Research Article

Geophysical Imaging of Lithology of a Coastal South Indian Block for Aquifer Conservation and Management

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Abstract:
Manifold inflation in the usage of groundwater has fostered us to meet out this study to throw light on the aquifer zones of Thirukkazhukundram Block, Tamil Nadu, India to validate the subsurface lithological layers interms of resistivity and thickness. Hence, a geophysical resistivity survey aligned to Schlumberger array was conducted in 30 grided villages of the study domain. IPI2Win and ArcGIS softwares supported the study. The first to fifth layer iso resistivity and first to fourth layer thickness maps reveal the water storage zones to aid in water resource management. Researchers, policy makers, and government obviously profit from this study to sustain and conserve water by recharging.

Keywords: Groundwater, potential zones, geophysical resistivity survey, IPI2Win, ArcGIS

1. Introduction

Groundwater, a primary source for almost all purposes like drinking, domestic, agriculture and industry has become the need of the hour. The vital theme settles with knowledge about the prevailing water quality needs and aligning the society to smartly shaped aim proposals as put up by the model of Painter (2018). An enormous amount of water extraction especially for irrigation and a relatively very slow renewal rate of groundwater stand raw proofs for groundwater resource threat (Gleeson et al. 2011). Both the natural and artificial recharge and the groundwater movement all rely on various factors like geology, geomorphology, soil depth, topography, lithology, depth of weathering, extent of fracture, slope, drainage pattern, land use and land cover, permeability, soil depth, drainage intensity, soil texture, water holding capacity of the soil and physiography of the soil, climatic conditions and interrelationship between these factors (Arivalagan et al. 2014). In hard rock topography, groundwater potential mapping is relatively tedious due to the drastically fluctuating nature of the geological topography (Kellgren 2002; Anbazhagan et al. 2011).Artificial aquifer rejuvenation, managed aquifer renewal, recharge area refuge, and erection of storage dams prove to be successful putting a full stop to the prevailing groundwater abstraction related issues and they are fine-tuned for practice to some extent (e.g., Bouwer 2002; Dillon 2005; Kumar et al. 2008;). Related research has been recorded by Hammouri et al. 2013, Khadri et al. 2014, Muthukrishnan et al. 2013, Murugiah et al. 2013, Ndatuwong et al. 2014, Patil et al. 2014, Savital et al. 2018, Singh et al. 2019. Restricted water quantity tends to prevail in hard rock terrains (Boobalan, 2016). Thirukkazhukundram Block geology diverges from recent alluvium to sedimentary and ends up in crystalline charnockite and gneissic rock basement.

2. Study Area

Thirukkazhukundram block belonging to Kanchipuram district, Tamil Nadu, South India is a coastal semi-arid block Fig.1 with 352.82 km^2 areal stretch. It is labeled as semi-critical area(CGWB, 2010) and is enveloped by Bay of Bengal in the east, by Maduranthagam in the West, by Kattankolathur, Thiruporur in the North, and to the South by Lattur. Latitudes 12˚00" N and 12˚10" N and Longitudes 80˚00" E and 80˚10" E is its limits. Survey of India, allocates the toposheet index of Thirukkazhukundram block as 66 D/2, 66 D/3 and 66 D/6.

