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Ground Water Head Declination and it's Impact on Society and Groundwater Quality of Rajshahi Division

Raziya Sultana Chowdhury[1], Mohammad Mainul Karim[2] and Md. Mafizur Rahman[1]

[1]Department of Civil Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

[2]Department of Applied Chemistry & Chemical Engineering, University of Dhaka, Dhaka, Bangladesh

E-mail: raziyasultana.2712@gmail.com

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Abstract

Prolonged absence of groundwater within the operating range of shallow tubewells during dry season is a common problem in the northwestern districts of Bangladesh in the recent years. Also, deficiency of groundwater is causing major difficulties in drinking water supplies and irrigation. This study was conducted to explore the overall view of the successive declination and fluctuation of groundwater level and identify the effect of groundwater scarcity on the agricultural practices of Rajshahi division using GIS interface. This study also generate contour map to visualize area of equal static groundwater head. Multicriterion modeling has been developed correlating groundwater levels data with the population distribution within the region and groundwater quality records (emphasizing on arsenic contamination) to identify the severely affected community under the surveyed area. This analysis illustrating the trend of ground water declination periodically affecting yield rate of withdrawal of water and also deteriorating of groundwater quality may act as a guideline in policymaking for area development and irrigation development project of this region.

Keywords: Groundwater head fluctuation, Arsenic, GIS, Contour.

1. Introduction

Bangladesh is an agro based country and hence depends largely on ground water for irrigation and production. Groundwater is the main source (about 75% water) of irrigation in the northwestern districts o Bangladesh. The contribution of groundwater has increased from 41% in 1982/1983 to 75% in 2001/2002 and surface water has declined accordingly[1]. The ratio of groundwater to surface water use is much higher in northwestern districts of Bangladesh compared to other parts of the country. The overexploitation has caused the ground water level falls to the extent of not getting fully replenished in the recharge season. Also, as water levels decline, the yield rate of water from well may decline.

The groundwater level declined below 8 meters from land surface in 12% areas of Bangladesh in 1986. This extent rose to 20% areas in 1992 and 25% areas in 1994[2]. The study on forecasting groundwater level fluctuation in Bangladesh indicated that 54% areas of Bangladesh are likely to be affected up to 20 meters in some areas particularly in northern part of the country.

