WATER MINING AND LANDSCAPE: STUDY ON NORTH-WESTERN PART OF BANKURA DISTRICT, WEST BENGAL, INDIA

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Received 13 April 2021, accepted in revised form 11 July 2022

Abstract
Groundwater depletion occurs when the rate of groundwater extraction is higher than the rate of replenishment. It is unequivocal that the demand for fresh-water is ever increasing. The study area lies in western part of West Bengal and it covers the three drought-prone blocks of Bankura District; namely Saltora, Gangajalghati and Mejhia. The area is dominated by semi-arid climatic conditions and agriculture is the main livelihood of people. The water scarcity leads to an impact on soil moisture and soil becomes drier during the dry months. The study is based on the changes in the regional water table which exhibit a relatively rapid response to acute scarcity of water. The study covers the temporal change of water table from 1990 to 2018. The water table measurement only includes the years 1990, 2000, 2010 and 2018. Among the 397 habitat villages, 98 dug well have randomly selected from 70 villages to create the database of temporal variation of ground water table. To specify the soil dryness gravimetric method has been used to study the selected soil samples. The groundwater withdrawal without estimating the water requirement at the regional level leads to soil dryness, and water stress situation to the agrarian economy, and it leaves a direct impact on the land. The perception of the farm owner, that ownership of farmland is synonymous with water mining right from their land leads to stress on the water table.

Keywords: Lowering of Water Table, Over Crowding of well, Landscape

1. Introduction

The climate is one of the dynamic phenomena of the earth's atmosphere and it leads to a direct imprint on the earth's surface. The climatic inquiry is a time-dependent phenomenon. The pieces of evidence are unequivocal that climate is changing and the ever-increasing trend of air temperature indicates the pattern of planetary-scale of warming (Seneviratne, et al., 2010). A few events are directly attached to Climatic variation mainly; warming of the ocean surface, ice melting from the Pleistocene iceberg, increasing the level of ocean water, and changes in the global hydrological cycle. Extreme climatic events may trigger regional catastrophes. It affects the natural ecosystem as well as the water availability (Katyaini & Barua, 2016). Moreover, the Earth's average temperature has increased to 1.5 ^{0}F since 1880 (Hinkel, 2011). The primary sectors; forestry, fishing, and agriculture still have high dependability on water and increased temperature and increased carbon dioxide up to some extent helpful for crop yielding and forestry (Minola & Simonet, 2014). But the high temperature is responsible for the high evapotranspiration, and soil dryness. The high temperature leads to a drought-like situation and more frequent drought occurrences could pose challenges to the food security and water policy of the nation (Kumar & Singh, 2005). The obvious consequence is the indiscriminate mining of groundwater for various purposes.

2. Objective

The aim is to identify the groundwater level from 1990 to 2018 and identify the reason behind the permanent lowering of the groundwater table since 1990 and anticipate its impacts on the land in the north western part of Bankura District. The later part of study covers the how the minor changes (lowering) of groundwater table lead to an impact on the soil dryness and shrinking of land in near future.

3. Study Area

The study area lies in the northwestern portion of the district of Bankura in West Bengal of India. It consists of three Community Development Blocks namely Saltora, Mejhia, and Gangajalghati. The study area covers 846.23 Km^2 (Saltora312.13 Km^2, Mejhia162.98 Km^2, and Gangajalghati371.12 Km^2) with a geographical extension from 23º16’ N to 23º33’ N latitudes and from 86º 47’ E to 87º15’ E longitudes. The study area has altogether 397 habitat villages (157 villages in Saltora, 75 villages in Mejhia, and 165 villages in Gangajalghati) and all are agrarian villages with semi-arid climates. The 98 dug wells (44 from Gangajalghati Block, 33 from Saltora Block and 24 from Mejhia Block) have been selected to measure the depth of water table (Table 1). The soil samples are collected from 21 villages (Table 1) and samples are collected from the depth of 5.9 to 8.66 inches (15 to 22 cm).

4. Material and Method

The study is based on the borehole data and the dug well data (Table 1). Among 397 habitat villages, only 70 villages have been randomly selected to measure the depth of the groundwater table and the hand-dug wells (98) are chosen to measure the water level. The water depth survey is conducted consecutively in 1990, 2000, 2010, and 2018 simultaneously. The water depth is measured manually through the measuring tape and it has been collected thrice in particular years (May, August, and January). The 70 villages have been randomly selected to survey the working hours of the water withdrawal pump and the average hours of availability of electricity. The period of available electricity and working hours of the water mining pump is recorded in the pre-monsoon and post-monsoon periods (2000 and 2018). The information regarding the soil texture, lithology has been collected from the NBSS (National Bureau of Soil Survey, Bankura, and West Bengal) maps. The soil samples were collected from the 21 villages (Table 1) during pre-monsoon and post-monsoon (covers all months of 2018). The Auger has been used to collect soil samples from depth of 5.9 to 8.66 inches (15 – 22 cm). The Gravimetric method (the oldest and easiest method) has been used to measure soil moisture contents. The collected soil samples are mixed thoroughly and after the removal of elements like roots, stone and the samples are stored in a clean polythene bag. The soil samples are weighted over dried until there is no further mass loss and it is reweighted. The shaking of sample before and after drying is the essential attributes (drying through sunlight). The topographical sheets of the Survey of India (Topographical Sheets No.73M/2, 73M/3, 73I/14, 73I/15, RF.1:50000) have been used to prepare the base map of the overcrowding zone of the wells and water table zone. The NDVI (Normalized differences vegetation index) maps have been prepared from the LANDSAT 8 –USGS Earth explorer data and it has been plotted through the Q-GIS (3.14 versions).

