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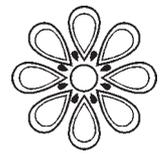
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Coastal water supply in Bangladesh

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THE COASTAL BELT of Bangladesh extended over 76 Thanas is identified problem area where complex hydrogeological conditions and adverse water quality make water supply difficult as compared to other parts of the country. The entire belt is crisscrossed by rivers and their tributaries which are under active tidal influence. In spite of having large number of natural streams, ponds and a good ground water storage, the scarcity of potable water is acute. The river water, in most of the time in the year, is highly turbid and saline. The low saline pond water is used for many domestic purposes, but completely unsuitable for drinking. Unlike other areas of Bangladesh, ground water of acceptable quality is not available in most parts of coastal area at relatively shallow depths for easy withdrawal by conventional handpump tubewells. The use of easily available waters as source of domestic water supply requires extensive costly treatment which is not a practical proposition for scattered rural population nor affordable in the context of rural economic condition. Development of an alternative low cost water supply system required to improve the water supply situation in the coastal area of Bangladesh.

Hydrogeological condition

The hydrogeological conditions of the coastal area vary considerably even within short distances. In the main aquifer ground water flows from north to south having localized outflow into rivers and ponds in dry season and inflow into the aquifer from surface water sources in the rainy season. The ground water gradient in the coastal area of Bangladesh is about 1:20 000. Transmissivities of the main aquifer in the coastal area ranges from 250m²/day to 10000m²/day with an average value of 1000m²/day. The storage capacity of the aquifer generally increases with depth with the increase in the size of aquifer materials. The entire area is underlain by thick water bearing formations of varying depths and the regional hydrogeology is very complex. Shamsuddin (1986) observed that the salinity distributions in Khulna, Barisal and Patuakhali regions were not in agreement with the Ghyben-Herzberg theory.

In the coastal area brackish ground water is available within 0 to 2.5m below the ground surface. In some regions low saline ground water is available in deep aquifers at a depth greater than 200m. It is believed that a continuous flow of fresh water in these deep aquifers from north to south has pushed saline water towards the sea. Pockets of fresh water are also available around low

saline surface water sources usually beneath the old ponds and the rivers. The lens of fresh water has been formed due to outflow of fresh water or accumulated rain water from the surface water source into the aquifer for years. The thickness of the lens of fresh water beneath the pond has been found to be directly related to the age of the pond. The low saline water in and around most of 81 000 ponds in the coastal area is considered as a potential source for low-cost water supply in the coastal area.

Water quality

Quality of water is the main constraint affecting water supply system in the coastal area. Salt water intrusion in the surface and ground waters in dry season is the major problem. The indiscriminate use and unhygienic sanitary practices of the people have polluted the available low saline surface water sources and made them unsafe for domestic uses. The application of organic and inorganic fertilizers for fish cultivation in ponds has aggravated the deterioration of water quality. Surface waters in rivers and unprotected ponds often show Faecal Coliform counts between 500 and 3000 per 100ml. Ground water from bacteriological point of view, is a more dependable source in Bangladesh. But in the coastal area, the presence of chlorides, and dissolved iron in excess of acceptable limits is the main water supply problem.

Ahmed (1981) and Choudhury (1985) assessed people's general opinion about the quality of water they drink. The people in the problem area use tubewell water having 5mg/l of iron and 1000mg/l of chlorides without much hesitation but water of such quality is not acceptable in other regions of the country. Since these water quality parameters normally do not involve health risk, people's acceptance receives priority in water supply in the coastal area. Taking this into considerations, DOE (1991) recommended the maximum limits of 1000mg/l for chlorides and 5mg/l for iron in case of handpump tubewell in the absence of a better alternative source in problem and coastal areas of Bangladesh.

The present water supply situation

The ground water supply in the coastal area is based on manually operated shallow tubewells, 20m to 75m in depth and deep tubewells, 75m to 350m in depth. Based on the availability of fresh groundwater, the Department of Public Health Engineering has divided the coastal regions into three types of area shown in Fig. 1.

