International Journal of Geology, Earth and Environmental Sciences ISSN: 2277-2081 (Online)
An Online International Journal Available at http://www.cibtech.org/jgee.htm
2012 Vol. 2 (3) September - December, pp.176-181/Ranbir Nandan
Research Article

GEOSPATIAL ASSESSMENT OF GROUND WATER CONDITION OF PATNA DISTRICT, BIHAR

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ABSTRACT

The Groundwater condition of the Patna district, Bihar in India was assessed using geospatial techniques. The block boundary map, depth to water level maps and SRTM DEM were used as spatial layers. The published data on Arsenic contamination and Physic-chemical characteristic of water were used as collateral data, which were joined with the spatial layers for GIS based overlay analysis. The groundwater collection sites were plotted on the satellite picture of the study area. The study revealed that the depth of water level is negatively correlated to the elevation of the study area. The 10 blocks were observed as Arsenic contaminated and Maner was found to be most affected blocks. The Physico-chemical parameters of water in the district showed abnormality when compared with the permissible standard limits of World Health Organisations (WHO). The present study concluded that though the study area possesses good to very good category of groundwater potential but it is facing a serious water crisis, and needs conservation and mitigation strategies.

***Key Words**: Groundwater, Aquifer, Patna, GIS, Water Level, Arsenic Contamination, Groundwater Quality*

INTRODUCTION

Groundwater is exists in pore spaces and fractures in rock beneath the Earth's surface (http://www.lenntech.com/groundwater/definitions.htm). It originates as rainfall or snow and seeps into the ground and stored as Groundwater (http://www.windows2universe.org/earth/Water/water_cycle.html) through process of hydrological cycle (http://www.cotf.edu/ete/modules/msese/earthsysflr/water.html). The water is one of the important natural resources. We cannot think of life without water. About 2% of the total water on earth is fresh but majority of it (1.6 %) is trapped in polar ice caps and glaciers. The 0.36 % of earth water is available in aquifers and wells in the form of groundwater and 0.036% of it is present in lakes and rivers as surface water (http://science.howstuffworks.com/environmental/earth/geophysics/question157.htm). The groundwater has a number of advantages over surface water due to its higher quality, better protection from possible pollution and infection, less seasonal and perennial fluctuations, and its uniform spread over large regions than surface water (Zektser and Everett, 2004). Still the quality of available water is a major concern as it has been reported that 80% of rural illnesses, 21% of transmissible diseases and 20% of deaths among children in the age group of 5 years, are directly linked to consumption of unsafe water (Hegde, 2012). On the other hand the demand of water is also growing day by day. In India in 2006, the consumption of water was 829 billion m^3 which is likely to increase to 1093 billion m^3 in 2025 and 1047 billion m^3 in 2050 (Government of India, 2009). The Bihar, which is the third largest Indian state in terms of population, is no exception to this. In addition to this the water in this region is not properly cultivated nor well stored and most of the rain water flows directly to sea without being harnessed and thus needs suitable management plan for its utilization (Pandey, 2003). In this scenario understanding of ground water condition in the region becomes imperative for its conservation and management and hence the present study was carried out in Patna district of Bihar, which is capital and headquarter city of Bihar.

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Study Area

The study area Patna district of Bihar (Figure 1) lies between 25° 13' to 25° 45 N latitude and 84°43' to 86°44' E longitude and occupies 3,202 km^2 geographical areas. Administratively, it is divided into 23 blocks namely Athmalgola, Bakhtiarpur, Barh, Belchhi, Bihta, Bikram, Daniawan, Dhanarua, Dinapur (Khagaul), Dulhin Bazar, Fatwah, Ghoswari, Khusrupur, Maner, Masaurhi, Mokameh, Naubatpur, Paliganj, Pandarak, Patna Rural, Phulwari, Punpun and Sampatchak. In the north, it is bounded by holy river Ganga, in the south by Jahanabad and Nalanda districts, in the east by Lakhisarai district and in the west by Bhojpur district. The district is covered on the other two sides by Son and Punpun rivers. The elevation ranges from 35 to 86 m amsl in the district. The average annual precipitation in the district is 1100 mm and average annual temperature is 26°C.