Table 1. Samples sites of the study area

	Dug Well Sites	Soil Sample Sites
Gangajalghati Block (44 sample sites for ground water table)	Ban Asuria (JL No.14, 4 dug wells from villages), Barsol (4 dug wells from four villages), Bhaktabandh (Ekchala JL No. 61, Itadangra JL No. 71, 4 dug wells) Gangajalghati (JL.No.109, Ranbohal J.L.No.103, 8 dug wells) Gobindadham (Amjor JL No. 4, Asanchua JL No. 9,4 dug wells) Kapista, (Kenduadihi JL No.88, Kapistha JL No.85, 4 dug wells) Lachmanpur, (JL No. 98, Khejuri JL No.91, dug wells) Latiabani, (Selara JL No. 102,4 dug wells) Nityandapur (JL No. 118,4 dug wells) Pirrabani (JL.No.130, 4 dug wells)	Kapistha (2 samples) Gangajalghati (3 Samples) Pirrabani (2 Sample) Latiabani (2 Samples)
Mejhia Block (24 sample sites for ground water table)	Ardhagram (JL.NO 2,4 dug wells) Banjora (J.No. 3,4 dug wells) Kustora (J.L.No.41,4 dug wells) Mejhia (JL.No.45,8 dug wells) Ramchandrapur (J.L.No.60, 4 dug wells)	Mejhia (3 Samples) Banjora (2 Samples)
Saltora Block (30 sample sites for ground water table)	Bamuntore (Bamuntore JL No.10, Balarampur JL No.9, 4 dug wells) Dhekia (Tentularakh JL No.151, Shipurmana J L No. 142, 4 dug wells) Gogra (4 dug wells: Aduni JL.No.1, Chautate 40, Dhapali 48, Latulia 92) Kunuri (Belebad 16, 4 dug wells) Pabra (Alunia J.L No.4, dug wells) Salma (Bhaluka J LNo. 23,4 dug wells) Saltora (Saltora 134, Sebapur 137, Shiarbedia 140, Shyampur 143, 6 dug wells) Tiluri (Bhaluka 23, Bhadaspur JL.No/21, Biharinath JL.No.29, Fatepur JL No55, 4 dug wells)	Saltora (4 Samples) Gogra (3 Sample) Tiluri (2 Samples)
	Dug Wells 98	Soil Samples 21

5. Discussion and Result

Groundwater is sub-surface water, but not all sub-surface water is groundwater. The upper surface of groundwater is the water table. Below this surface, all the pore spaces and cracks in sediments and rocks are filled (saturated) with water and it is known as the saturated zone (or the phreatic zone). The water table is an underground boundary between the soil surface and the area where groundwater saturates (Konikow & Kendy, 2005). Water pressure and atmospheric pressure are equal at this boundary (Dunne, 2019). The water found in the saturated zone is called the groundwater and the dependability on that water layer is ever-increasing even in rural areas (Cashman & Preene, 2001). The average depth of water table is not uniformly distributed and there is a close association between the landscape and the depth of ground water table (Fig.1, 2, 3, 4, 5 and 6).

Underlying Condition of Study Area

The study area is an ancient cratonic landmass (Prahladachar, 1994) with a long period of crustal stability (Fig. 1). The area lies in the vicinity of the Purulia Bankura shear zone which is ductile to brittle (Ghosh A. K., 2018). It's the interfluves zone of Damodar (in the northern part) and Dwarakeshwar (in the southern part) as well as the intermediate zone of Gondwana formation and Singhbhum craton (Ghosh A. K., 2018). Therefore, the area is dominated by the mafic, ultra-mafic, and amphibolite rocks (Ghosh & Chatterjee, 2008). The existence of pegmatite, aplite, and dumortierite is evidence of shearing and retrogressive metamorphism (Ghosh A. K., 2018). The base of the study area is formed by the hot retrogressive metamorphism and Proterozoic hard foundation (Ghosh A. K., 2018). Therefore, it is a hard, comparatively rigid, and tectonically stable landmass (Fig. 1). The quaternary formation is dominated by laterite layers and the topmost layer is covered by the quaternary laterite and patches of alluvium (Fig. 2, Table 2). The laterite layer is segmented into three parts; a soft laterite layer, hard laterite, and a gravel-rich layer (Fig. 2). Laterite is allochthones in character. The laterite cover is also stable. Saltora block and the Biharinath hill zone are dominated by the (Mesozoic era) Gondwana formation of Supra Pannchet sandstone (Veevers & Tewari, 1995). Mejhia block is covered by the Permo-Carboniferous shale with coal (Raniganj formation) and the rest of the study area is hard cratonic Archean

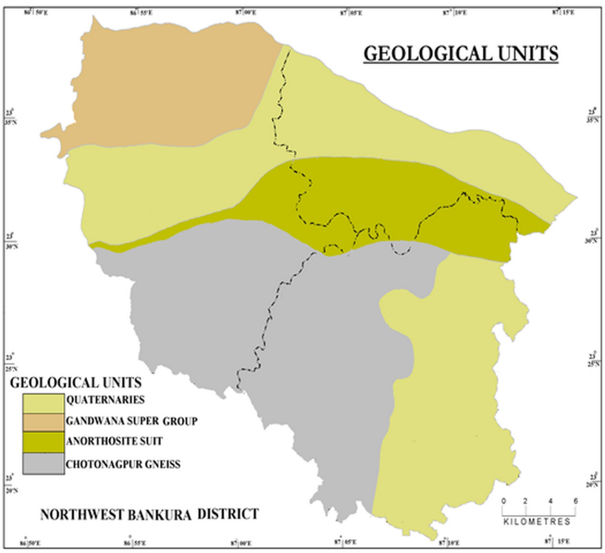

Fig. 1. Geological units

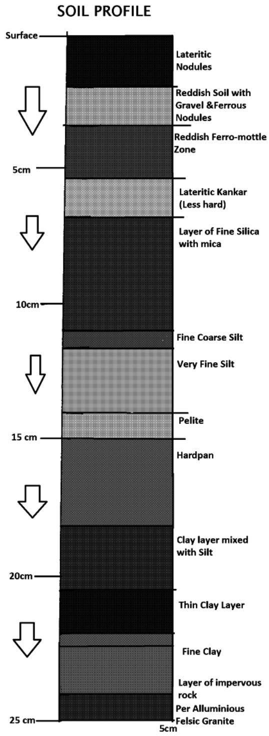

Fig. 2. Soil profile

Table 2. Geological set-up of study
(Source: Bankura District Resource Map prepared by the Geological Survey of India, Kolkata)