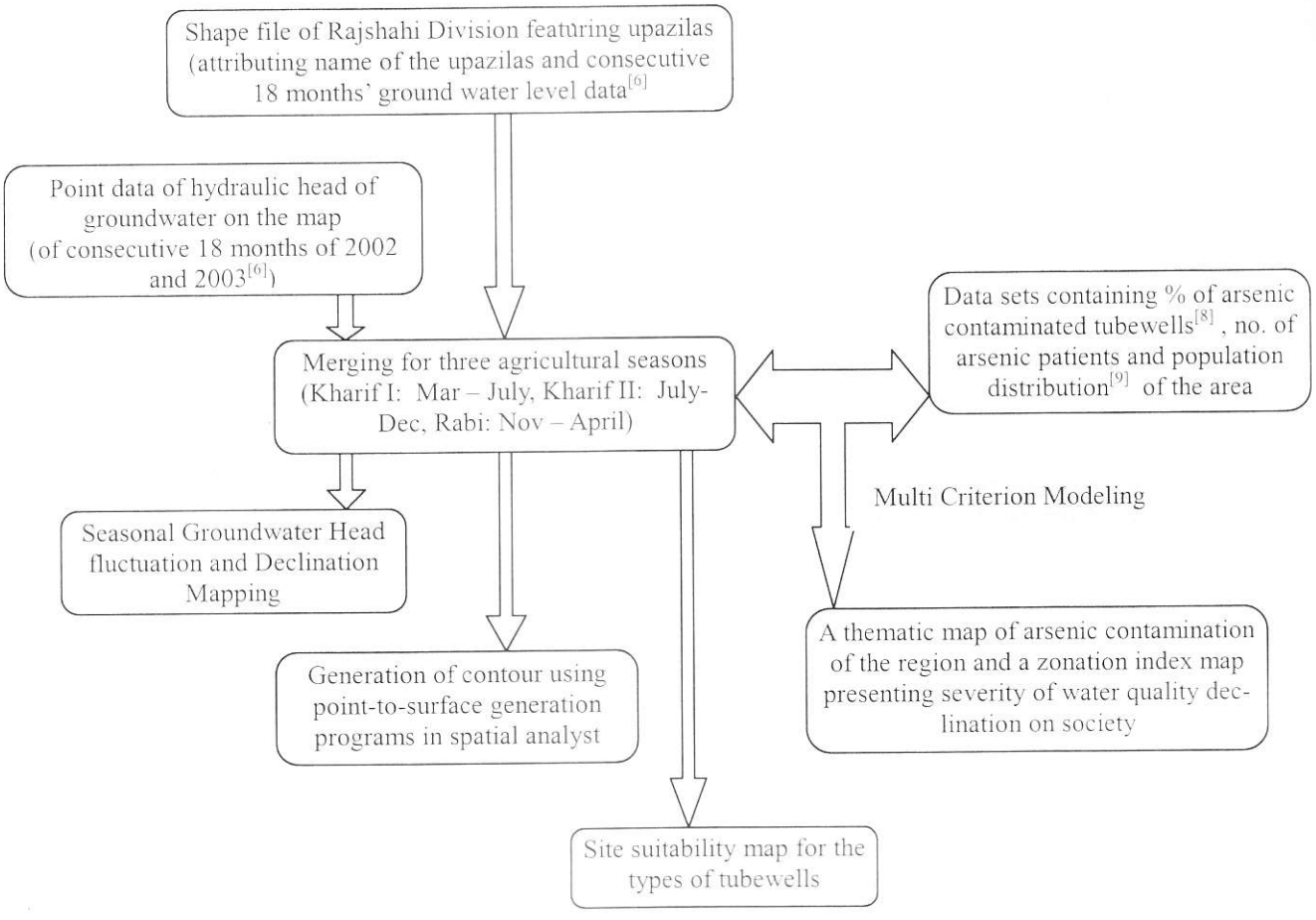
Assessment of ground-water-quality is necessary for the protection of ground-water resources because deterioration of ground-water quality may be virtually irreversible. The problem of Arsenic (As) contamination of groundwater in Bangladesh has received considerable attention as a serious health risk for the population, drinking water containing Arsenic above the maximum national permissible level of 50 μg per litre of water (=50 ppb)[4]. Peoples are using millions of hand-operated tubewells (estimated 10–12 millions) for extracting groundwater for drinking and approximately 1 million shallow wells for dry-season irrigation purposes, of which many contain dangerously high levels of dissolved arsenic[5].

The relationship between water supply and population dynamics is reciprocal. In rural areas population growth has contributed to increased demands for water supply, expanded drilling of boreholes (for tube wells), and resulting depletion of groundwater resources and scarcity of water. For ground water management the following areas should be considered: groundwater exploitation/ resources, groundwater vulnerability (on society and water quality) mapping and protection, ground water management, groundwater quality etc.

Geographical Information System (GIS) acts as a tool to unify data from various sources and integrate them into a single environment to analyze the relationship amongst them. An attempt has been made to model hydraulic head distribution of the region and the affected zonal map due to groundwater head declination using various GIS technology. The data layers will be constructed for the regional level. A GIS can link information (attributes) to location data such as ground water level, arsenic, population of that particular location of the region. GIS databases will be used to map and analyze of infrastructure and ground water quality data in the study area.

2. Methodology

The study was carried out to analyze the effect of ground water head fluctuation on society, cultural practice and water quality of Rajshahi division. The processing steps involved and followed in this study are given in the flow chart.



2. 1. Study Area

Fig 1: Location Map of the study area

Our Study area includes all the 125 upazilas and 16zilas of Rajshahi division of Bangladesh.

Primary or raw data of Rajshahi division required for the analysis are ground water-level data[6] of consecutive eighteen months (from January 2002 to June 2003), ground water-quality data (arsenic contamination)[8] and no. of arsenic patients, population distribution[9] at upazilla level and maximum depth up to, which shallow tube well can lift water.

3. Results and Analysis

3.1. Periodic Ground Water Head Fluctuation at Different Cropping Season

The fluctuation in groundwater level (change in hydraulic head) has been monitored every month. The groundwater level reached the lowest level in the hottest dry periods end of rainy seasons. Generally crop season in Bangladesh is

divided into three major classes throughout the year. i.Kharif I (March to July) → Pre-monsoon season. ii.Kharif II (July to December) → monsoon period and sometimes extent to post-mosoon period and iii. Rabi (November to April) → winter season.