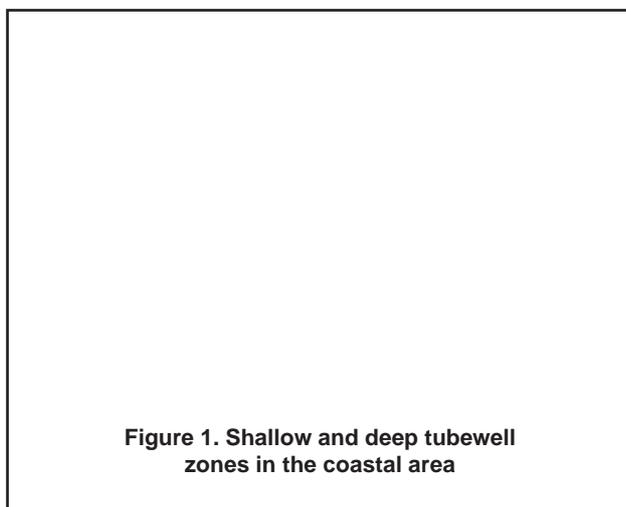


Figure 1. Shallow and deep tubewell zones in the coastal area

In the coastal area 146,538 shallow tubewells and 40,827 deep tubewells were sunk up to June 1993 and the population coverage achieved was 216 persons per TW against the national coverage of 79 persons per TW in the shallow water table areas (Bux and Rahman, 1994). There are areas where tubewells are not successful to produce low saline water. Moreover, failure of existing tubewells to yield water of satisfactory quality is quite frequent. As a result, people use contaminated water from unprotected rivers, ponds, and shallow wells. The percentage TW producing water with chlorides and dissolved iron in excess of permissible limit computed from BUET-BIDS (1992) study is shown in Fig. 2.

Piped water supply is available only in major urban centres in the coastal area covering a small percentage of total population. The source problem intensity computed based on 1991 census report indicates that the problem is very acute near the coast. The source problem intensity in most of the coastal area is more than 50 per cent (BBS, 1991). As a result, in spite of sinking a large number of hand pump tube well, the water supply situation in many areas remains unsatisfactory.

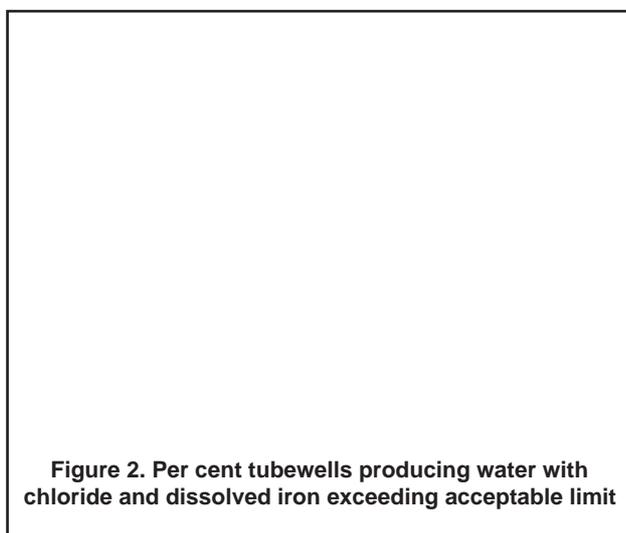


Figure 2. Per cent tubewells producing water with chloride and dissolved iron exceeding acceptable limit

Alternative water supply system

Very shallow shrouded tubewells (VSST)

These are low-cost hand pump tubewells, about 8m in depth with 2m strainer shrouded with coarse sand. The VSSTs are designed to collect water from shallow aquifers. In many places, the ponds dry up but fresh water in shallow aquifers remains beneath the ponds. Immobile preserved aquifers are also found at shallow depth in various locations in the coastal area. A VSST is a low cost convenient method for the withdrawal of water from such aquifers. At present about 1800 VSST are in operation in the coastal area. In some places the water discharged by the VSSTs became saline, due to upcoming of saline ground water caused by over pumping. Installation of low capacity handpumps is being considered to prevent over exploitation of the shallow aquifers. The system is considered feasible for small and scattered settlements where water demand is limited.

Shallow shrouded tubewells(SST)

In some locations fresh water is available in shallow aquifers composed of fine sand. Shallow Shrouded Tubewells 15 to 20m in depth have been designed to abstract water from these aquifers. In order to increase yield capacity and prevent discharge of sand with water, these tubewells are shrouded with coarse sand. The performance of 223 tubewells sunk in the coastal area is very good. The SSTs are cheaper than conventional STWs.

Slow sand filters(SSFs)

Slow sand filters are package type filter units developed to treat surface waters usually low saline pond water for domestic consumption. In this system, pond water is discharged by a hand pump in a reservoir underlain by a sandbed and the filtered water is collected through a tap. The program initiated in 1984 with the construction of 20 experimental units. At present, 375 units are in operation in the coastal area and the ownership has been transferred to the beneficiaries. The units are serving 200-500 people per unit. The problems encountered were low discharge and difficulties in washing the filter beds. The situation has been greatly improved by design modifications and community involvement in operation and maintenance. The sand filter system being a low cost technology with very high efficiencies in turbidity and bacterial removal has received preference as an alternative water supply systems for medium size settlement in areas where low saline ground water is not available.

