

RIVER BANK FILTRATION- A NATURAL TREATMENT OF DRINKING WATER

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Abstract

Most of the drinking water schemes in the State of Andhra Pradesh, India mainly depend upon river water through infiltration galleries or intake wells. Some of these drinking water schemes are operating by diverting river water through canals into artificial or natural tanks/ponds and thereby to elevated water tanks after proper treatment. Presently the Rural Water and Sanitation (RWS) department is supplying protected drinking water to villages from groundwater by drilling bore wells in suitable geological formations and nearby river banks. After conducting field survey in alluvium formations of Andhra Pradesh, it is found that there is no technically designed River Bank Filtration (RBF) method found in the field. However few river bank bore wells yields good quantity and quality of water. Drinking water schemes in coastal Andhra Pradesh were visited, and during the visit river water/riverbank bore water samples were collected and analyzed for chemical parameters. It is found that there is a significant difference between river water and river bank bore well water hydrochemistry. There is a potential scope for technically designed RBF schemes in the coastal alluvium formations in Andhra Pradesh.

Introduction

The growth rate of population in Andhra Pradesh as per the previous census (1991) records is 21 per cent per decade on an average. Assuming the same growth rate, the total population of A.P. State by the year 2020 will increase significantly. The normal annual rainfall of A.P. State is 940 mm, which remained nearly constant during the past quarter century. Similarly the change in the normal annual rainfall during the next quarter century to come may be negligible. Coastal districts of Andhra Pradesh are Srikakulam, Vijayanagaram, Visakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam and Nellore. The alluvium formation is located mainly in the coastal Andhra Pradesh. From the groundwater point of view, rock formations in the State can be classified into three distinct categories of (a) hard rocks, (b) soft rocks and (c) alluvial formations. Groundwater in these rocks occurs under water table, semi-confined or confined conditions. As far as drinking water in the State is concern, three departments are responsible in the State. These authorities are: Municipal Corporation/ Municipalities, Irrigation Department and Rural Water Supply and Sanitation. Major Rivers in coastal Andhra Pradesh are given in the Table 1. Most of the

river flows are seasonal. Bank Filtration (BF) or River Bank Filtration (RBF) is a process in which the subsurface at a river or lake bank serves as a natural filter and biochemically removes potential contaminants present in the surface water. The concept and various process involved in RBF system is shown Figure 1 (Hiscock and Grischek, 2002). Existing and potential BF sites were discussed by Sandhu et al (2011 and 2012). BF can be used at sites where groundwater resources are limited (Grischek et al 2002). Scientific studies on water quality aspects during bank filtration in India have been conducted and demonstrated by Dash et al., 2010 and Bartak et al., 2014. BF has a high potential for future application in India, where alternative solutions are required to mitigate water scarcity and reduce the over exploitation of groundwater (Essl et al., 2014). There is no technically designed drinking water schemes of River Bank Filtration exists in the coastal Andhra Pradesh and however the source of drinking water mainly depends upon river waters through infiltration galleries in the river or intake wells. Some drinking water schemes are running by diverting river water through canals to artificial or natural tanks and thereby to elevated water tanks after proper

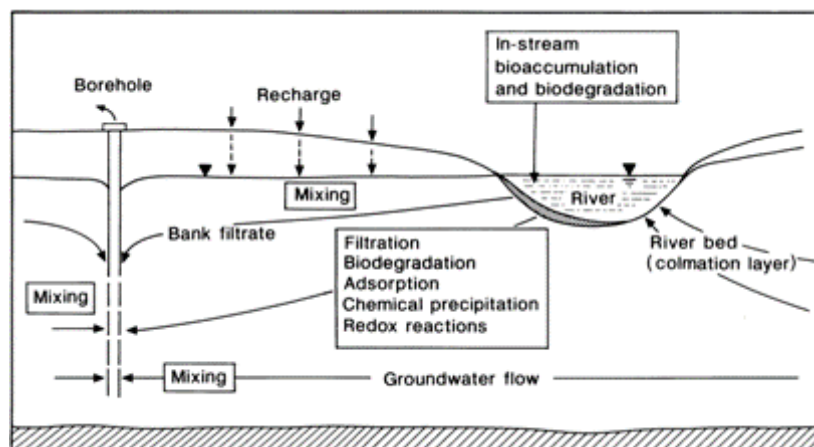


Figure 1. Mixing of Groundwater and River water through river bank bore well Pumping

treatment. The Rural Water and Sanitation department is supplying drinking water to villages from groundwater by drilling bores in suitable geological formations and nearby river banks. Few water works were visited wherein river water and riverbank bore water were extracted by different departments for supplying of drinking water to Municipalities and villages. Water samples from these two sources at various water schemes were collected and analyzed for chemical parameters at water quality laboratory of National Institute of Hydrology (NIH), Kakinada. The details of such water works are discussed below.