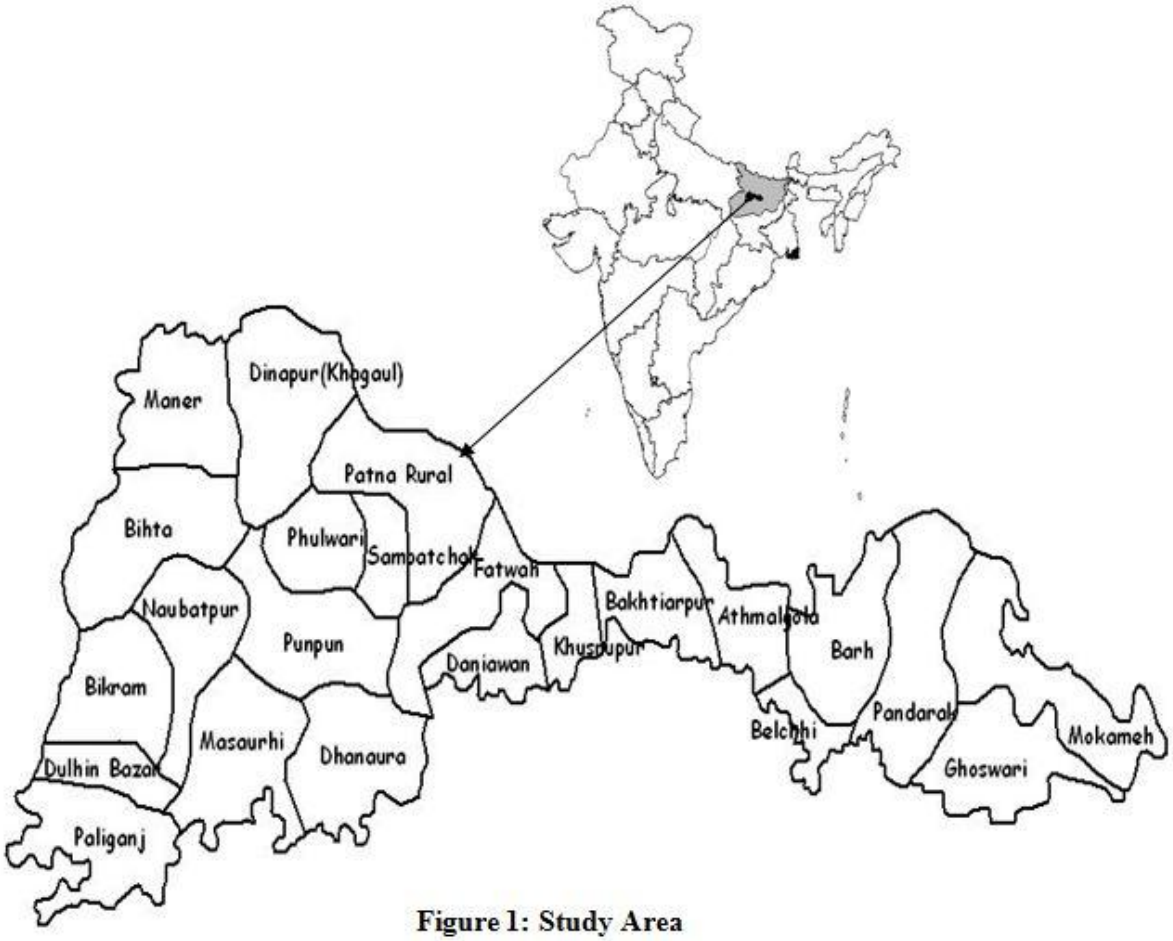

Figure 1: Study Area

The alluvial sediments of various grades of clay silt and sand of Quaternary age forms ground water reservoir of Patna, which is part of Indo-Gangetic Plains. It consists of upper shallow and lower deeper aquifer separated by an aquitard layer at the depth of 45 to 70 m. These aquitard is made up of clay and clay mixed with sand or kankar. The deeper aquifer is made up of medium to coarse grained sand (CGWB, 2011).

MATERIALS AND METHODS

The block boundary map and depth to water level map of the study area were downloaded from internet links in jpeg formats (http://www.mapsofindia.com; http://cgwb.gov.in/). These maps were then geo-

referenced and digitized in Geographic Information System (GIS) environment. The NASA Shuttle Radar Topographic Mission (SRTM) 90m Digital Elevation Model (DEM) was used for the elevation related analysis (http://srtm.csi.cgiar.org/). The satellite picture of the study area was downloaded from the Google Earth online applications (http://www.googleearth.com) and was used to depict water sample collection sites.