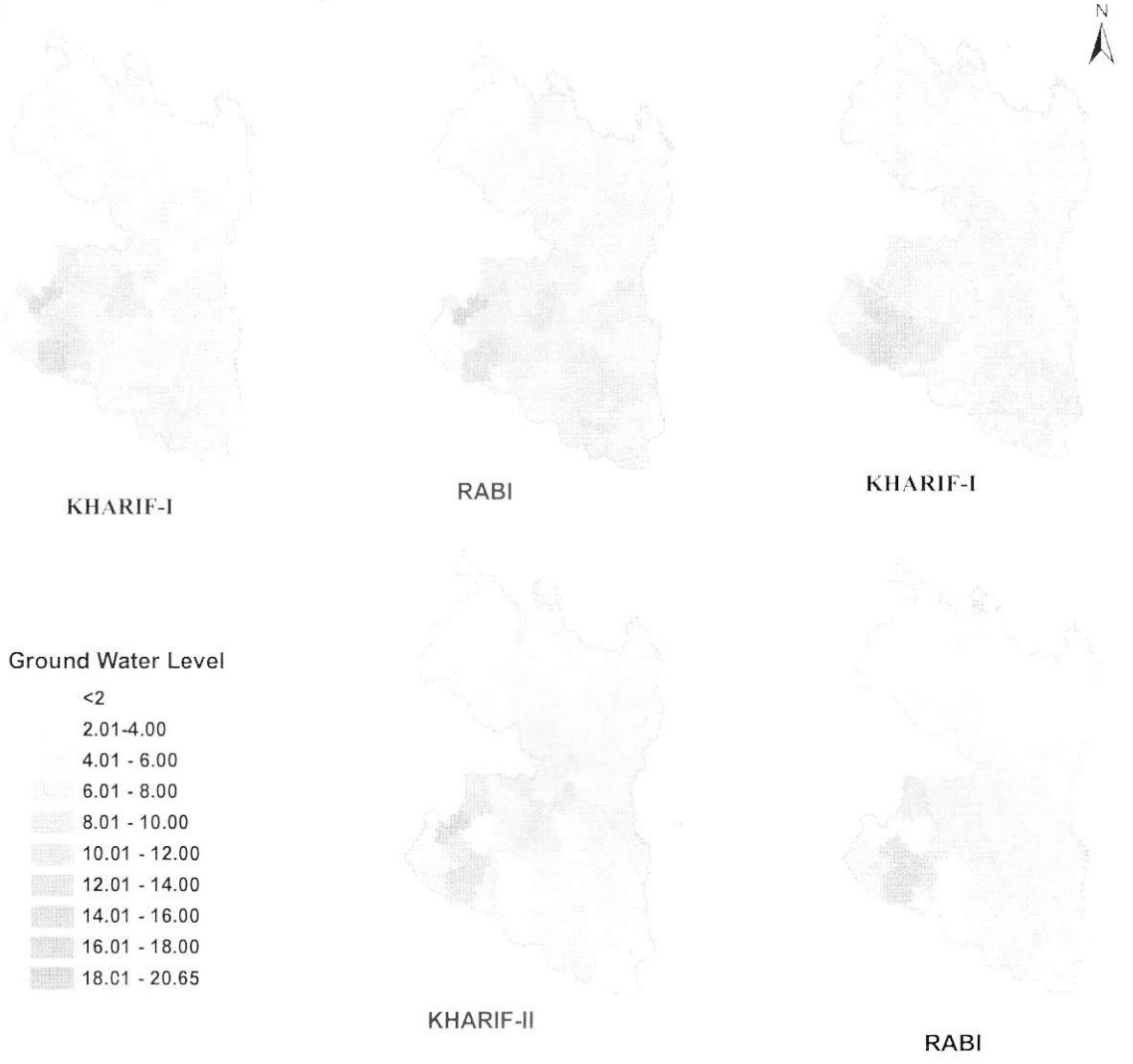
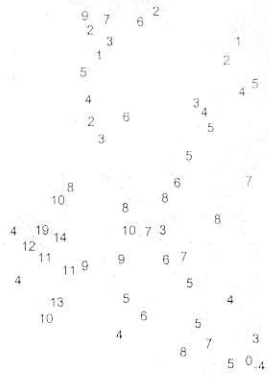