Table 1. East Flowing Rivers in A.P

Coastal Andhra Pradesh District	River Name
Srikakulam	Vamsadhara and Nagavali
Vizianagaram	Champavathi and Gostani
Visakhapatnam	Sarada, Varaha, Thandava
East Godavari	Godavari
West Godavari	Godavari
Krishna	Krishna
Prakasam	Gundlakamma, Musi, Paleru, Manneru
Nellore	Pennar, Swarnamukhi

Boni Water Works in Vishakhapatnam District nearby Gostani River

Gostani River is one of the prominent rivers in Visakhapatnam District. It has its origin deep in

Borra Caves and flows towards Bheemunipatnam, where it meets with the Bay of Bengal. Gostani River is a historically important river, which once served as an important navigation canal for inland trade. The million-year-old Borra Caves, filled with charming stalagmite and stalactite formations, is formed as a result of the action of the Gosthani River. Boni water works is located at 18.161147° N and 83.178918° E and nearby drinking water bore well is located at 18.161713° N and 83.179281° E. The river water is main source for Visakhapatnam city. Two 350 HP motors have been installed in the water works. One motor will work for 14 hrs per day. Rural water supply department provided three 100 HP motors at their pump house. The location of Boni water works, location of intake well and river bank bore well with connected overhead tank are shown in Figures 2, 3 and 4 respectively.

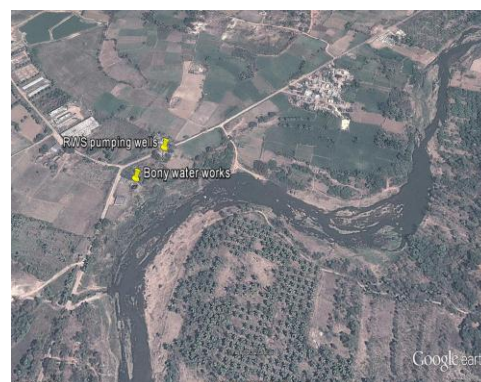


Figure 2. Location of Boni water works and near by bore well at Gostani river

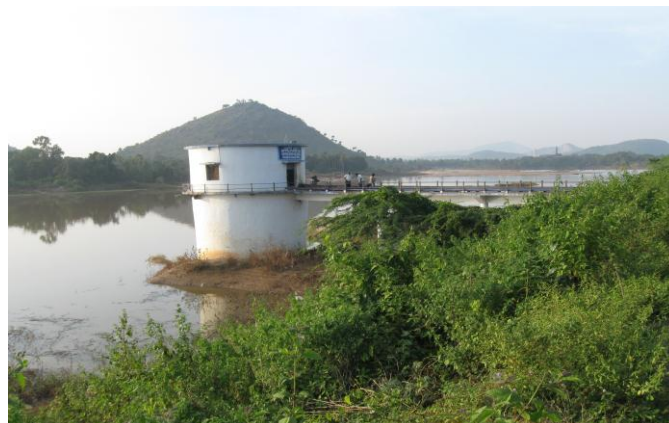


Figure 3. Photograph of Intake wells in Gostani river



Figure 4. Photographs of river bank bore well and elevated water tank nearby Gostani river.

The chemical quality of river water and riverbank bore wells are given in the following Table 2. The comparison of EC, TDS and Cl indicates that there is a significant change in the hydrochemistry of river water and bore water. It may be noted that water pumping from borehole may be a mix of river water and groundwater.

On enquiry with local people it was informed that there is no pumping well feasible nearby area which provides better than river bank bore well water. Even the bore well is located in the riverbank the source of water not only from river and it may be mix of river base flow and groundwater.