Table 1: Details of collateral data

Type of data	Sources
Arsenic Contamination	Ghosh *et al.*, 2007 & 2008
Water Quality	Rai *et al.*, 2011; Sinha *et al.*, 2011; Yadav *et al.*, 2012

The collateral data on arsenic contamination and water quality were recorded from secondary (published) sources (Table 1). These collateral data were linked to the spatial block boundary map for GIS overlay analyses.

RESULTS AND DISCUSSION

The depth to water level in the district during pre-monsoon period varied between 3.00 to 8.57 m bgl. In the 25% of the observed wells, the water level varied in the range of 2-5 m bgl while in the 76% of the wells, it was recorded in the range of 5-10 m bgl. The south-west and eastern parts of the district reflected the depth range of 3 to 6 m bgl, while in the central part it was observed as 6-9 m bgl (CGWB, 2007).

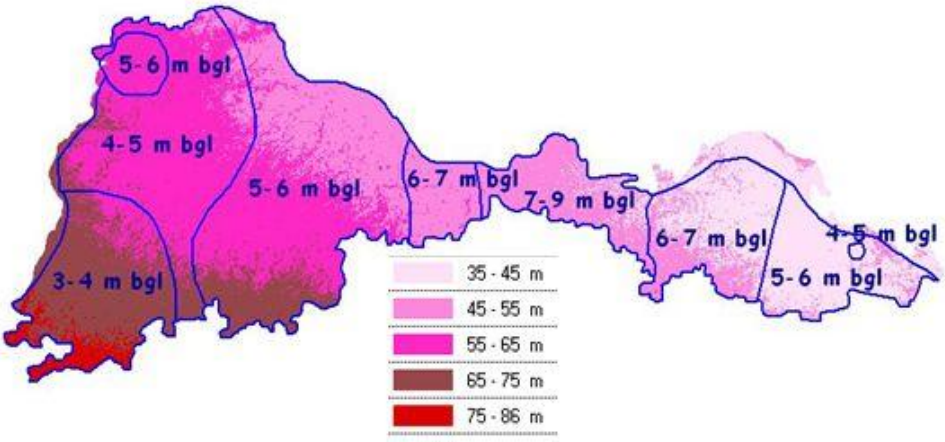

Figure 2: Depth to water level overlaid on Digital Elevation model

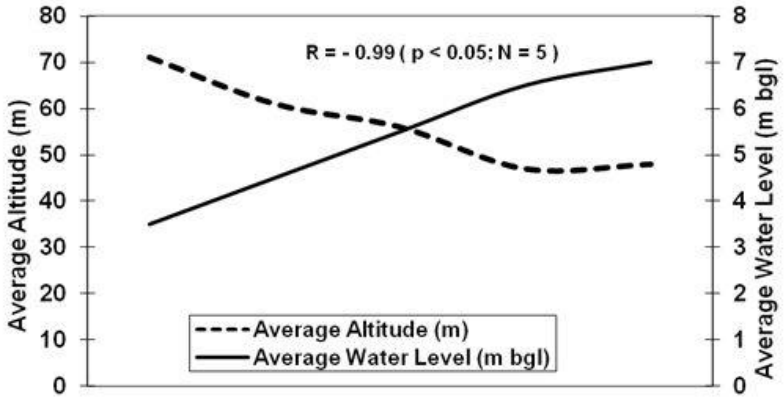

Figure 3: Correlation between altitude and depth to water level

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When DEM was overlaid on the depth to water level map (Figure 2), a significant negative correlation (R = 0.99) was observed between observed water level and the elevation of the region (Figure 3).

A study on arsenic contamination in the study area reported that Maner and Dinapur blocks in the north-west had 38.06% and 26.87% contaminated water pumps respectively. The south and eastern regions of the district had sporadic occurrences of arsenic (Ghosh *et al.*, 2007 & 2008). Out of 10 contaminated blocks, Maner was found to be most affected blocks. The Sampatchak and Bakhtiarpur blocks had 10-20 villages under risk while in Dinapur, Phulwari, Fatwah, Khusrupur, Barh, Pandarak and Mokameh blocks, 3-10 villages were observed under risk due to arsenic contamination (Figure 4).