Fig 2: Ground water head fluctuation of Rajshahi Division for consecutive six cropping seasons of the year 2002 and 2003

The above arc map is reflecting seasonal fluctuations of ground water level throughout the consecutive crop seasons. From the GIS map, it can be easily visualized that Kharif I is the mostly severe seasons in the view of ground water level and requires irrigation for crop production. The rise and fall depends upon the amount, duration and intensity of precipitation, depth of weathering, specific yield of the formation etc. Also, it is apparent that there is a trend of declination of groundwater head in the successive years or cropping phases.

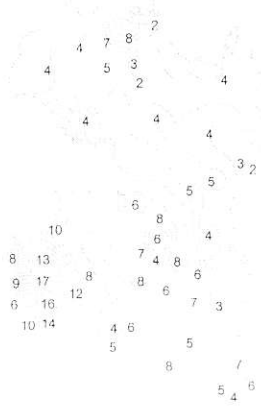
3.2. The Contour Map of Static Ground Water Head

Kharif I (Mar - July), 2002



Rabi (Nov-April), 2002

Kharifl II (July - Dec), 2002



Kharif – I, 2003

Fig 3: Contouring of static ground water head of Rajshahi Division of the year 2002-03 at different agricultural periods of Bangladesh

From the contour map, spatial analysis helps to visualize area of equal ground water level easily. Because ground water level in Rajshahi division vary greatly from 1.84 m to 20.62m.

3.3. Appropriate Locations and Types of Tubewells

The following figure represents where will be suitable locations for shallow tubewell (which maximum depth is less than 7 meter) and deep tubewell (tubewell depth is greater than 7 meter).

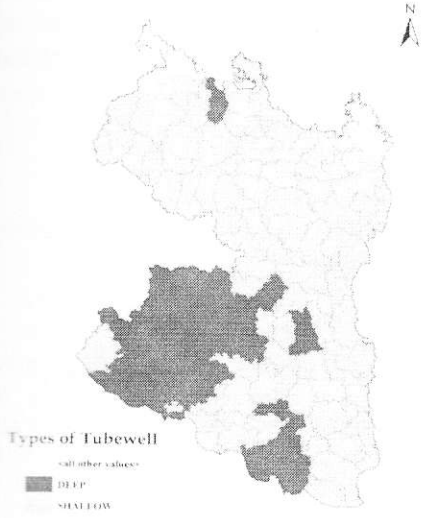


Fig 4: Locations for shallow and deep tubewell of Rajshahi Division upazilas

3.4. Arsenic Contamination Map of Rajshahi Division

The map showing the arsenic patients indicates the level of hazards of different upazilas from consumption of arsenic contaminated water.