Infiltration gallery (IG)

Installation of artificial infiltration gallery along the bank or under bed of a low saline surface water source supplies clean water for domestic purposes. The experimental unit showed a high degree of clarification of surface water due to slow rate of flow through artificial sand bed placed between the source and the infiltration gallery. The granu-

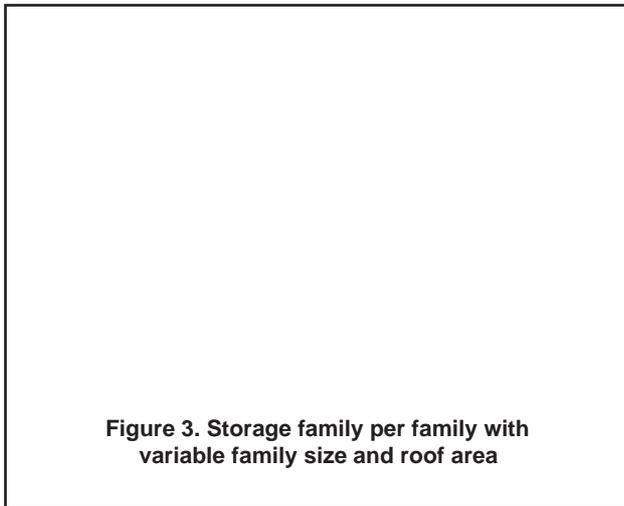


Figure 3. Storage family per family with variable family size and roof area

lar materials at the entrance of surface water from the source become clogged by entrapped suspended particles and deposition of clayey materials. The clogged granular materials required frequent replacement and the system showed many operational difficulties.

Rain water collection system

In the coastal area of Bangladesh, the average annual rainfall is about 3000mm, of which 75 per cent occurs during May to September. In a water supply system completely based on rain water, the excess rain water in the wet season is to be stored for use during the dry period. A study shows that only 26 per cent families in the coastal area having family size 4 to 8 persons have roof area varying from 50 to 90m², suitable for rainwater collection. The water consumption in the coastal area was found to be dependent on many factors. An average water consumption for the rural people in coastal area was estimated to be 50 lpcd for all domestic purposes. Taking 15 years' monthly rainfall data, the storage volume computed for these families by Yield After Storage (YAS) method for 90 per cent reliability has been shown in Fig. 3. It may be observed that large capacity storage tank is required to develop a completely rain water based water supply system.

Solar desalination

Experimental solar desalination unit based on conventional evaporation and condensation facilities constructed in the coastal areas produced 0.6-2.4 l/m²/d of water with an average yield of 1.4 l/m²/d. The system requires further development for use in water supply in rural areas.

Discussion

The water supply situation in the coastal area in terms of coverage, quality and quantity is very poor. Ground water is a dependable source for water supply in Bangla-

desh. But in the coastal area, the salinity distributions in ground water and replenishment of water in deep and shallow aquifers are regulated by complex hydrogeological phenomena. In some parts of the coastal area, the conventional shallow and deep handpump tubewells are not successful because of very high salinity in ground water.

In some parts of the coastal area having very shallow immobile and continuous fresh water aquifers and scattered population, drinking water supply by means very low cost VSST and SST has been proved successful. In some cases, difficulty arises in determining the safe yield capacity of the shallow aquifers. Over pumping to meet high water demands causes saline water intrusion and damage to fresh water aquifers. The low saline surface water may also be filtered by low cost slow sand filters near the source and make it safe for domestic water supply in the coastal area. The systems need washing and replacement of filter materials. Community participation in operation and maintenance is encouraging. The experimental units of IG were not successful due to operational problems.

Rainwater harvesting is in practice in a limited scale in the coastal area. A large fraction of population does not possess suitable roofs for the collection of clean rain water. About 26 per cent of families may be covered under rainwater collection system in the coastal area. Due to unequal distribution of rainfall throughout the year and nonavailability of suitable roof for rain water collection, a system completely based on rain water requires very large storage facilities. Solar desalination is not yet feasible for water supply under rural conditions in the coastal area of Bangladesh.

Conclusions

Ground water is the most preferred source of water supply in the coastal area of Bangladesh. The VSST and SST are low cost alternative technologies for abstraction of ground water from very shallow floating aquifers and fine grained sandy aquifers respectively for water supply to scattered communities. The STW and DTW are relatively costly but reliable for pumping out low saline ground water from shallow and deep aquifers, where available in the coastal area. In some locations community type iron removal plants are required to be installed to remove excess dissolved iron.

In areas where ground water of salinity lower than the acceptable level is nor available, community managed SSFs are recommended to treat available low saline surface water to produce potable water for water supplies. In most difficult areas, where low saline water from a single source is not available, an integrated system based on more than one technological options is recommended for uninterrupted water supply for all domestic purposes. Rain water is a potential supplementary source in the integrated water supply system in the coastal area.

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