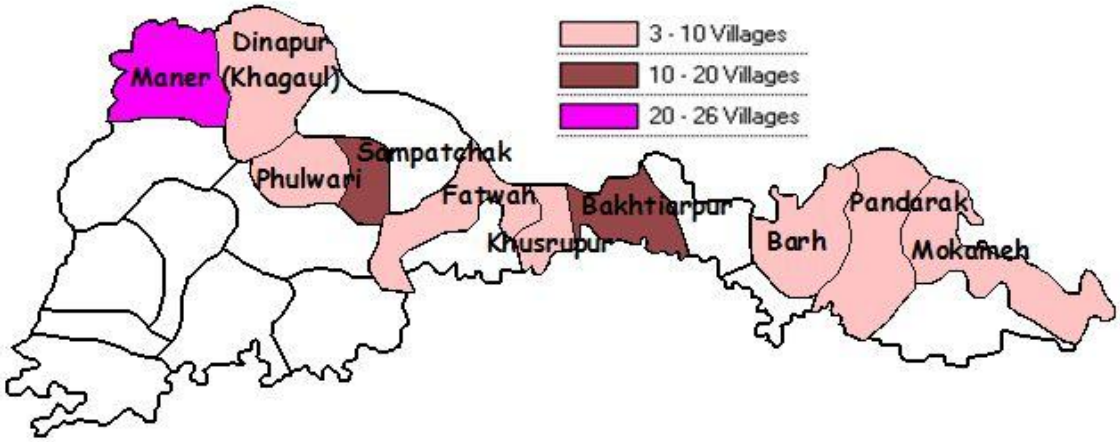
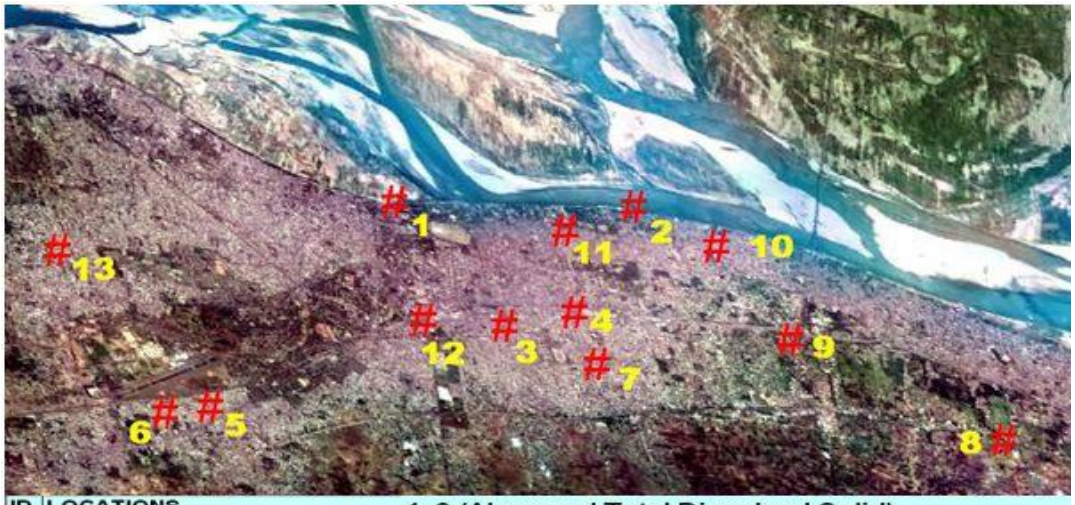


Figure 4: Arsenic contamination in the study area



ID	LOCATIONS	
1	Pahalwan Ghat/Bans Ghat	1, 2 (Abnormal Total Dissolved Solid)
2	Krishna Ghat/Gandhi Ghat	1, 2 (Abnormal BOD)
3	Kankarbagh	8, 10 (Abnormal Total Hardness)
4	Rajendra Nagar	8, 11 (Abnormal Electric Conductivity)
5	Chitkohra Bazar	8, 11 (Abnormal Magnesium)
6	Anisabad	2, 8, 9 (Abnormal PH)
7	Hanuman nagar	3, 4, 5, 6, 7 (Abnormal Turbidity)
8	Patna City	1, 2, 8, 9, 13 (Abnormal Total Alkalinity)
9	Agam Kuan	1, 2, 9, 10, 11, 12, 13 (Abnormal Dissolved Oxygen)
10	Pathar Ki Masjid	
11	Makhania Kuan	
12	Patna Railway Station	
13	Rajabazar	

Figure 5: Sites showing abnormal physico-chemical properties of sampled water

In order to assess Physico-chemical characteristics of ground water, the water samples were collected from 13 sites in Patna (Rai *et al.*, 2011; Sinha *et al.*, 2011 and Yadav *et al.*, 2012). The various Physico-chemical quality parameters which were estimated and tested in laboratory were pH, Turbidity (NTU), EC (micromhos/cm), Total Alkalinity (mg/l), Total Dissolved Solids (ppm), Dissolved Oxygen (mg/l), Total Hardness (mg/l), Calcium (mg/l), Magnesium (mg/l), Chloride (mg/l) and BOD.

