Impact of Climate Change on suitable aquifers for drinking Water Supply and agricultural water use in Southwest Coastal Area

Khurshid Jahan, Shahadat Hossain

Presented By
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Background

• Salinity intrusion is a growing problem in the coastal areas around the globe.

• In Bangladesh, groundwater is a dependable source for water supply in Bangladesh; it is crucial for agriculture, drinking water and industrial use.

• This study was an attempt to make use of a number of recent measurements, especially borehole geophysical logging data, by a number of agencies to delineate groundwater salinity at different depths, and hence help identify suitable aquifers for agricultural and domestic water supply in part of southwest coastal region.
Objective

The overall goal of the study was to delineate suitable aquifers for agricultural and drinking water supply in southwest coastal area. The specific objectives were as follows:

(i) To map salinity distribution at different depths in the study area
(ii) To identify aquifer layers with acceptable limits of salinity for different uses

The main expected outcome of the study was a database for groundwater salinity distribution at different depths, which would be useful for planning of southwest coastal groundwater resources as well as for any future research requiring salinity data.
Khulna and Satkhira were selected as the study area since these two districts are widely recognized as areas affected by the most severe groundwater salinity problem.
Data Collection and Location

Location of DPHE wells used for resistivity logging

Location of BAEC wells used for resistivity logging

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Data Collection and Location (contd....)

Location of BADC wells used for salinity measurement

Location of BWDB wells used for salinity measurement

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**Methodology**

- Lithological Log for analyses the aquifer settings.

- Using Geophysical Data for salinity measurement.
  - *Calculation of formation water resistivity from formation resistivity*
  - *Temperature correction for $R_w$*
  - *Estimation of EC from empirical relationship*

- Validation the EC data which was derived from geophysical logging with the other Organizational salinity data like DPHE, BAEC and BWDB.

- Preparing the map to delineate the suitable aquifer for drinking and agriculture.
Lithological log analyses

Cross-Section A-B', Assasuni, N-S Direction

Cross-Section A-B', Kalaroa, W-E

Cross-Section A-B', Debhata, W-E Direction

Lithology:
- Clay
- Very Fine sand
- Fine to Very Fine sand
- Fine to Medium sand
- Medium to Fine sand
- Medium to Coarse sand
Lithological log analyses

- Lithologic analysis was conducted using 276 borelog data in Satkhira and Khulna districts. Aquifer was assessed by developing cross section in different direction using Rock Works 2004.

<table>
<thead>
<tr>
<th>Upazila</th>
<th>Aquifer description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assasuni</td>
<td>A relatively thick (~70 m) upper shallow aquifer between depths 40-110 m and a main aquifer of about 100 m thickness between depths 120-220 m, separated from the upper aquifer by a thin clay aquitard; deeper aquifer exists at depths greater than 230 m.</td>
</tr>
<tr>
<td>Debhata</td>
<td>Highly discontinuous aquifer layers, with no clear boundaries; a mixture of very fine sand and medium to coarse sand dominates in the upper layer (at depths 40-80 m), medium to fine sand and medium to coarse sand dominate in the deeper layer (depths 150-220 m).</td>
</tr>
<tr>
<td>Kalaroa</td>
<td>A thick (~130-150 m) composite aquifer overlain by thin surficial clay layer. Deeper aquifer is present in the northern part and not much in the southern part</td>
</tr>
<tr>
<td>Kaliganj</td>
<td>Composite aquifer of fine to very fine sand</td>
</tr>
<tr>
<td>Sadar</td>
<td>Very thick composite aquifer with variable thickness (~130 m) at depths 20-150 m, overlain by relatively thin (15-30 m) surficial clay layer; discontinuous deeper aquifer with thickness ~60-70 m</td>
</tr>
<tr>
<td>Shyamnagar</td>
<td>In most places composite aquifer is dominated by very fine sand with thickness ~50 m at variable depths of 5-50 m. The deeper aquifer is of ~40-60 m thickness with discontinuity present at depths 180-240 m, separated from the upper aquifer by very thick (100-150 m) clay layer</td>
</tr>
<tr>
<td>Tala</td>
<td>Good composite aquifer with thickness ~80 m overlain by upper clay layer of 15-40 m thickness; good deeper aquifer of about 100-120 m thickness separated from upper aquifer by clay with variable thickness.</td>
</tr>
</tbody>
</table>
Salinity Mapping

- Electrical conductivity has been used as a surrogate for salinity in the groundwater in the two coastal districts.

