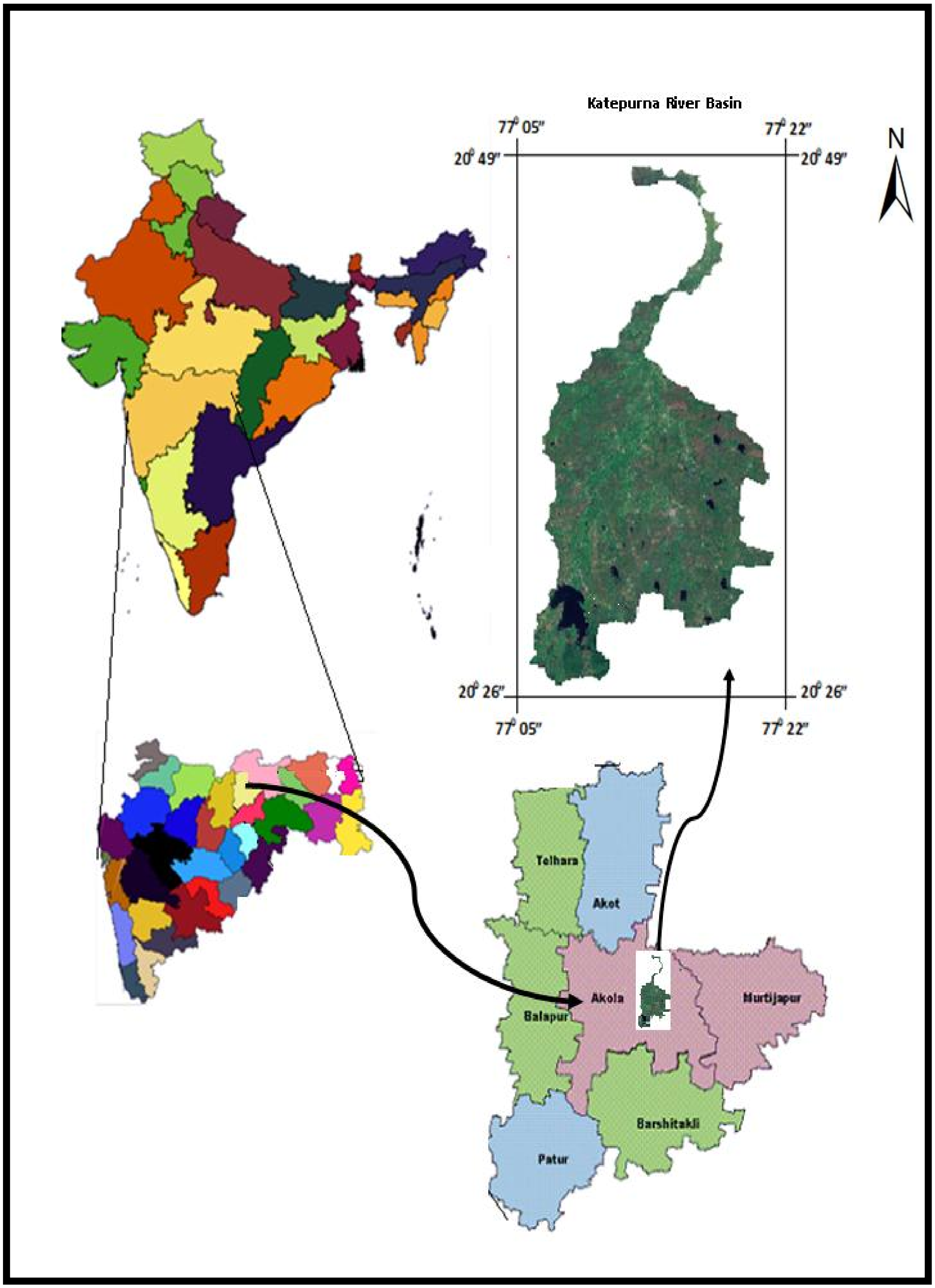

Fig. 1 Location Map of Study Area

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Geological Succession:

The area is mainly occupied by the basaltic lava flow of Deccan trap of Cretaceous to Eocene age. Only few sq km areas is occupied by Purna alluvium in the Northern part of the Katepurna river basin. The basaltic lava flow of Deccan trap is the major rock formation of the area. The flows were emplaced from fissures towards the close of the Mesozoic era. There are several lava flows having thickness varying from 50 to 60 meters. During the long period over which the volcanism giving rise to these flows, there were quiescent phases between these activities which at time were long enough for the development of the drainage and accumulation of clays, silt and sand and the same were covered by the subsequent flows. They thus formed the intertrappeans beds which are often referred as red boles. Whenever the lava flows are thick, top portion were subjected to high spheroidal weathering and portion below them were left massive, dark grey in colour with the development of columnar jointing exposed in Katepurna riverbank near village Jambha in study area. The study area is mostly dominated by compound flow of vesicular, amygdaloidal and massive in nature. The massive flow are well exposed at traverse no 1 near the village Mahan. More than one smaller flow unit with limited areal extent can be observed in the compound flow. Compound flows show a shield like form and are tough to develop when the rate of extrusion of lava is relatively slow.(Walkar,1972).The sticking variation not only in the phenocryst contain between one flow unite and the another also between top and bottom of the same unit is the characteristic feature of the flow. The flow unites are characterized by the presence of pipe amygdule or spiracles at the base and ropy vesicular tops.

Table 1: Geological succession of the study area

AGE	Formation	Litho logy
Recent	Black Cotton soil Local Alluvium	Thick Layer of Black Cotton Soil
----------------------------	Angular Unconformity	--------------------------------
Quaternary	Alluvium	Yellow colour clay, With sand bed and Silt with course sand, gravel, and Boulder
------------------------------	Unconformity -	-----------------------------------
Upper cretaceous to lower Eocene	Deccan trap	Basaltic Flow

Soil Texture analysis

ISSN 2229-5518

Soil texture is a qualitative classification tool used in both the field and laboratory to determine classes for agricultural soils based on their physical texture. The classes are distinguished in the field by the 'textural feel' which can be further clarified by separating the relative proportions of sand, silt and clay using grading sieves, the particle size distribution. The class is then used to determine crop suitability and to approximate the soils responses to environmental and management conditions such as drought or calcium (lime) requirements. A qualitative rather than a quantitative tool it is a fast, simple and effective means to assess the soils physical characteristics.

The soils in the Akola district are derived from the Deccan trap and are well-known for their fertility. The soil can be classified into three categories:-

a) Coarse shallow soil.
b) Medium black soil and
c) Deep black soil.

The coarse shallow soil is found in the middle part of the Patur and Barshi Takli talukas in dist. The soil is medium black in colour, sub angular in texture, moderately well drained with low to moderate water holding capacity. Medium black soil occurs in middle and south part of Balapur, Barshi Takli and Akola taluk in the Akola district. This soil is medium black in colour, sub angular in texture, moderately well drained with low to moderate water holding capacity. The area under investigation is a part of Purna river basin, of which Katepurna river is one of the major tributaries, covering part of Washim and Akola dist. The river originates in Kata village near Washim. The river flowing South to North of Akola district across the course of river a major reservoir of Mahan located near village Mahan in Barshi Takli Taluka of Akola district.

The study area can be divided into low lying plains towards the Northern part which consisting deposition of Purna alluvium attaining the 270 m. minimum elevation of the study area whereas abrupt vertical cliffs made up of horizontal basalt flows with multiple scraps with denudation hills attaining the maximum elevation about 380 m to 410 m towards the Southern part of the study area. The lava plains with undulations at places, the lava plateau having the preservation of a number of lava flows and the isolated conical or dome shaped hillocks originally extensive flows are the major land forms exposed in Deccan Basalt province. Physiographical study area refers to the Deccan plateau and Purna alluvial deposits. The Purna River is a major, perennial river. It is joined by Katepurna, Vidrupa, Morna, Man and Nirguna in Akola district. The study area covers the local hills in Southern parts attaining highest altitude is 400 meters above mean sea level and lowest elevation covered during the traverse is 270 meters at alluvial tract near the village Bhatori in Murtizapur

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taluka. The drainage pattern is characterized by dendritic drainage pattern the network of tributary of various order and magnitudes joining the trunk or master stream resembles the branches and roots of tree.(Fig.2.2).

