Estimation of Potential Recharge and Groundwater Resources - A Case Study in Low Barind Area, Bangladesh

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Introduction

Agriculture has great importance on the economy of Bangladesh. Population growth poses pressures on agriculture and sustainable development and demands at the same time for more food production. For increasing the agricultural production and to reduce environmental impacts from agriculture, it is also necessary to investigate the interrelationship between rainfall, surface water and groundwater on one side and demand for irrigation water and crop production on the other side. The study area has limited scope of surface water development and potential for groundwater development. The Master Plan Organization (MPO) and the Bangladesh Water Development Board (BWDB) identified the areas suitable for groundwater irrigation. During the recent past years, the number of Deep Tube wells (DTW) has been significantly increased. At present, about 2100 DTWs, 45,000 Shallow Tube Wells (STW) and other mode of irrigation wells are being used in the study area for irrigation. In total it covers 88% of the total irrigable area in the study area. The remaining irrigable area has been planned to cover by installation of additional DTWs under a specific project.

Study Area

EIGHT UPAZILAS

Population: 1982203

Total Area: 210800 ha

Net. Cul. Area: 160952 ha

Rainfall: 1200-2100 mm

Temperature: 10 °C-35 °C

Humidity: 46%- 83%

Problems

•Rainfall Scarcity from November to April.

•Very limited scope of conserving large volume of water in wet months for irrigation.

•Most of the rivers become dry during the dry season.

•Inadequate power supply is another problem for the smooth operation of DTWs.

•Present status of potential Aquifer Recharge, available Aquifer Recharge and trend of actual Aquifer Recharge has not been assessed.

Objectives

The main objective of the study is to investigate how to increase the agricultural production through a sustainable utilization of available water resources, especially groundwater. ,"

Specific Objectives:

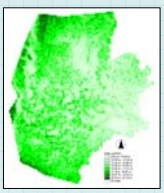
- Development of mathematical models using existing hydro-geological and meteorological data including calibration and validation of the model.
- Assessment of groundwater resources and aquifer recharge, including the assessment of surface water contribution to aquifer.
- Application of models for various development scenarios development.
- Assessment of groundwater availability as well as potential use for the future.