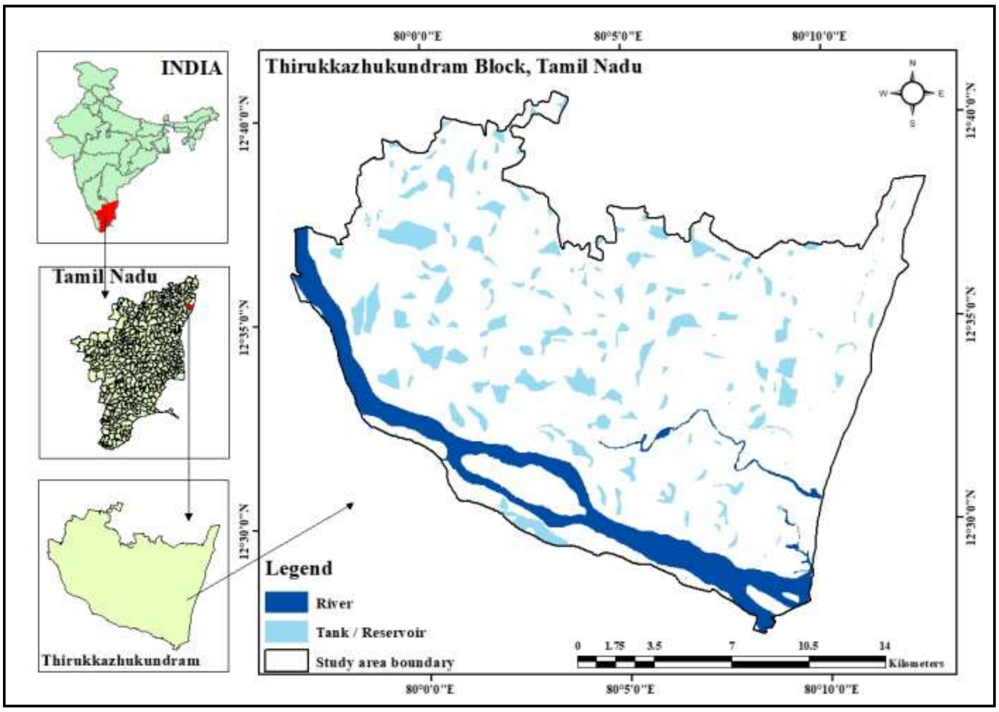

Fig.1. Location map of Thirukkazhukundram Block

3. Methodology

SOI Toposheet indexes of Thirukkazhukundram Block viz. 66 D/2,66 D/3 and 66 D/6 helped in base map preparation. Aquameter CRM500 surveyed 30 locations of study domain deploying Schlumberger array methodology of geophysical resistivity survey. The current was injected through 2 electrodes and the 2 potential electrodes measured the corresponding potential difference. The maximum spacing of the current electrodes was a distance of 100m. For the miscellaneous ground, the arrived apparent resistivity was noted down.IPI2Win assisted in curve matching and hence subsurface geo-electric layers were picturized. True resistivity and thickness were drawn from the apparent resistivity. The generated Pseudosections serving as the output of the places tethered in the profile lines demarcate the aquifers of that particular profile. The outcomes were inspected in ArcGIS 10 version software. Each layer was interpolated by spatial analysis tools which took over inverse distance method to acquire the Iso-resistivity distribution maps and layer thickness maps.

4. Results and Discussion

The interpretation scrutiny of VES data puts up markedly that the first layer resistivity stretches from 1.96 to 152.9 Ω m with 32.5 m thickness. The second layer resistivity stretches from 1.79 to 15378 Ω m with 4.26 m thickness. The third layer resistivity limits between 3.64 and 20,245 Ω m with thickness up to 19.8 m.The fourth layer resistivity extends from 7.31 to 2700 Ω m accustomed to 83.7 m thickness. The fifth layer resistivity takes over from 42.04 to 12889 Ω m. Four to five layers along with their respective resistivities scaled up by the soil and the prevailing minerals of the place were demarcated. Groundwater occurrence and movement are aligned by the geological setting (Jhariya et al, 2016).

First layer Isoresistivity map

The first layer, which is the topsoil finds its iso-resistivity map in Fig.2. Resistivities lower than 30Ωm are sighted at Thirumani, Alagusamudram, Keerapakkam, Mosivakkam, Thazhambedu, Manapakkam, Ponvilayanthakalathur, Thirukazhukundram, Thathalur, Amaipakkam, Kunnathur, Kilapakkam, Neikuppi, Pandur, Sadurangapatnam, Lattur, Irumbilicheri, and Nallathur.The soil might be clay or sand plus salt-water, red clay, sediments enhanced with saltwater, clay plus kankar, clay with or without dispensed water. Here, pore fluid conductivity projects over with affected water quality and lithology. Weathered sandstone and weathered granite are prevalent at many places of Nenmeli, Kuzhipanthandalam, Pulikundram, Mamallapuram, Igai, Navalur, Kadambadi, Salur, Pattikadu, Veerapuram, Vilagam, and Voyalur. A small spot of Nenmeli has sand and gravel saturated with freshwater with resistivity higher than 150Ωm.

Second Layer Iso-resistivity Map

Vast zone of the study domain has sand, gravel and fractured charnockite saturated with freshwater with resistivity more than 300Ωm. This nature of second layer lithology is watched out in the northern, north-western and southern sectors extending upwards to the southeastern realm of the study block. The Central portion has resistivity limit from 30 to 150Ωm accustomed with a sedimentary textured layer with freshwater aquifer. Few regions in the northern and along the coastal view have alike resistivity. The Central zone of the study block has resistivities below 30Ωm. Places with resistivities between 150 and 300Ωm are pictured in few of the north and the central zones of the study block.

Third layer Isoresistivity Map

Sedimentary litho unit extends from the north to the central location with resistivity tuned upto 30 to 150Ωm. Northwest and few central sectors have lithology with resistivity limit from 150 to 300Ωm. One patch in the northwest and the south extending to the southeast realm has subsurface lithology of resistivity more than 300Ωm. A few patches of small areas endure water quality deterioration and these are sighted in the north and the central sectors of the study realm.