In the area of study the dendritic drainage network developed over most of the basin. The development of dendritic drainage networking in the terrain is associated with the areas of homogeneous lithology having gentle slope with extremely low relief to horizontal or flat topography in addition with it is also due to horizontal deposition of piles of and there uniform resistance to weathering. The deep black soil founds in Southern part of Akola, Balapur and Murtizapur Taluk. This soil is deep in colour, heavy texture with angular blocky structure in sub surface horizon, moderately well drained with low to moderate water holding capacity. The northern part of the district, the central part of Washim tahsil and north-western part of Mangrulpir tahsil has good black soils. On the other-hand, the soils on the plateau are shallow with weathered material substratum. In Murtizapur tahsil a large portion is under very rich black soil and also in the north-eastern portion are less productive, shallow and stormy. About three-quarters of Balapur tahsil have a deep black soil cover. The most fertile soils of the district is commonly known as black cotton soil. (Fig. 2) Land use pattern in study area most of the area occupied by agriculture land and forest land while remaining part of land occupied by wasteland in study area.

Soil textures are classified by the fractions of each soil separate (sand, silt, and clay) present in a soil. Classifications are typically named for the primary constituent particle size or a combination of the most abundant particles sizes, e.g. "sandy clay" or "silty clay." A fourth term, loam, is to describe a roughly equal concentration of sand, silt, and clay, and lends to the naming of even more classifications, e.g. "clay loam" or "silt loam."In the United States, twelve major soil texture classifications are defined by the USDA. Determining the soil textures is often aided with the use of a soil texture triangle. The first classification, the International system, was first proposed by Albert Atterberg (1905), and was based on his studies in southern Sweden.