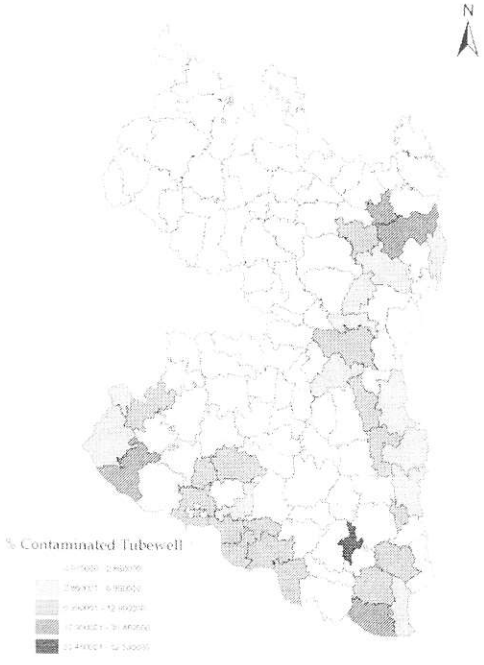


Fig 5: Percentage of contaminated tubewell of Rajshahi Division

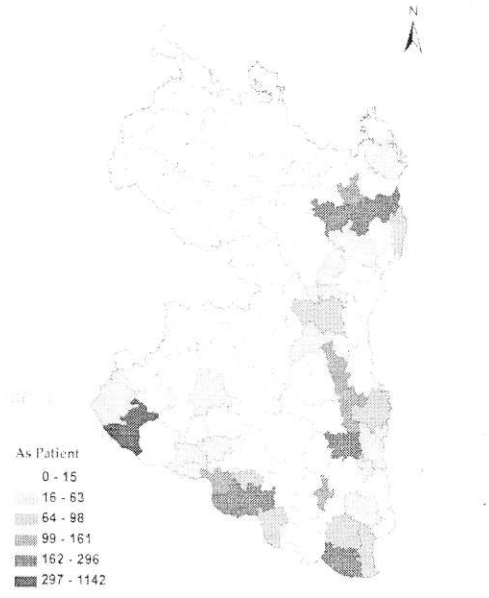


Fig 6: Number of Arsenic patient

3.5. Severely Affected Zone (parameter: population and ground water level)

Population data will be co-related with the water level data using GIS concept. An Arc map has been developed displaying population affected from water scarcity of Rajshahi division overlapping the layers of ground water level (considering the lowest level period).

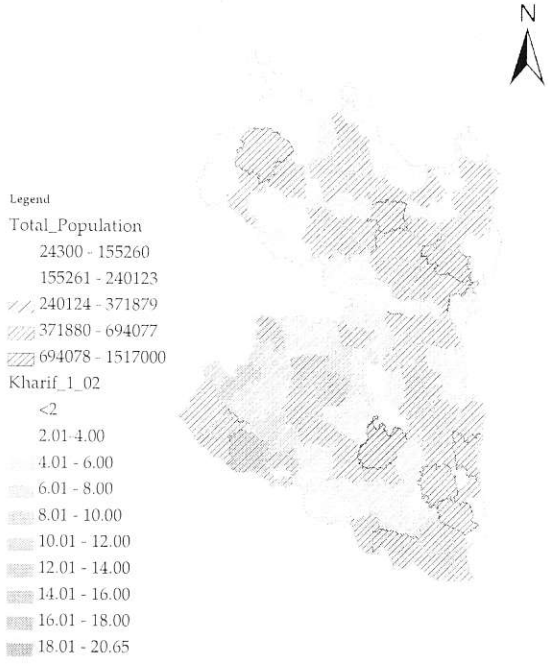


Fig 7: Severely affected zone (parameters: population and Ground water level)

From the map it was found that Singra upazila of Natore district is the most densely populated and the severely affected community under threat of arsenic contamination.

4. Discussion

Mapping of ground water level of upazillas of Rajshahi division over a period of successive eighteen months of 2002 and 2003, the trend of groundwater head fluctuation in different agricultural seasons of a year were determined. The trend may also be used to meet the future needs and to take necessary steps.

Static ground water mapping of Kharif I, Kharif II and Rabi season of consecutive eighteen months can be used for policy formulation and strategic planning in areas such as, agricultural practices, irrigation requirement, crop diversification and investments in irrigation development work.

Development of a map of arsenic patients at upazilla level of Rajshahi division leads to a broader understanding of its regional presence and significance. Mapping of percentage of arsenic contaminated tubewell was helpful in understanding of severely affected zone that may guide to take remedial actions.

GIS based mapping water level in all seasons may be used to identify dried up areas in winter and thus to determine percentage of society under threat that may helpful to determine the extent of necessary steps.

From the study presenting the relative consumption, the highest consumption zone can be found and hence necessary steps can be taken. Therefore, necessary strategic planning can be undertaken for the most severe locations from this study. Presentation of water table variation from month to month can be used to decide suitable location and appropriate type of wells to be installed.

6. Conclusions

From this study, it is observed that ground water level of the region is depleting with time in Rajshahi Division causing shallow wells to go dry day by day, particularly during dry season which creates major difficulties obtaining drinking-water and for irrigation. It also has major equity effects. It also increase sing arsenic contamination level affecting population severely in some areas.

Consideration should be given to the creation of economical low water consuming activities. Rules on equitable utilization of shared groundwater resources, prevention of harm to such resources and the environment, exchange of information and data should be taken by Governments and International Organizations. GIS is a indirect tool of estimation in water resource field. Other tools may be considered and correlated with this process. In light of this research, new approaches are urgently needed to manage water resources rationally and equitably. This entails efforts that will simultaneously address population dynamics, consumption patterns, and environmental conservation.

Acknowledgement

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