LITHOLOGY	PERMEABILITY	BEARING CAPACITY	FOUNDATION CHARACTERISTICS	GROUNDWATER POTENTIALITY
QUATERNARY	CUMULATIVE HIGH	LOW (1-2K.g /Cm^2)	POOR	HIGH
GONDWANA SANDSTONE	MODERATELY HIGH TO LOW	VARIABLE 1100Kg/Cm^2	FAIR TO POOR	MODERATELY HIGH
ANORTHOSITE	LOW	VERY HIGH 1500-2900 kg./Cm^2	EXCELLENT	VERY LOW
CHOTANAGPUR GNEISS	LOW	MEDIUM WITH 500K.g /Cm^2	MODERATELY GOOD	MODERATELY LOW

formation with gneisses (Table 2) and schist (Acharyya, 2018). Therefore, there is a sharp contrast in water potentiality (Fig. 6) between the eastern and the western part of the study area.

Surface Attributes of Study Area

The groundwater recharge depends on surface elevation, average slope, and dissection index and the slope stability is related to the stability of the groundwater table and vice versa (Ghosh & Nag, 2013). A slight variation of water table (permanent lowering) affects the stability of the surface slope and it hits adversely the sloppy areas than the adjacent plain (Radcliffe & Todd , 2002). There is a strong positive correlation between average slope and the depth of the

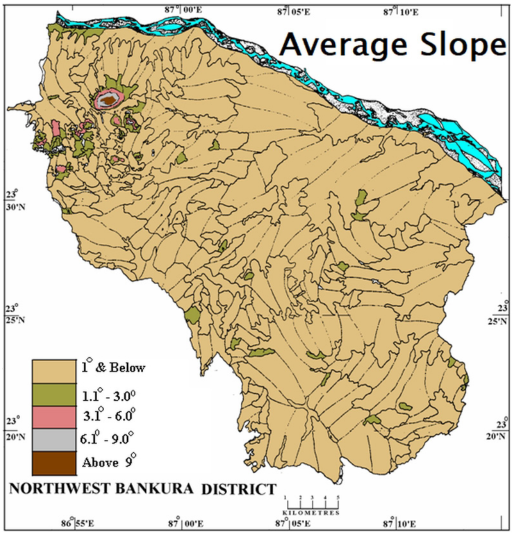

Fig. 3. Average slope of study area
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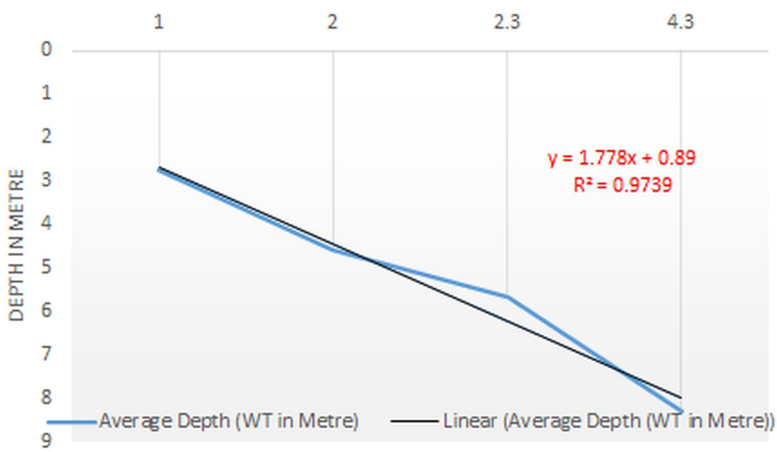

Fig. 4. Average slope and depth of water table (2018)

water table (Fig. 3, 4) which may lead to slope instability in the western part of the study area.

The dissection index is the ratio between relative relief its absolute relief. It indicates vertical erosion and intensively dissected land extends the surface area to percolation water. The value of dissection near '0' indicates maximum denudation stages of evolution and near '1' indicates minimum denudation stages of geomorphic evolution. The value ranges from 0.002 to 0.18 (Fig. 5).

The average depth of water table is not uniformly distributed and there is a close association with the landscape and the depth of ground water table (Fig. 6).

The comparatively high dissection index (Fig. 5) provides more surface area and stimulates the replenishment of the water table and the correlation value between dissection index and depth of water table is positive (Fig. 7).

