Detection of Bacteriological Pollution of Groundwater in Shendi-atbara Basin, River Nile State, Sudan

Abdelatif Mokhtar Ahmed and Ahmed Mohamed Khair Badi

College of Water and Environmental Engineering, Sudan University of Science and Technology, P.O. Box 407, Khartoum, Sudan.

Abstract: The main objective of this paper is to discuss the degree of bacteriological pollution in Shendi-Atbara basin in the River Nile State, Sudan. A bacteriological survey was performed on untreated, individual, rural and urban groundwater supplies which included drilled wells and dug wells. Groundwater samples have been collected from 23 boreholes and dug wells for determination of E-Coli. The bacteriological test covered the area from Shendi, Ed Damer and Atbara towns, and mainly concentrated on the towns due to their dense population. The bacteriological test carried out in the study area covered all water sources in Shendi, Eddamer and Atbara towns. Coliform bacteria are grown and measured using the membrane filter (MF) method. The bacteriological test revealed that groundwater have been polluted by E. Coli.

Key words: Groundwater Bacteriological Pollution Shendi-Atbara Basin Basement rocks Nubian sediments

INTRODUCTION

Public water systems are required to deliver safe and reliable drinking water to their customers 24 hours a day, 365 days a year. If the water supply becomes contaminated, consumers can become seriously ill. Fortunately, public water systems take many steps to ensure that the public has safe, reliable drinking water. One of the most important steps is to regularly test the water for coliform bacteria (http://www.doh.wa.gov/ehp/dw/Programs/coliform.htm). The main objective of this study is to determine the bacteriological pollution of groundwater at Shendi-Atbara basin, from which the people of Shendi, Atbara and Ed Damar and villages scattered around get their drinking water. This study was mainly conducted in Eddamar, Atbara and Shendi towns, which lie within the so-called Shendi-Atbara basin. This basin is about 150 km in length parallel to the River Nile and extending about 40 km to the east and its depth ranges between 50 m and reaches 200 m in some bore holes located in the basin[1].

The study mainly deals with the bacteriological pollution caused by microorganisms. The presence of these microorganisms such as bacteria, viruses and protozoa in the groundwater system can cause different diseases such as Typhoid fever, Hepatitis and Diarrhea[2].

It is now generally recognized that the quality of groundwater is just as important as its quantity. The groundwater contain salts in solution that are derived from the location and past movement of the water. Reported salt contents range from less than 25 mg/l in a quartzite spring to more than 300,000 mg/l in brines[3]. de Moel et al.,[4], mentioned that, groundwater is hygienically reliable and typically has a constant composition. According to the World Health Organization[7] international standards for drinking water and for human consumption, the water must be free from organisms and from concentrations of chemical substances that may be hazardous to human health.

The population of the study area is around half million. The people of the area are living around the River Nile. The majority of the people earn their living by growing horticulture crops and legumes, and raising few animals for domestic uses.

Location, Climate and Topography: The study area Figure (1), lies south River Nile State extending along the River Nile, from south Shendi ‘Wad Bannaga’ to Atbara town. The study area lies 320 km north of Khartoum. The area climate belongs to the desert and semi desert, with temperature that may reach 45° C in summer with low relative humidity. May and June are the hottest months in the year. The temperature in winter season reaches 15°C as minimum value in January. The rainfall ranges from few mm to 200 mm per year. Ta Eddamer area the rainfall doesn’t exceed 100 mm since 1973. In the year 1999 from
Fig. 1: Location map of bore holes in the study area.

Shendi to Atbara the area have heavy rainfall which differ from other seasons in the last 10 years. The area topography is gently sloping from east to west and from south to north. There are few Jebels and high land at Jebel Um Ali, and low land at River Atbara junction with River Nile.

Geological Setting: Geologically the area is mainly covered with sediments Figure (2). These sediments are underlain by the basement complex rocks, which appear at Wad Bannaga south of Shendi town, and appear again at Atbara town. This appearance made a convex shape which is filled by Nubian Sandstone and recent deposits and gives a potential basin of groundwater known as Shendi-Atbara basin. The area is mainly covered with three geological units, Basement Complex, Nubian Formation and recent sediments. The basement complex (Pre Cambrian-Cambrian in age), consists mainly of crystalline rocks that characterized by high foliated gneiss outcropping on the western bank of the Nile about 20 km west of the River Nile at Atbara area. There are some marble outcrops in the area covering some square miles\textsuperscript{(6)}. The area from Sabaloka to Wad Bannaga is covered by crystalline granite of different colors due to mineralogical composition. Also there are thick exposed crystalline rocks acting as a groundwater divide, in south the area between Khartoum basin and Shendi-Atbara basin.

Shendi-Atbara basin is covered with thick Nubian sediments extending from Shendi to Atbara. The Sandstone is occupying a large area north-east of Kabushiya village to the north of Shendi\textsuperscript{(6)}. Mudstones are widely distributed throughout Khartoum-Shendi area because of the ease with which they disintegrate in highly corrosive climate of Desert-Savanna transition zone\textsuperscript{(9)}. Mudstones are rarely exposed and commonly occupying low ground. The recent deposits overlie the Nubian Formation, and these deposits consist of sand dunes, wadi deposits and
river terraces. The region from Sabaloka to Wad Bannaga on the main Nile valley, clay and silt occur mainly on the left bank. Islands of sand and clay along the River Nile were also found. From Al qoz to Kabushiya, sand dunes and creeping sand are covering the area. From Kabushiya to Atbara wide clay terraces are deposited and better developed on the left bank north of Aliab. Atbara area is covered by extensive gravels[6].