Data

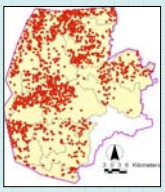
Thiessen Polygon

Rive network

Abstraction Zone



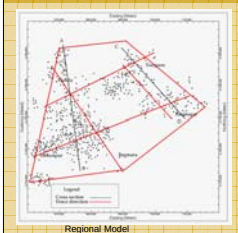
Digital Elevation Model



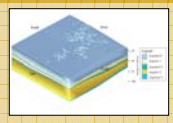
Digital Elevation Model

Initial GWL Contour

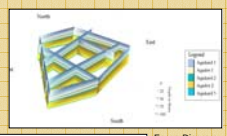
Geology



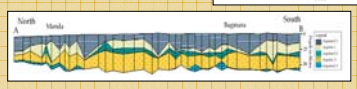
Regional Model



North-East View of Regional Model



Fence Diagram



Cross section (AB) through Manda and Bagmara Upazila

Depth of Second Aquifer from Surface in Atrai Upazila

Model Setup

Cell Size : 500 m X 500 m

Boundary Condition: Groundwater and Surface Water Level

River Network: Internal and External Boundary

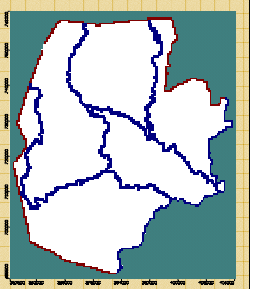
Digital Elevation as Surface Topography

Hydraulic Conductivity, Specific Yield, Specific Storage

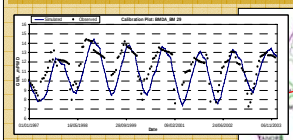
Initial Condition

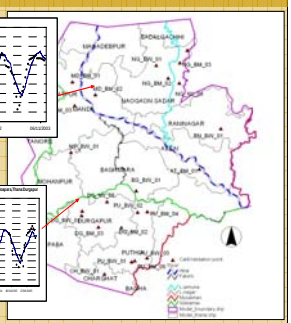
Recharge

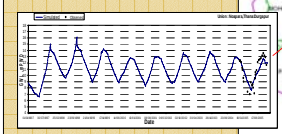
Observation wells



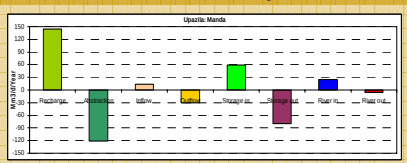
Calibration &Validation



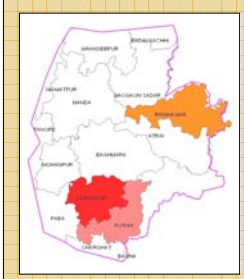




Result Analysis



Water Budget of Manda Upazila



Over Exploited Upazilas Based on Irrigation req. for Boro in 2005

Over Exploited Upazilas Based on Abstraction Data of Year 2005

Sl.No	Upazila	Recharge (mm)	Inflow (mm)	Outflow (mm)	River In (mm)	River Out (mm)	Actual Aquifer Recharge (mm)
1	Atrai	484	47	63	90	27	531
2	Bagmara	348	63	31	58	19	418
3	Durgapur	344	52	38	10	03	365
4	Manda	407	39	99	84	16	414
5	Mohanpur	378	56	157	98	24	351
6	Naogaon	433	106	80	65	23	500
7	Puthia	403	30	80	33	10	377
8	Raninagar	513	70	92	29	33	486

Actual Recharge of each Upazila in Year 2005

Scenarios Analysis

Option 0: Base Condition i.e. Existing Situation

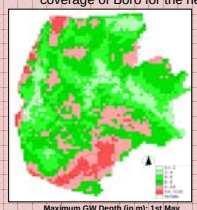
•Hydrological condition for the year 2001 (avg. condition).

•Crop coverage, irrigation demand etc. of year 2005.

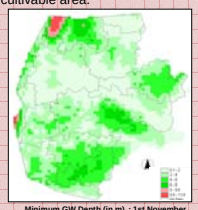
Option-1: Future Option with design year and increased crop coverage

•Hydrological condition for the year 2001 (avg. condition).

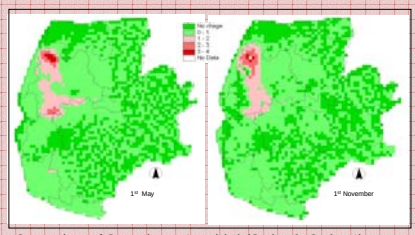
•Crop coverage for future condition; Upazilawise at least 80% crop coverage of Boro for the net cultivable area.



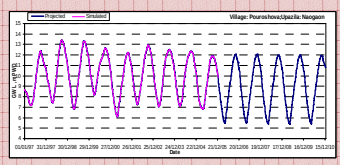
Maximum GW Depth (in m): 1st May (option 1)



Minimum GW Depth (in m) : 1st November option 1)



Comparison of Groundwater Level (m) (Option 0- Option 1)



Prognosis Analysis up to year 2010

Conclusion

•The study area is semi confined aquifer. The geology of the study area contains two aquifers which are interconnected in many places. The lower aquifer is the main aquifer of the study area.

•The recharge due to rain and flooding starts in May and continues to the end of October. The groundwater model prepared in this study shows that the average recharge of the groundwater is 398 mm per year (average of year 1997 to year 2005) in the study area, varying from 306 mm (in Puthia Upazila) to 439 mm (in Naogaon Upazila) in the same period.

•According to the assessment of aquifer recharge, irrigation requirements of year 2005 for Boro (a type of rice which requires highest amount of water for cultivation) and extracted water in 2005 depict that Durgapur, Raninagar and Puthia are over exploited areas.

•The total recharge for the period 1997 to 2005 (due to rainfall, irrigation and river leakage) is around 800 Mm³/day/year, where as river leakage contributes with around 70 Mm³/day/year, which is about 9% of the total recharge.

•According to the model study results, the river is in direct contact with the aquifer system, contributing to the aquifer recharge from March to November and receiving water from aquifers from December to February. River has positive influence on groundwater recharge

•If the Boro rice production increases to 80% of the net irrigated cultivable area of the upazilas, the groundwater level would drop to about 1 m in some places, even more than that in Manda upazila. In those places some shallow tubewells might be out of order.

•According to the selected scenarios, the groundwater level in dry season will be lowered by 0.2 m per year with the average recharge (year 2001) and current groundwater extraction condition (year 2005). Also in wet season the peak does not recover its original level, probably due to the high extraction if compared to the actual recharge.

Recommendation

The most effective and efficient way to reduce the pressure on groundwater extraction is the crop diversification which is of course difficult but possible to implement to some extent. Changing the cropping pattern from major Boro-crop, which requires more irrigation water, to mixed Boro, wheat and vegetables would reduce the groundwater extraction.

The geographic location of the deep tube wells (DTW) should be determined. Groundwater table and quality monitoring should be done regularly. The production well monitoring should also be done periodically to minimize the operation and maintenance costs of the BMDA management as well as to optimize the resource utilization.

The estimation of remaining water based on actual recharge shows that Puthia and Durgapur withdrawing more water than recharge. These leads to inoperable condition of the shallow tube wells. The adverse effect of over exploitation of groundwater may be overcome by aquifer recharge induced by surface water. This adverse effect should be assessed through more extensive modelling over 10-15 years time period.

Acknowledgement

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