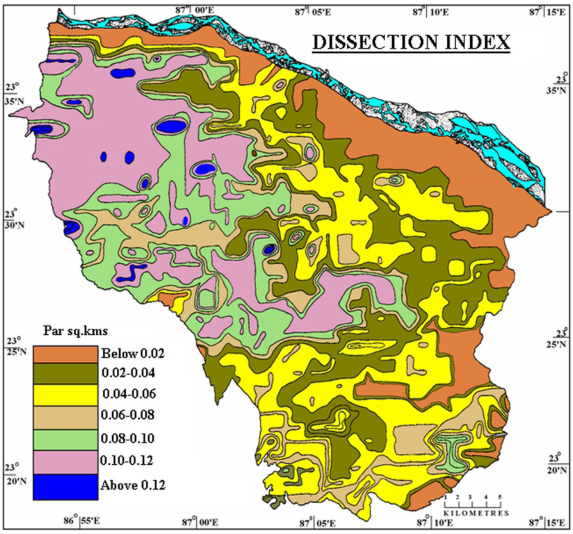

Fig. 5. Dessection index
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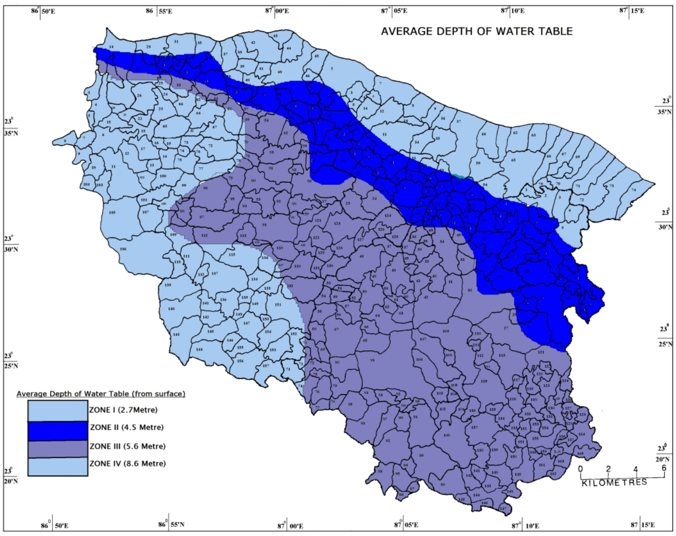

Fig. 6. Average depth of water table

The shape and height of the water table are influenced by the land surface that lies above it; there is a co-association between the higher average slope (Fig. 4), surface elevation (Fig. 8, 9) and the higher level of the water table. The comparatively higher zone displays the higher the depth of the water table (Fig. 9). Therefore, higher surface elevation and highly dissected zone do not act as a good infiltration zone (Haitjema & Mitchell, 2005).

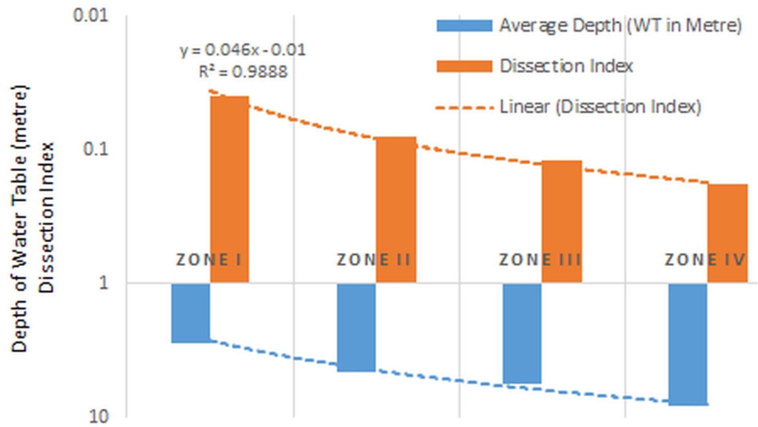

Fig. 7. Depth of water table and dissection index (2018)

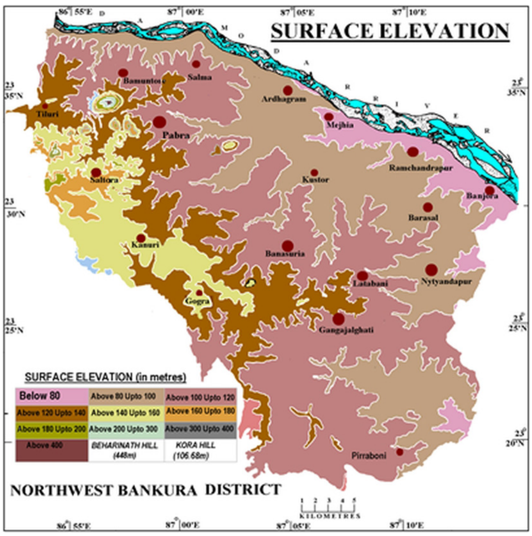

Fig. 8. Sueface elevation
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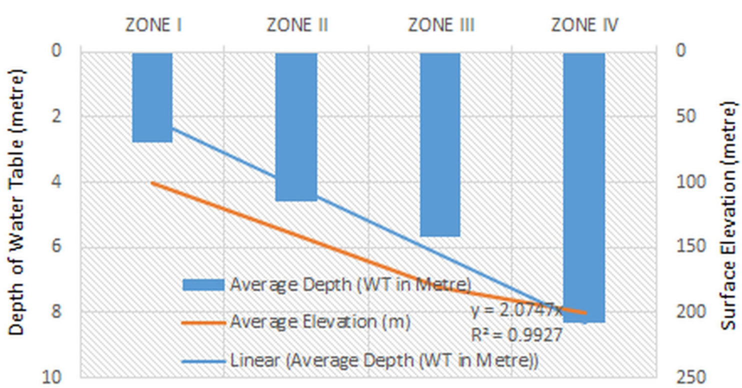

Fig. 9. Depth of water table and dissection index (2018)

Groundwater table of Study Area

It is unequivocal that the surface is getting warmer (increasing trend of maximum temperature, crop evapotranspiration, transpiration, minimum temperature), and subsequently sub-surface soil is getting dry. That leads to ultimate stress on agriculture and it makes irrigation dependability of agricultural activities. The average depth of the groundwater table was 3.38 m (11.08 feet) in 1990, 3.49 m (11.45 feet) in 2002, 3.72 m (12.20 feet) in 2010, and 3.9 m (12.79 foot) in 2018 (Fig. 10, 11). The permanent lowering rate since 1990 (last 28 years) is 18.57 mm (1.85cm /annam or 0.72 inch / annum).