**Salinity classification based on electrical conductivity (Source: FAO, 1992)**

<table>
<thead>
<tr>
<th>Electrical conductivity (µS/cm)</th>
<th>Salinity classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1,000</td>
<td>Fresh (limit for drinking)</td>
</tr>
<tr>
<td>1,000 – 3,000</td>
<td>Slightly saline (limit for irrigation)</td>
</tr>
<tr>
<td>3,000 – 10,000</td>
<td>Brackish</td>
</tr>
<tr>
<td>10,000 – 35,000</td>
<td>Saline</td>
</tr>
<tr>
<td>≥ 35,000</td>
<td>Sea water</td>
</tr>
</tbody>
</table>

- A classification of salinity is often used based on the electrical conductivity range is given in Table (Source: FAO, 1992).

- According to Table the allowable limit of electrical conductivity for drinking and irrigation water is 1000 µS/cm and up to 3000 µS/cm, respectively.

- Map was developed for 50m, 100m, 150m, 200m, 250m and 300m.
Salinity Mapping

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<table>
<thead>
<tr>
<th>District</th>
<th>Upazila</th>
<th>Union</th>
<th>Aquifer Depth in meter</th>
<th>EC (µS/cm)</th>
<th>Suitable zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satkhira</td>
<td>Kalaroa</td>
<td>Chandanpur</td>
<td>(30-120)</td>
<td>931</td>
<td>Both for Drinking and irrigation water</td>
</tr>
<tr>
<td></td>
<td>Banshdaha</td>
<td>(30-160)</td>
<td>553</td>
<td></td>
<td>Both for Drinking and irrigation water</td>
</tr>
<tr>
<td></td>
<td>Labsa</td>
<td>(20-110)</td>
<td>219</td>
<td></td>
<td>Both for Drinking and irrigation water</td>
</tr>
<tr>
<td></td>
<td>BrahmaRajpur</td>
<td>(20-120) &amp; (160-180)</td>
<td>3582 &amp; 4256</td>
<td>Not suitable for both drinking and irrigation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dhulihar</td>
<td>(160-200)</td>
<td>3944</td>
<td></td>
<td>Not suitable for both drinking and irrigation</td>
</tr>
<tr>
<td>Tala</td>
<td>Nagarghata</td>
<td>(20-100)</td>
<td>315</td>
<td></td>
<td>Both for Drinking and irrigation water</td>
</tr>
<tr>
<td>Debhata</td>
<td>Kulia</td>
<td>(50-100) &amp; (125-140)</td>
<td>1870 &amp; 1336</td>
<td></td>
<td>Both aquifer is suitable for irrigation</td>
</tr>
<tr>
<td></td>
<td>Parulia</td>
<td>(30-110) &amp; (150-170)</td>
<td>882 &amp; 3582</td>
<td>Upper aquifer suitable for both drinking and irrigation but lower aquifer is not suitable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Noapara</td>
<td>(50-80) &amp; (180-210)</td>
<td>3892 &amp; 984</td>
<td>Upper aquifer not suitable but lower aquifer suitable</td>
<td></td>
</tr>
<tr>
<td>Assasuni</td>
<td>Fingari</td>
<td>(60-90)</td>
<td>4235</td>
<td></td>
<td>Not suitable</td>
</tr>
<tr>
<td></td>
<td>Budhhata</td>
<td>(40-90) &amp; (160-185)</td>
<td>5230, 4256, 4128</td>
<td>Very high</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Durgapur</td>
<td>(50-105)</td>
<td>3582, 3892</td>
<td>Not suitable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baradal</td>
<td>(20-200)</td>
<td>3892, 4668</td>
<td>Not suitable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Khajra</td>
<td>(60-130)</td>
<td>4935</td>
<td>Not suitable</td>
<td></td>
</tr>
<tr>
<td>Assasuni</td>
<td>Assasuni</td>
<td>(40-100) &amp; (825-1360)</td>
<td></td>
<td>Suitable for both</td>
<td></td>
</tr>
<tr>
<td>Kaliganj</td>
<td>Nalta</td>
<td>(25-60)</td>
<td>2340</td>
<td></td>
<td>Suitable only for irrigation</td>
</tr>
<tr>
<td></td>
<td>Sobhnali</td>
<td>(30-90)</td>
<td>3536</td>
<td></td>
<td>Not suitable</td>
</tr>
<tr>
<td></td>
<td>Sreeula</td>
<td>(40-90)</td>
<td>2610</td>
<td></td>
<td>Not suitable</td>
</tr>
<tr>
<td></td>
<td>Khushlia</td>
<td>(20-70)</td>
<td>(897-1899)</td>
<td>Suitable for irrigation in very shallow depth its suitable for drinking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bishnupur</td>
<td>(30-65)</td>
<td>6777</td>
<td></td>
<td>Very high</td>
</tr>
<tr>
<td>Shymnagar</td>
<td>Shymnagar</td>
<td>(0-120)</td>
<td>1997</td>
<td></td>
<td>Suitable for irrigation</td>
</tr>
<tr>
<td></td>
<td>Puri Goslini</td>
<td>(10-60)</td>
<td>5320</td>
<td></td>
<td>high range</td>
</tr>
</tbody>
</table>
# Aquifer Delineation