MATERIALS AND METHODS

Pathogenic microorganisms in water are determined by passing the water through a membrane filter and placing the filter residual on a growth medium for a special organism, then in an incubator at an optimum growth temperature. After sufficient growing time in the incubator, the number of colonies that have been formed is counted and reported as colony forming units (CFU) per volume[2]. In this study groundwater samples were tested for bacteriological pollution and the Membrane Filtration Method was used. The presence of bacteria in the groundwater is an indication of its faecal pollution by faeces.

RESULTS AND DISCUSSION

The bacteriological test carried out in the study area covered all water sources in Shendi, Eddamer and Atbara towns. From Table (1) of bacteriological test, it is found that
Table 1: Showing results of bacteriological test

<table>
<thead>
<tr>
<th>Location</th>
<th>Water Source</th>
<th>TC</th>
<th>FC</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air port</td>
<td>BH</td>
<td>+ve</td>
<td>-</td>
<td>On duty</td>
</tr>
<tr>
<td>North Extension</td>
<td>BH</td>
<td>+ve</td>
<td>-ve</td>
<td>On duty</td>
</tr>
<tr>
<td>East Extension</td>
<td>BH</td>
<td>+ve</td>
<td>+ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Abu Ammar</td>
<td>BH</td>
<td>+ve</td>
<td>-</td>
<td>On duty</td>
</tr>
<tr>
<td>Elazaa</td>
<td>BH</td>
<td>-ve</td>
<td>-ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Square 9</td>
<td>BH</td>
<td>+ve</td>
<td>+ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Wohda</td>
<td>BH</td>
<td>+ve</td>
<td>+ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Eddamer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elgadi well</td>
<td>BH</td>
<td>+ve</td>
<td>-</td>
<td>Chlorinated</td>
</tr>
<tr>
<td>Industrial area</td>
<td>BH</td>
<td>-ve</td>
<td>-ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Square 13</td>
<td>Bk</td>
<td>+ve</td>
<td>+ve</td>
<td>Closed</td>
</tr>
<tr>
<td>Shahinab</td>
<td>BH</td>
<td>+ve</td>
<td>+ve</td>
<td>Closed</td>
</tr>
<tr>
<td>State Council</td>
<td>BH</td>
<td>+ve</td>
<td>-ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Hudeiba Station</td>
<td>M</td>
<td>+ve</td>
<td>+ve</td>
<td>On duty</td>
</tr>
<tr>
<td>A/Ahrahman Shaadouf</td>
<td>M</td>
<td>+ve</td>
<td>+ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Shaadinab 2</td>
<td>M</td>
<td>+ve</td>
<td>-ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Elsadig Ahmed Shaadinab</td>
<td>M</td>
<td>+ve</td>
<td>+ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Shendi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Square 1</td>
<td>BH</td>
<td>+ve</td>
<td>+ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Square 5</td>
<td>BH</td>
<td>-ve</td>
<td>-ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Square 7</td>
<td>BH</td>
<td>+ve</td>
<td>+ve</td>
<td>Chlorinated</td>
</tr>
<tr>
<td>Square 9</td>
<td>BH</td>
<td>+ve</td>
<td>+ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Square 24</td>
<td>BH</td>
<td>-ve</td>
<td>-ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Elborhania</td>
<td>BH</td>
<td>-ve</td>
<td>-ve</td>
<td>On duty</td>
</tr>
<tr>
<td>Gurish village</td>
<td>BH</td>
<td>+ve</td>
<td>+ve</td>
<td>Closed</td>
</tr>
</tbody>
</table>

Abbreviations:
- BH: Bore hole
- TC: Total coliform
- FC: Faecal coliform
- M: Matara (Hand Dug wells)

Groundwater have been polluted by *E. Coli* as shown by Figure (3), and this pollution is discussed as follows:

**Shendi Area Pollution Risk:** In Shendi area, pollution of groundwater appears in the south part of the town at the edge of the basin where shallow wells dug (about 80–100 m deep). Due to the geological setting, there are no geological layers to separate the upper zone from the lower one, which was affected by sanitation sewage. Also the high porosity permits quick spread of sewage materials. *E. Coli* was found and reported in polluted wells. Gurish village well is closed, and other wells are still in duty with chlorination.

**Eddamer Area Pollution Risk:** In this area, the basement is shallow and the sandstone rocks possess high porosity which enhance the downward infiltration, beside the absence of thick layers of mudstones which separate the upper zone from the lower ones. Well depths range from 60 to 100 m and are affected by sanitation sewage. Groundwater pollution was reported overall area of settlements. The smell of H$_2$S (Hydrogen Sulphide) (rotten eggs smell), was notified in the area. At Eddamer area the groundwater pollution covers a great part of the
area inhabited by the people. Most of the bore holes at Eddamer have been closed because of the pollution, some bore holes are chlorinated.

**Atbara Area Pollution Risk:** The situation at Atbara town is similar to that of Eddamer town. E Coli were present in the groundwater as an indication of groundwater pollution, some polluted wells are also chlorinated.

**Conclusion:** Based on the chemical and bacteriological analyses carried out by Badi in the study area, it can be concluded that the groundwater in the study area is of fresh type with TDS not exceeding more than 1000 ppm. The total hardness (TH), differs from one zone to another, in mid-basin the groundwater is of soft type, while in the area with the contact to the basement complex, south and north of the basement, the total hardness ranges from hard to very hard. The bacteriological test carried out using the membrane filter (MF) method, revealed that groundwater have been polluted by E. Coli.

**REFERENCES**