Ground Water mining technology

Agriculture is very sensitive to weather phenomena (Kathpalia & Kapoor, 2002). The minute change in surface air temperature can impose an effect on crop production and the water requirement (UNEP, 2013). To sustain the food security and rural economy, the agricultural growth is the foremost step (Kumar, Sivamohan, & Narayanamoorthy,

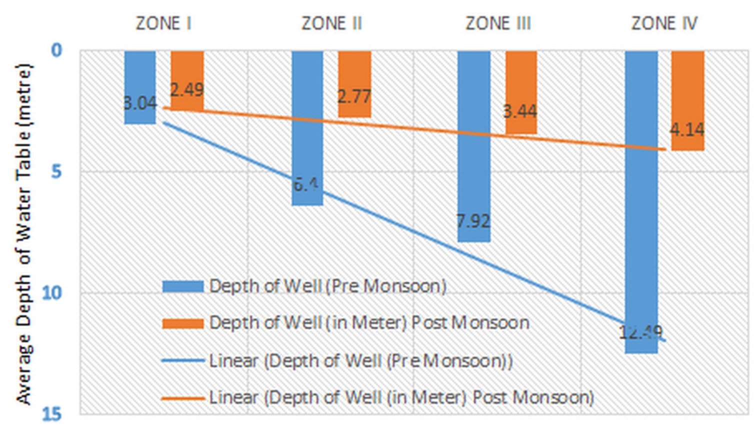

Fig. 10. Depth of ground water table (2018)

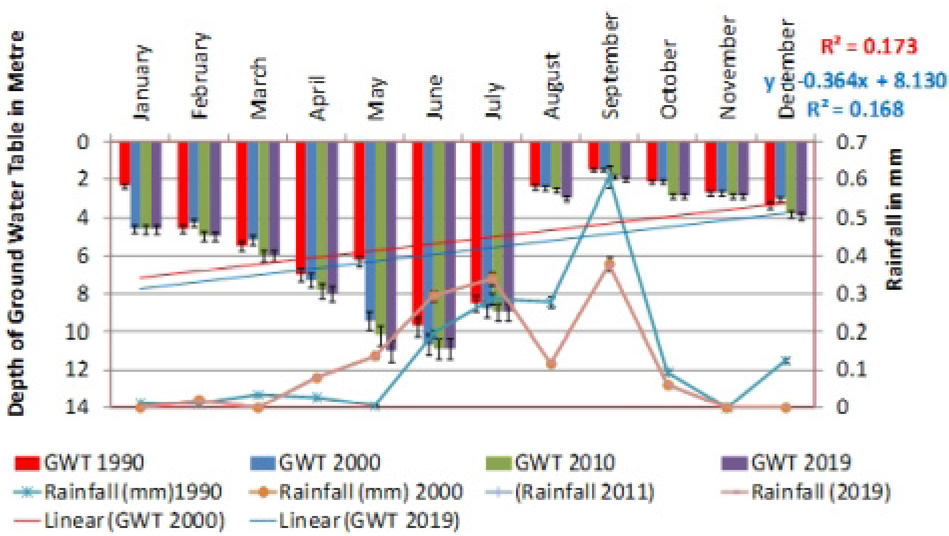

Fig. 11. Seasonal variation of ground water table (1990-2019)

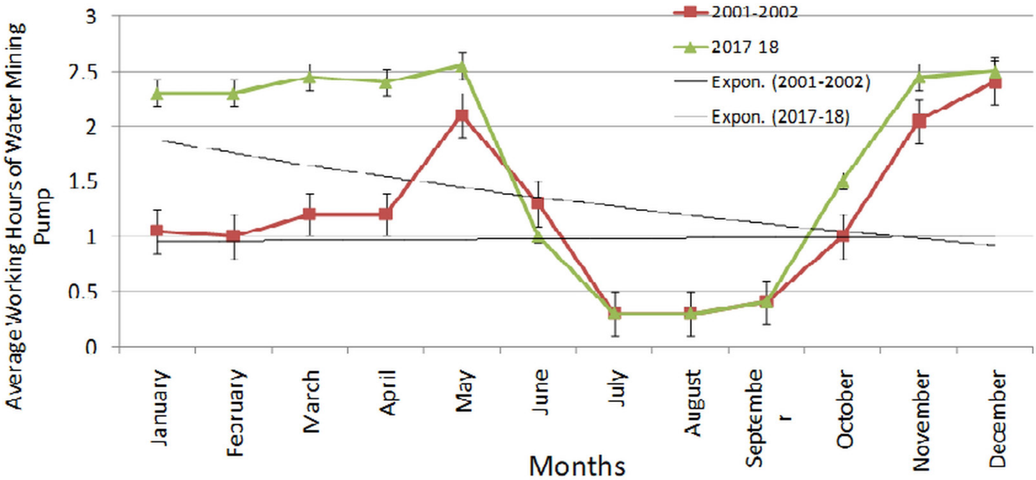

Fig. 12. Monthly variation of working hours of water withdrawal pumps (2001-02 and 2017-18)

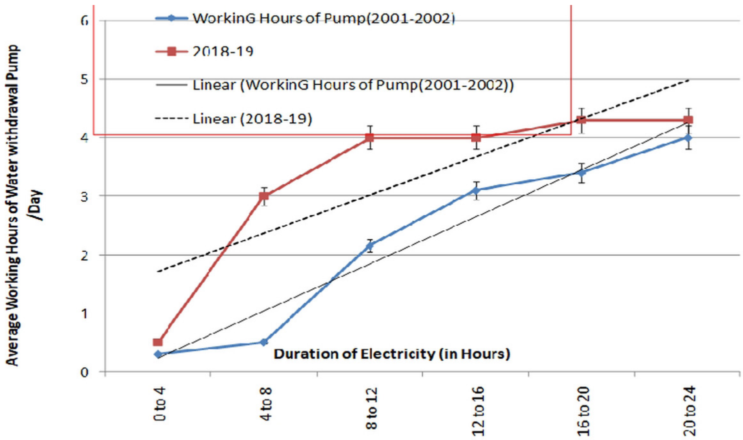

Fig. 13. Avaiable hours of electricity and working housr of water mining pumps

2012). Due to the positive impact of the green revolution, several changes have been observed in the agricultural field (Mukherjee, 2007). The water withdrawal pump (water mining pump) and power tiller are in the first row of agrarian technologies. The NDVI map of the study shows more greenery (Fig.14). The agricultural expansion and intensive farming activity increased the demand for water for irrigation (Katyaini & Barua, 2016).