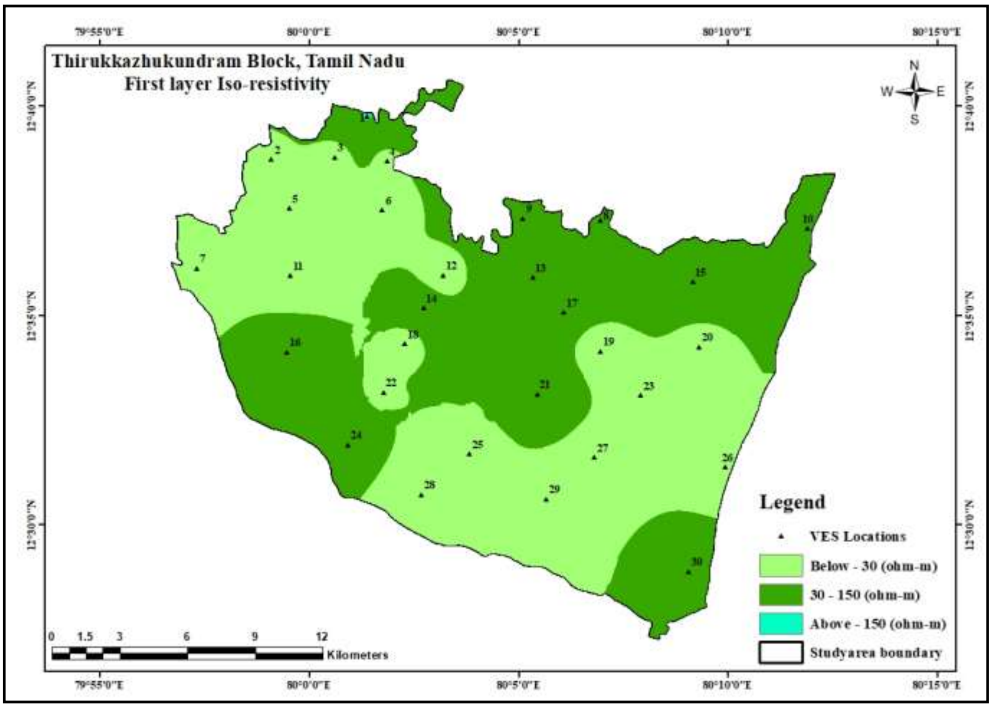

Fig.2. First layer Iso-resistivity

Fourth layer Isoresistivity Map

Starting from northwest extending to the south up to southeast has resistivity higher than 300Ωm lighting up the presence of fractured and fissured charnockite and gneisses as the fourth layer lithology. Northeast to central regime has a majority resistivity of 30 to 150Ωm and a few patches with resistivity limiting between 150 and 300Ωm. Few patches of a very small portion having degraded water quality with resistivity lower than 30Ωm are seen scattered. Groundwater recharge could be approved in this subsurface layer which has a promising pronounced capacity to hold and yield more water.

Fifth layer Isoresistivity Map

The Fifth layer Iso-resistivity map stipulates the presence of more of the clefts, wrenched and compact charnockite and gneissic type of rocks with resistivity higher than 300Ωm. Hither and thither few patches of very small areas of litho units of resistivity extending from 30 to 300Ωm are seen marking the existence of sedimentary formations.

First layer thickness

The majority of the field study has topsoil thickness below 5m.5 to 10m depth is viewed at Salur and close by Kadambadi. Topsoil extending to 15m is met at places nearby Mamallapuram and at Mamallapuram, the thickness extends to greater than 15m below ground level.

Second layer thickness

The majority of the second layer of the study area has a thickness of less than 5m.2 patches and few places not far away from Mamallapuram have thickness limitation from 5 to 10m.10 to 15m layer thickness is met out at Mamallapuram alone.

Third layer thickness

Layer thickness above 15m(bgl) exists solely at Kadambadi.10 to 15m (bgl)depth restriction is sorted at Mamallapuram and surrounding places of Kadambadi.5 to 10m(bgl) depth limit is revealed along the east coast and few patches of places in the north, northwest and towards the southern study zone.

Fourth layer thickness

This layer vividly spots the groundwater recharge zone. 8 locations namely Manapakkam, Mamallapuram, Ponvilayanthakalathur, Navalur, Kadambadi, Thathalur, Sadurangapatnam, and Lattur are sorted out with a layer thickness greater than 15m(bgl). This encompasses a horizontal strip of zone in the northwest and the realm along the east coast extending to the south of the study domain.10 to 15m(bgl)depth of layer are prevalent from northwest to the central portion covering Mosivakkam, a very small patch of Igai, Salur, Amaipakkam, Veerapuram, Kilapakkam, Vilagam, Nallathur and few places around Voyalur. The Northern sector and a few patches in the central and southern zones meet out layer thickness stretch from 5 to 10m(bgl). Within the northern, central and southern sectors, there are patches of the very small area contributing to below 5m(bgl) layer thickness. Locations with greater layer thickness always serve right for groundwater recharge owing to their greater water-holding capability.

5. Conclusion

Considering both the isoresistivity and layer thickness maps, it could be interpreted that shallow to deep aquifers' disposition for recharge align at Manapakkam, Mamallapuram, Ponvilayanthakalathur, Navalur, Kadambadi, Thathalur, Sadurangapatnam, and Lattur owing to its resistivity and layer thickness which is above 15m(bgl). Overall, the net outcome specifies the best suitable places for groundwater recharge as northwestern and eastern zones widening to the south of the study domain.

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