<table>
<thead>
<tr>
<th>District</th>
<th>Upazila</th>
<th>Union</th>
<th>Aquifer Depth in meter</th>
<th>EC (µS/cm)</th>
<th>Suitable zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khulna</td>
<td>Koyra</td>
<td>Nalian Range</td>
<td>(30-80)</td>
<td>8102</td>
<td>Very high</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UttarBedkashi</td>
<td>(40-80)</td>
<td>5400</td>
<td>High Range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Koyra</td>
<td>(10-80)</td>
<td>2850</td>
<td>Suitable for irrigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bagali</td>
<td>(30-70)</td>
<td>3892</td>
<td>Not suitable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chalna</td>
<td>(30-110) &amp; (160-210)</td>
<td>850 &amp; 1763</td>
<td>Upper aquifer suitable for both and lower one is suitable for only irrigation</td>
</tr>
<tr>
<td>Dacope</td>
<td>Banishanta</td>
<td>(20-80)</td>
<td></td>
<td>5088</td>
<td>High range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kailasganj</td>
<td>(30-90)</td>
<td>4935</td>
<td>High range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kamarkhola</td>
<td>(20-80)</td>
<td>4342</td>
<td>High range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Batiaghata</td>
<td>(20-60)</td>
<td>1412-2030</td>
<td>Suitable only for irrigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jalma</td>
<td>(30-80)</td>
<td>4100</td>
<td>Not suitable</td>
</tr>
<tr>
<td>Batiaghata</td>
<td>Rupsha</td>
<td>(10-70) &amp; (80-240)</td>
<td></td>
<td>527, 1070</td>
<td>Suitable for both</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Madhupur</td>
<td>(10-70)</td>
<td>325</td>
<td>Suitable for both</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dighalia</td>
<td>(30-90)</td>
<td>2240</td>
<td>Suitable only for irrigation</td>
</tr>
<tr>
<td>Rupsha</td>
<td></td>
<td>Damodarpur</td>
<td>(20-105)</td>
<td>760</td>
<td>Suitable for both</td>
</tr>
<tr>
<td>Terakhada</td>
<td></td>
<td>Kharnia</td>
<td>(30-90)</td>
<td>580</td>
<td>Suitable for both</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dighalia</td>
<td>(10-70)</td>
<td>1987</td>
<td>Suitable only for irrigation</td>
</tr>
<tr>
<td>Dighalia</td>
<td></td>
<td>Damodarpur</td>
<td>(20-60)</td>
<td>715</td>
<td>Suitable for both</td>
</tr>
<tr>
<td>Phultala</td>
<td></td>
<td>Kharnia</td>
<td>(20-75)</td>
<td>(216-527)</td>
<td>Suitable for both</td>
</tr>
<tr>
<td>Khulna Metro</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Conclusion and Recommendation

• Groundwater salinity needs to be monitored on a continuous basis.

• Since resolution of monitoring stations would determine the degree of accuracy in maps at local levels, the number of location of monitoring stations should be accordingly designed.

• The methodology adopted in the study may be extended to other areas of the coastal zone, especially where resistivity logging data are available.

• The analysis for suitability of aquifers for drinking and irrigation purposes should be extended by taking into consideration other important and relevant quality parameters.
Thank you