After the 1960s, rapid and smooth electrification provides motion to rural life but up to some extent 'rural electrification has enhanced pressure of groundwater resource' (Dhawan, 1998). The groundwater table is determined by the boreholes and wells (Gray, 2000). The main withdrawal means of groundwater are the dug wells, tube wells, and shallow tube wells. The mean level of the groundwater table ranges from 50 to 100 meters (164.04 – 328.08 feet) above the mean sea level (Nag & Ghosh, 2013). The zone of permanent saturation is not uniformly distributed; it varies from 10 m to 15 m approximately (Konikow & Kendy, 2005). The advancement of sophisticated means of groundwater withdrawal makes the groundwater easily accessible (Sastry, Rashmi, & Rao, 2011). The electric pump sets are best suited for continuous pumping of water from any depth and electric power

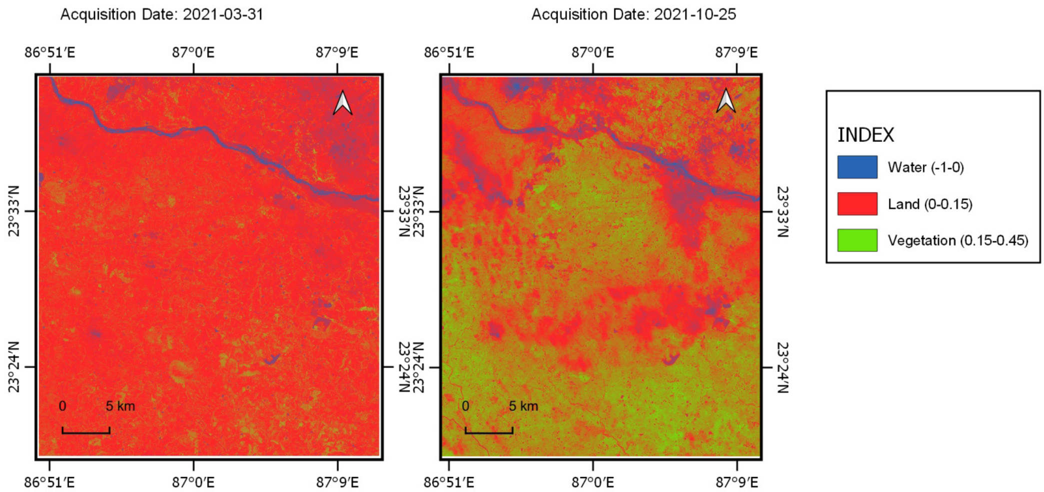

Fig. 14. NDVI from Landsat 8 OLI

is heavily underpriced in comparison to alternative sources of energy used for lifting water. The linking of power tariff with a horsepower of a motor instead of the actual consumption of power in many States makes well owners behave as if the marginal cost of pumping water is zero (Dhawan, 1998). The water withdrawal pump is running proportionally to the available hours of electricity in different villages (Fig. 12, 13). Sometimes easy accessibility causes over-exploitation that is leading to a downward trend in the groundwater table in the long run (Lohman, 1972).

Present Impact and its Anticipation

The groundwater mitigates the ever-increasing demand for water and its positive consequences are reflected in the NDVI map (Fig. 14) of the study area.

Overcrowding of hand-dug well and Interference

Water mining is related to agrarian land utilization. In each 200 m^2 area, there are 10-13 dug wells (Fig. 15) which create overcrowding of well. The Gangajalghati and Mejhia are most adversely affected by the over-crowing of well (Fig. 15). The demand for freshwater for agrarian and domestic purposes is responsible for the overcrowding of the dug well (Malassis, 1975). Hand-dug wells are less expensive in comparison to standard drilled wells and it's the cheapest way for the villagers to collect water for domestic and as well as irrigation purposes. The dug well with the large diameter is exposed to a large area and it is well suited to obtain water from less-permeable soils, such as fine clay, sand, and silt. The dug well can be made deeper easily and most of the hand-dug well is 8 to 13 (26.24 -42.65 foot) meter in depth.

The depth of a drilled well becomes insufficient due to increased demand for water and landowners make it deeper easily. Therefore, an unrestricted hand-dug well with a larger diameter has a chance of subsidence even in very mild changes in the water table (Healey, 2010). Most of household possesses a hand-dug well and there is no restriction regarding the depth of the well. Without the gross estimation of water requirement, water mining from a well lowers the water table to the peripheral zone of the wells (Fig.16). The lowering water table zone is called a cone of depression (Fig. 16). The intensity or the curvature of a cone of depression depends on the withdrawal rate. The land area just above a cone of depression is known as area of influence. The area influence is the potential zone for land shrinking. Groundwater flows to the well and