Table 2. Chemical Characteristics of River water and bore well water at Boni works

S.No	Sample Location	pH	Electrical Conductivity (micro-mhos/cm)	Total Dissolved Solids (mg/l)	Chloride (mg/l)	Date of sample collection
1	Gosthani River, Boni Works (Borewell)	7.8	660	422	56	16-11-2012
2	Gosthani River water, Boni Works	7.9	480	307	40	16-11-2012

Anakapalli Metro Water Works in Vishakhapatnam District nearby Sarada River

The catchment area of Sarada river basin is 2,665 square kilometers. It rises at an elevation of 1,000 meters in the Eastern Ghats. It runs eastwards for a distance 122 kilometers and joins the Bay of Bengal. The basin is surrounded by River Nagavali in the north, River Gosthani, Gambiramgedda, Megadrigedda in the East, Bay of Bengal in the South and Machhkund sub-basin of the River Godavari in the West.

Visakhapatnam is the major city in the basin. Yelamanchili and Anakapalli are important towns in the basin. The location of Metro Water Works (17.706729° N and 82.995959° E) and Rural Water Supply (17.606635° N and 82.996363° E) Drinking water well locations near by Sarada River are shown in the Figure 5. River water sample and bore well samples were collected and analyzed for pH, EC, TDS and Cl at water Quality Laboratory of NIH, Kakinada. The details are given in the Table 3.



Figure 5. Location of Anakapalli Metro water Works and RWS Bore well at Sarada River

Table 3. Chemical Characteristics of River water and bore well water at Sarada River

S.No	Sample Location	pH	Electrical Conductivity (micro-mhos/cm)	Total Dissolved Solids (mg/l)	Chloride (mg/l)	Date of sample Collection
1	Sarada River at Anakapalli	7.6	490	314	40	16-11-2012
2	Bore water nearby Sarada river (Anakapalli)	7.0	1030	659	116	16-11-2012

Godavari River Water Works Schemes

The comparison of EC, TDS and Cl indicates that there is a significant change in the hydrochemistry of river water and bore water. It may be concluded the water pumping from bore well may be a mix of river water and groundwater. Even through riverbank bore wells are present along the river, the water drawn from bore well is not totally from river water. It may be due to local geology, groundwater table conditions and land use/cover conditions.

Rajahmundry Municipal Corporation located in the East Godavari District is supplying drinking water to Rajahmundry Corporation from Godavari River at two locations as intake wells. One intake well (Head water works) is on the bank of Pushkar ghat (Latitude: 17.0052° N and Longitude: 81.7665° E) and other one is at Dowlaiswarem (Latitude: 16.9711° N Longitude: 81.7826° E). The location of these intake wells is shown in Figures 6 and 7 respectively.

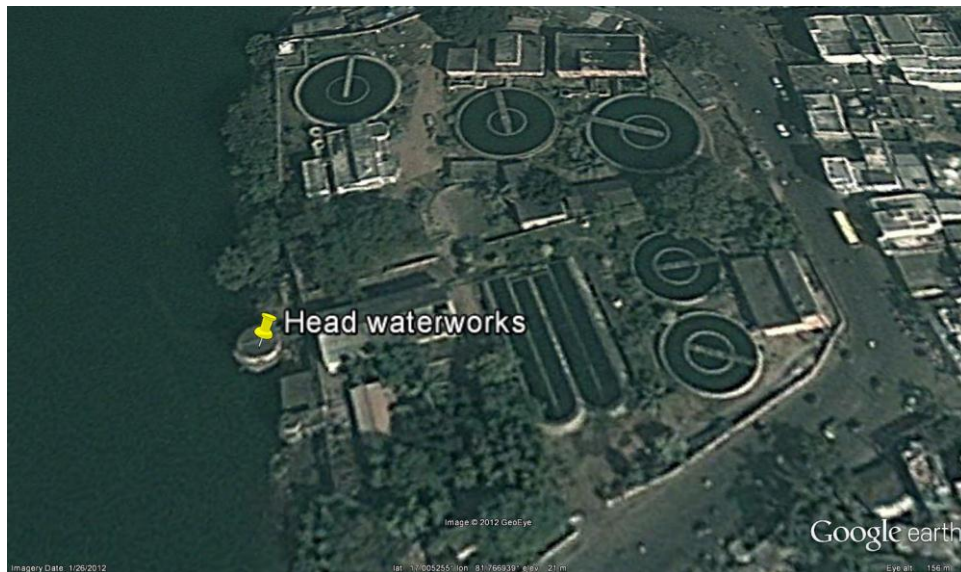


Figure 6. Location of intake well in Godavari at Pushkar Ghat (Municipal Head water works, Rajahmundry)