ISSN 2229-5518

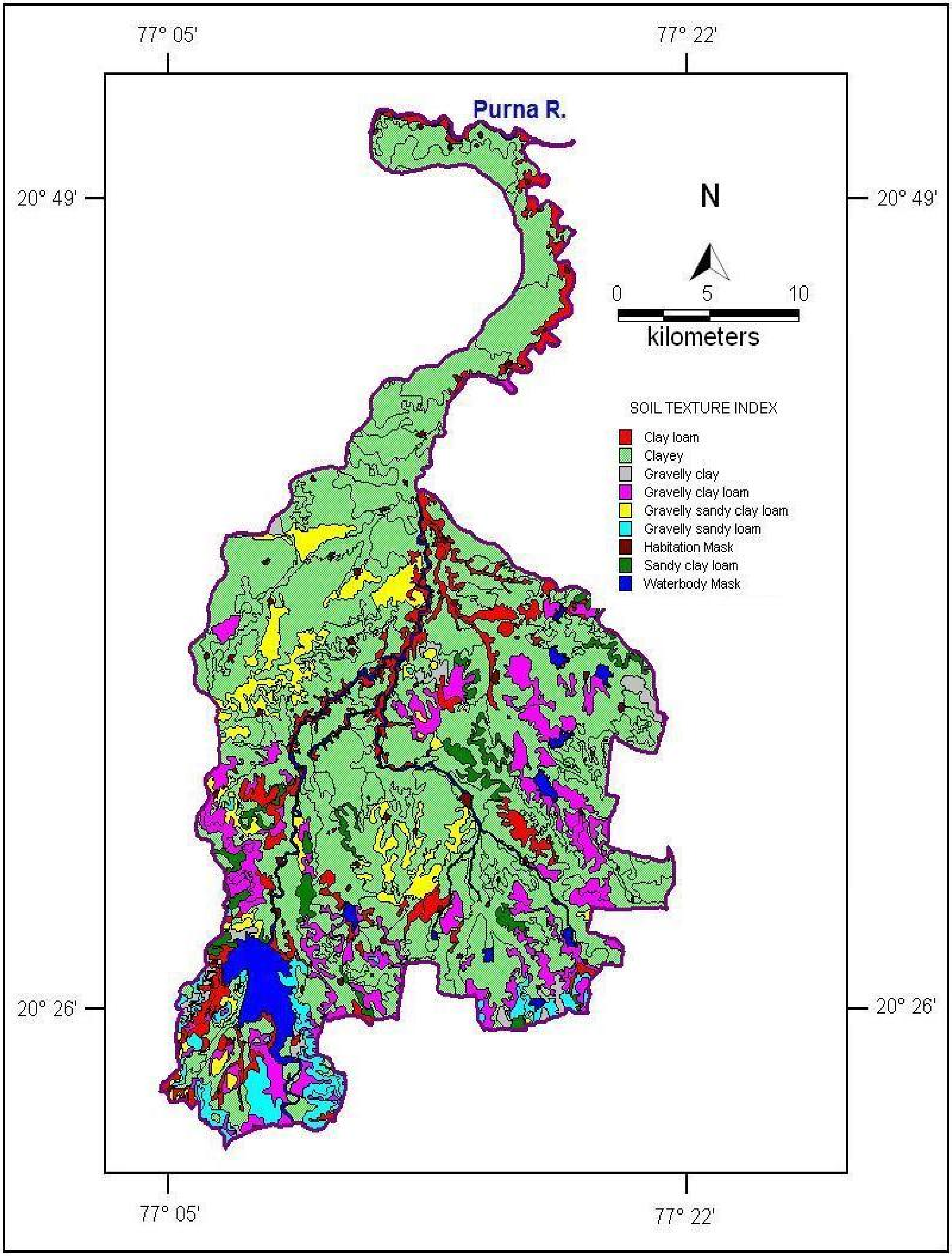

Fig. 2 Soil texture analysis map of the Study Area

ISSN 2229-5518

Atterberg chose 20 μm for the upper limit of silt fraction because particles smaller than that size were not visible to the naked eye, the suspension could be coagulated by salts, capillary rise within 24 hours was most rapid in this fraction, and the pores between compacted particles were so small as to prevent the entry of root hairs. Commission One of the International Society of Soil Science (ISSS) recommended its use at the first International Congress of Soil Science in Washington in 1927. Australia adopted this system and according to Marshall (1947) its equal logarithmic intervals are an attractive feature worth maintaining. The USDA adopted its own system in 1938, and the FAO used the USDA system in the FAO-UNESCO world soil map and recommended its use.

Water resource management

The occurrences and distribution of groundwater is mainly controlled by litho logical, structural, geomorphologic on climatic condition in basaltic terrain, under the water table, semi-confined and unconfined condition, it is interesting to note that basaltic lava flows develop peculiar characteristics, especially on the top layer which makes the basaltic rock capable of holding and transmitting groundwater. Secondary features like degree of weathering, spheroidal weathering, jointing, fissuring and fracturing develop the secondary storage space for groundwater. The Deccan trap has three different water bearing horizons viz. massive basalt (Jointed, fractured), vesicular basalt and weathered basalt. The permeable zone includes the flows, themselves. The basic properties such as ability to receive recharge, hold water in storage and transmit it by gravity are different for different litho logical units of the trappean flows. In basalt formation groundwater occurs generally in unconfined condition. In general the physical characters of basalt control the groundwater potential, it's degree of weathering and weathered products.

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Summary and Conclusions

Geomorphologic studies have demonstrated the presence of five distinct landforms namely shallow dissected plateau, moderately dissected plateau, highly dissected plateau, undulations and valley fills. The shallow dissected plateau is characterized by the presence of thick weathered mantle ranging from 4 to 8 m with less dissection, and intersecting lineaments indicating a potential storage zone. The depth to water level ranges from 5- 10 m bgl during post monsoon and 12 – 18 m bgl in pre monsoon. The safe yield in the open dug wells various from 45 – 70 m/d with sustained discharge of over 3-5 hours indicating phreatic and confined to semi confined aquifer conditions. The moderately dissected plateau occurs along the fringes of steep scarps indicating moderate thickness of the weathered horizons showing 3-5m. The bed rock is shallow and depth to water level various from 3-8 m bgl with moderate water bearing horizons depending upon the placement of interflow zone suggesting the recharge nature and higher hydraulic potential. The highly dissected plateau is characterized by the presence of compact and massive lava flows showing intricate network of dissection. The availability of groundwater is scare due to negligible weathered mantle except where the top portion is either altered or due to the presence of vesicular horizon, which may retain some groundwater. The undulating plains represent potential groundwater horizons due to the availability of aquifer zones. The depth to water levels in highly dissected area various from 15-18 m. The area can be divided into low lying plains towards the Northern side along Purna river valley and abrupt vertical cliffs made up of horizontal basalt flows with multiple scraps towards the Southern side.

ISSN 2229-5518

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