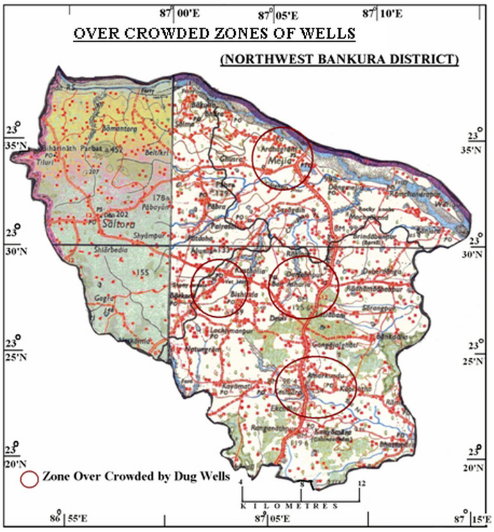

Fig. 15. Overcrowded zones of wells
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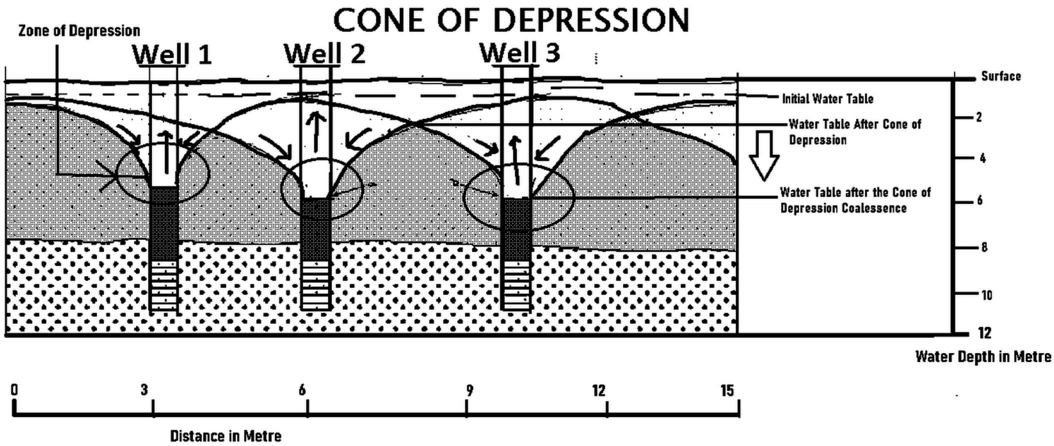

Fig. 16. Cone of depression

it follows the direction of cone of depression and that flowing direction does not maintain parity with the natural or inherent direction of groundwater flow within the area of influence around the well (Prahladachar, 1994). The zone of a cone of depression has overlapped due to overcrowding (Fig.15) of wells. The overlapping wells zone is the area of good interference. The interference reduces the water availability of individual well. During summer (April to July) well interference is a common fact in almost all dug wells zone. The process continues for a long period and the zone of interference of individual well gradually coalescence and forms a large area of depression instead of the individual cone of depression. The cone of depression and large area depression extended to the nearby water tanks. It lowers the water table below the water tank and the lake begins to lose water (Fig. 16).

Crack and Anticipation of Subsidence

The study area covers the agrarian village and land shrinking has just started. Due to the absence of high rising buildings, it is not considered a danger. But in each habitat village, a few old households have old earthen houses and the cracking of walls and floors are common facts. There is a difference in water content in the ground beneath a building, swelling pressures cause the wall to lift; this is often called 'heave'. This can happen at the corners or towards the centre of a building. During the last three years, boreholes become popular and a few houses and the farmer abandoned the hand-dug wells. Those haunted vacuum dug wells are susceptible to land subsidence. The dug-well failure is responsible for small-scale land subsidence. Though the lateritic zone is the stable zone but the exposed lateritic layer sometimes acts as a fragile layer (especially soft laterite) and the consequence is the cracking of old earthen buildings.

Changes in soil moisture

Soil is not the only habitat of growing crops; it indicates potentiality and problem for comprehensive development of land-use plans aimed at not only sustainable agriculture but for the development of forestry too. The soil texture (Fig.18) is one of the important physical properties of soil to determine the nutrient supplying ability of soil (Malassis, 1975). More irrigation

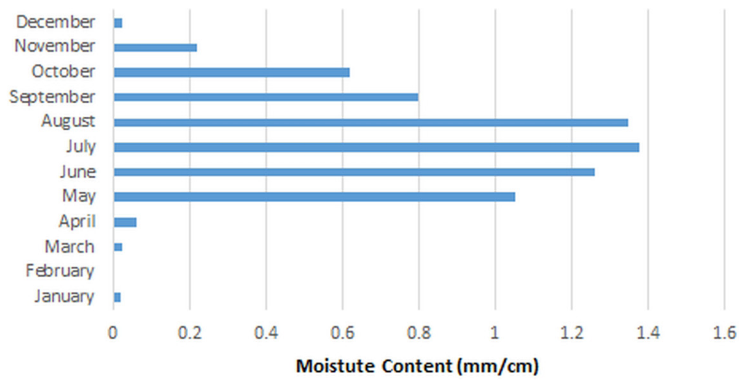

Fig. 15. Moisture content of surface soil
Source: Average of tsoil moisture of 21 samples (by Gravimetric method)

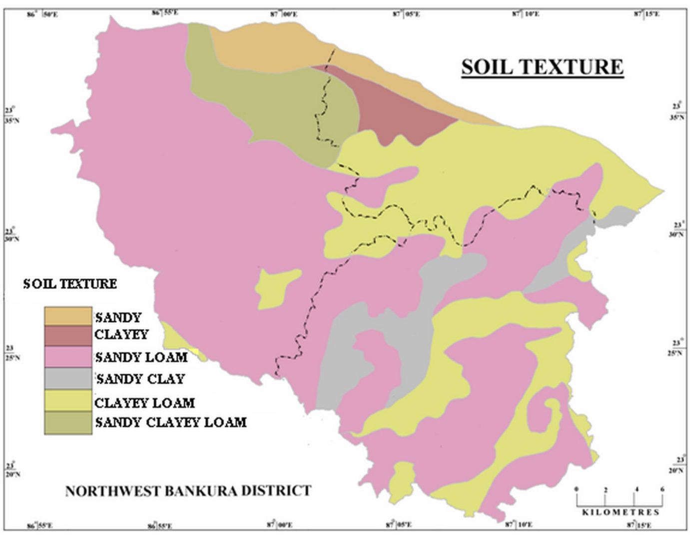

Fig. 16. Soil texture

provisions help to achieve better greenery and it supports the ever-increasing trend of cropping intensity (Fig 14). The drier part (study area) of the continents takes time to react to the lowering of the groundwater table. Despite that slight variation in the water table leads to the impact of soil dryness, and ultimately it creates pressure on land (Dunne, 2019). Study area is mainly covered by the sandy loam (Fig 18), the average water holding capacity of sandy loam is 1.4 mm/cm, and during monsoon season it goes high, it ranges up to 1.38 mm/cm. Among 21 samples the average range of water holding capacity is 0.019 to 1.38 mm/cm. The maximum concentration of water in soil pore space is observed from June to August. From January to March, it remains almost nil to a trace level (Fig. 17) of moisture.