Figure 7. Location of intake well in Godavari at Dowlaiswaram (Municipal water supply)

Water is being pumped to filtration plants throughout the day using two 100 HP, one 60 HP and one 40 HP motors from head water works (Pushkar ghat). These schemes are supplying water to nearly 3 lac people in the Municipal Corporation of Rajahmundry. Another water works at Dowlaiswaram is supplying 10 million litres per day to ILTD, Balajipeta, Simbunagar and Alcot Gardens. This water works is having one 100 HP motor working 18 hours/day. Water is being supplied to nearly 60,000 populations in Rajahmundry city.

Rural Water Supply under Panchayatraj Department is having one separate intake well on the banks of Godavari River upstream to Pushkar Ghat (Latitude: 17.0092° N Longitude: 81.7678° E). Water is being pumped using 30 HP and 50 HP motors (18 hours per day) and water is being supplied to Kolamuru, Kontamuru, H B Colony and near by 9 habitations after treating raw water with Rapid Sand Filter (RSF) technique. Total population benefited from this scheme is around 20,000. This RSF plant is having capacity of pumping 2.70 million liters per day. Reliance Company just adjacent to Godavari River

constructed one tube well at the depth of 70 ft bgl. This water is being used for other purposes and not for drinking purpose. The location of RWS intake well and Reliance tube well are shown in Figure 8.

Water samples from Godavari river water at RWS intake well and Reliance tube well were collected and analyzed for pH, EC, TDS and Cl at DRC, NIH, Kakinada water quality laboratory. The chemical quality of these samples are given in the Table 4. There is no riverbank infiltration well located near by Godavari River as the

groundwater quality is brackish. Keeping in view the width of the Godavari River up to 2 kms, suitable RBF techniques may be proposed to augment river water with less treatment cost. There is no scientific design of RBF wells exist in the field but at present the mixing of river water and groundwater is being pumped for drinking water needs in coastal Andhra Pradesh. A set of Godavari river water and nearby groundwater samples were collected in the month of June 2013 and analyzed at NIH, Kakinada and the major anions and cations are given Table 5.



Figure 8. Location of RWS intake well and location of Reliance tube well

Table 4. Characteristics of River water and bore well water at Godavari river

S.No	Sample Location	pH	Electrical Conductivity (micro-mhos/cm)	Total Dissolved Solids (mg/l)	Chloride (mg/l)	Date of sample collection
1	Godavari River water at Head Water works (Raw Water)	8.1	300	192	36	22-11-2012
2	Reliance tube well nearby RWS intake well	7.3	1250	800	104	22-11-2012

Table 5. Chemical analysis samples collected in the Month of June 2013

S.No	Sample Location	pH	TDS	Ca	Mg	Na	K	Cl	HCO ₃	SO ₄	NO ₃
1	Godavari River water	8	83	25	1	40	2	28	96	4	6
2	Reliance Tube well	7.1	563	57	29	65	40	68	360	29	38

All dimensions are in mg/l

There is a significant difference between river quality and nearby groundwater quality. Godavari River is a potential area to identify the suitable location for RBF site to demonstrate the advantages of RBF for Andhra Pradesh State Government and thereby other potential areas would be explored for meeting rural villages drinking water needs.

Conclusions

Field survey conducted in the coastal districts of Andhra Pradesh especially in alluvium formations to identify possible sites for River Bank Filtration. It is observed that there is no technically designed RBF schemes exist in the coastal Andhra Pradesh. However, river bank bore wells are yielding good quantity and quality of water which is mainly used for drinking water purposes. The present demands of drinking water are being met from river water and bore wells in the coastal Andhra Pradesh. Godavari River at Rajahmundry would be the potential site for RBF schemes wherein the flow is continuously available.

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