The result of the study revealed that the out of 13 tested sites, all the sites reported higher/ lower values (at least for one parameter) of the tested parameter as suggested by World Health Organisations (WHO) as permissible limits (Figure 5). The site 1 and 2 had abnormal total dissolved solid, and sites 8 and 10 had abnormal water hardness. Sites 8 and 11 had abnormal electric conductivity and Magnesium content. Sites 2, 8 and 9 were abnormal in pH values. Sites 3, 4, 5, 6 and 7 were abnormal in turbidity. Sites 1, 2, 8, 9 and 13 showed abnormality in terms of total alkalinity. Sites 1, 2, 9, 10, 11, 12 and 13 had abnormal dissolved Oxygen.

Conclusion

The present study concluded that the Patna district possess good to very good category of groundwater potential. In spite of this favourable ground water aquifer, the region is facing a serious water crisis. Due to urbanisation, the various sources of ground water recharge, such as ponds, lakes etc., is diminishing leading to depletion of aquifers. These aquifers are also getting polluted due unmanaged land use practices. These contaminations have further deteriorated the physico-chemical standards of water as prescribed by World Health Organisation for healthy water. The situation has become grimmer when rainwater in the region flows as surface runoff without recharging the groundwater due to lack of proper rain water harvesting management. Therefore it is high time to take precautionary measures for conservation of management of groundwater in the region. It can be achieved through identifying and monitoring of susceptible aquifers, and developing and adopting their best management practices.

REFERENCES

Zektser IS and Everett LG (2004). Groundwater resources of the world and their use (IHP-VI), Series on groundwater no. 6, United Nations Educational, Scientific and Cultural Organization (UNESCO), USA.

Hegde NG (2012). Water scarcity and security in India, Indian Science Congress 2012, Bhubaneswar, Orissa.

Government of India (2009). Background note for consultation meeting with Policy makers on review of National Water Policy, Ministry of Water Resources, Government of India.

Pandey MN (2003). Management and utilization of water resources in Bihar in RB Mandal edition Water resource management concept publishing company, New Delhi.

CGWB (2011). Ground Water scenario in major cities of India, Ministry of Water Resources, Government of India. Available at: (http://www.mapsofindia.com;http://cgwb.gov.in/;http://srtm.csi.cgiar.org/;http://www.googleearth.com)

Ghosh AK, Singh SK, Bose N and Chaudhary S (2007). Arsenic contaminated aquifers: a study of the Ganga levee zones in Bihar, India. *Annual Conference of Royal Geographical Society, London Session key: BSG-session 3* 5.

Ghosh AK, Singh SK, Singh SK, Singh A, Roy NP, Upadhyaya A, Bose N, Chaudhary S and Mishra R (2008). Study of Arsenic Contamination in Ground Water of Bihar, (India) along the River Ganges, *3rd International Conference on Water Quality Management, 6-8 February 2008, Nagpur, India* in Water and Energy Abstracts 2008 **18**(1) 293-303.

Rai AK, Paul B, Mudra L and Kishor N (2011). Studies of water quality parameters of river Ganges at Patna, Bihar. *Journal of Advanced Laboratory Research in Biology* **2(4)**.

Sinha MR, Dev M, Prasad A, Ghosh M and Tagore RN (2011). Physicochemical examination and quality assessment of groundwater (Hand-Pump) around Patna main town, Bihar state, India. *Journal of Chemical and Pharmaceutical Research* **3**(3) 701-705.
Yadav KK and Yadav RS (2012). Assessment of ground water quality of Patna, Bihar. *International Journal of Advanced Biological Research* **2**(2) 363-364.
CGWB (2007). Ground Water Information Booklet Patna District, Bihar State, Central Ground Water Board, Ministry of Water Resources (Govt. of India), Mid-Eastern Region, Patna.