The withdrawal of groundwater creates a vacuum on sub-surface soil. Normally fine-grained, clay-rich soils absorb moisture during monsoon, becoming heavy and it becomes very hard when dry, resulting in shrinking and cracking of the ground. The hardening and softening are known as the 'shrink–swell' behaviour of subsurface soil. It's very common in laterite soil too. The shrinking of soil depends on soil moisture in surface and subsurface soil contents. During the dry season, the water molecules move up as capillary water and leave iron oxide in the topmost layer (Baldwin, Kellogg, & Thorp, 1938). The hardpan prevents water to percolate and capillary action leads to the vertical movement of water flow. It creates an impermeable compact layer and oxide deposits at a short distance from the soil top. It prevents the smooth infiltration process (Fig. 2).

The ever-increasing dryness of soil leads to impacts on soil texture. The sandy loam area is more susceptible to hardpan formation. The Sandy loam covers almost 54.99% of the area (Table 2, 3, Fig. 18) and hardpan formation restricts the infiltration processes (Fig. 2). The unrestricted withdrawal and its consequences are observed in capillary action and its leaves oxides on the surface. Therefore, lowering the water table is

Table 2. Geological set-up of study
(Source: Bankura District Resource Map prepared by the Geological Survey of India, Kolkata)

SOIL TEXTURE CATEGORY	AREA (km^2)	% OF AREA COVERAGE	ADMINISTRATIVE AREA COVERAGE
1	2	3	4
SAND	38.79	4.58	The extreme northern portion of Salma G.P. of Saltora P.S. &Ardhagram G.P. of Mejhia P.S.
CLAY	19.95	2.36	Ardhagram G.P. of Mejhia P.S.
SANDY LOAM	465.32	54.99	Most of the places of Saltora P.S. except Salma G.P. and Pabra G.P., selected portion of Banasuria G.P., Nityanandapur G.P., Gangajalghati G.P., Latabani G.P., Barasal G.P. of Gangajalghati P.S.
SANDY CLAY	48.35	5.71	The southern portion of Banjora G.P. of Mejhia P.S, Northern portion of Barasal G.P., Latchmanpur G.P., Latabani G.P., Banasuria G.P. of Gangajalghati P.S.
CLAY LOAM	219.62	25.95	Most of the part of Mejhia P.S. (except Ardhagram G.P.) & a selected portion of Nityanandapur G.P. Latabani G.P. Pirrabani G.P. of Gangajalghati P.S.
SANDY CLAY LOAM	54.20	6.41	Bamuntore G.P., Salma G.P. of Saltora P.S. & western portion of Ardhagram G.P. of Mejhia P.S.
Total Area	846.23	100	Source: N.B.S.S. & L.U.P. (ICAR)

the impetus to hardpan formation and it restricts the movement of the water as well as infiltration process.

Through the study area lies in an ancient cratonic landmass despite that the slow and steady lowering of the groundwater table is noticeable (Fig. 6, 10, 11). The farmers are mining the water without estimating their requirement of water and the working hour of the water mining pump and available hours of electricity are positively related (Fig. 12, 13). Therefore, the marginal cost of withdrawing water is zero to the farmers. The obvious consequences are the lowing of the water table and its lowered 1.85 cm per annam in the last thirty years (Fig. 10, 11). The laterite-dominated region faced the lowering of the groundwater table and water capillary action leads to more thickness to the hardpan formation and that hard-pan prevent water motion and it hurdles to the infiltration process (Todd & Larry , 2004).The surface covers with the sandy loam (shallow in soil depth) is the more susceptible to hardpan formation and it's a common fact of Mejhia and Gangajalghati blocks. The overcrowding of the dug well (Fig. 15) is a common in Gangajalghati and Mehjia Blocks and it reduces the recharge rate of the wells (Fig. 16). The permanent lowering of the water table decreases the compactness of the above soil horizon and the overcrowding well zone (Fig. 15) is susceptible to the subsidence in near future. The agrarian society of rural West Bengal is not free from the hazard related to the lowering of the groundwater table in near future.

6. Conclusion

Groundwater is considered a free resource, as anyone who can afford to drill, can usually draw up merely according to the ability of the pump. Most of the farmers inherited their farmland or sometimes they have purchased the farmland and, they have achieved ownership of farmland (Bredehoeft, Papadopulos, & Cooper, 1982). Although in Indian constitution does not provide a right of property as the fundamental right, despite the fact, farmers have a preconception that they achieved the ownership of land and they have every right to water withdrawal from their land. The groundwater withdrawal without estimating the water requirement at the regional level leads to soil dryness, and water stress situation to the agrarian economy, and it leaves a direct impact on the land and hardpan formation. The perception of the farm owner, that ownership of farmland is synonymous with water mining right from their land. That perception leads to stress on the water table. The agricultural activities in lateritic and hardpan zone are the hurdle to the farmers and the gradual decline of water level creates soil dryness. In near future it creates hazard like sinking of land and also leads to extreme water tress situation. The surface as well as the ground water use depends on the surficial attributes. The minute but gradual lowing of groundwater table (1.85 cm per annum) not only creates pressure on groundwater table, it leads to surface soil dryness and water stress condition and regional subsidence in near future.

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