Effect of Riverbank filtration and infiltration in Mahi River

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Abstract:
Surface water is exposed to dangers of permanent and sudden pollution by wastewaters or due to inappropriate storage, transport or application of water-endangering substances. In order to preserve the protective character of groundwater at least partly when utilizing surface water for drinking water preparation, surface water is subjected to an underground passage via bank filtration or artificial groundwater recharge. However, underground passage is not sufficient for complete removal of polar, tenacious organic substances. The Elimination rates of these substances are affected by residence time and length of the subsoil passage and the redox status. Thus water-treatment systems should follow additional treatment such as oxidation and adsorption. Subsequently bank filtration or infiltration remove biodegradable substances naturally and needed less chemicals for subsequent flocculation and oxidation steps.

Keywords: *Infiltration, Groundwater, filtration*

1. Introduction

In Gujarat, groundwater is a major source for drinking water. Generally groundwater is quite protected against most forms of pollution. In comparison to surface water, ground water is of relatively consistent in quality, and its excavation can be easily attuned to instant variations in consumption. However, use of groundwater sources is controlled with regard to quantity [1-5]. In Gujarat, this limitation is not given to such an extent for surface waters. However, surface water, particularly river water, is exposed to dangers of permanent and sudden pollution by wastewaters or to disturbances due to storage, transport or application of water-endangering substances, thereby always reflecting its function as receiving water [4,6-8]. Inorder to preserve the protective character of groundwater at least partly when utilizing surface water for drinking water preparation, surface water is subjected to an underground passage via bank filtration or artificial groundwater recharge [9].

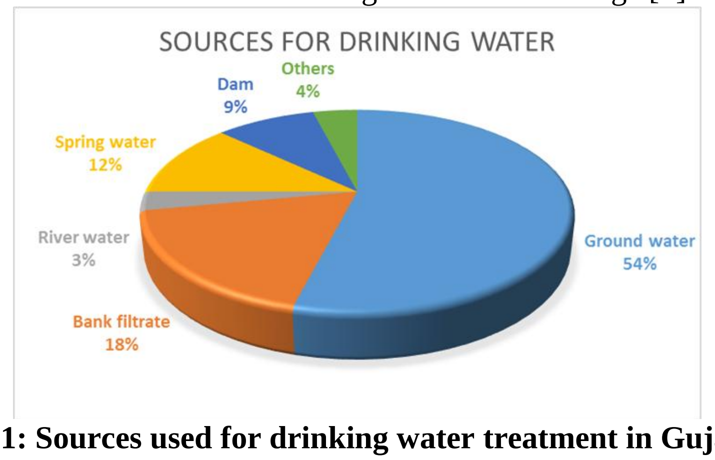

Fig. 1: Sources used for drinking water treatment in Gujarat

To simplify the terms bank filtration and artificial groundwater recharge, the distinctive historical development of water extraction facilities in groundwater that is originating from precipitation commonly flows towards the river and infiltrates particularly in low-flow periods into the flowing wave of the river [10, 11]. In times of high flow, however, river water infiltrates vice versa into the aquifer. Thus, the flow direction of the groundwater is variable under natural conditions even without extraction of groundwater. In major river bends, where the river bed is located on a sedimentary cone, an infiltration of surface water takes place permanently.

The quality of the water often deteriorated with the passage of time. The threat of contaminations in the groundwater infiltrating from the area requires protection of its watershed area by division of water protection regions [12]. However, this is also effective at the restricted area lie between riverbank and watershed area.

From the beginning of 19th century claimed, increasing chemical pollution, especially in areas with significant human activities, which may result in high concentrations of organic compounds, and micro pollutants in the river water, necessitated introduction of supplementary pre-and post-treatment steps to build up a multiple-barrier system. A variety of technologies may be applied to treat bank filtrate and infiltrate and treatment strategies may be quite different depending on the river water quality. Aeration or ozone may be used to oxidize metals that are picked up in anaerobic aquifers and activated carbon can be used for adsorption and protection against more-persistent contaminants.

2. Methodology

Natural groundwater usually free from pathogens and had a refreshing taste. The major drawback associated with natural groundwater is limited availability to cater the demand of larger cities/towns. To increase the supply of natural groundwater by the infiltration of surface water can be achieved. Thus, the waterworks located at rivers took place mostly in such a manner that in the first instance natural groundwater, than mixed groundwater and later on almost pure bank filtrate was extracted. Since at smaller rivers even the bank filtrate was not sufficient, river water was impounded at some sites.

By construction of a production well in the river valley, water, that is withdrawn from the production well, comes from slope-sided native groundwater as long as the pumping water level is not lowered too much.

Riverbed clogging could be surmounted by colossal ground slackening. With the construction of artificial trenches and side stations further infiltration zones were created. To improve water quality and to achieve easier clean abilities of infiltration zones, a specific sand layer was later incorporated in percolation ditches, channels, and ponds. A further stage of development was finally the construction of recharge basins similar to those found in nearly all artificial groundwater recharge plants nowadays. In these recharge basins, raw water is passed through a filtering medium that consists of a layer of sand. Artificial groundwater recharge can be used to bank filtration, but can also be used as protection tool to pull back riverbank filtrate. Process of recharge and watershed at a distant from the riverbed could be remain unchanged by riverbank filtrate interference.

For artificial groundwater recharge, river water is subjected to particle removal by flocculation, sedimentation, or filtration. Further ozonation and adsorption are carried out to ensure the protection against contamination used under special circumstances. As bank filtration is not possible at all level due to the geographical conditions, often it is observed that groundwater sources at the river bank are observed contaminated.

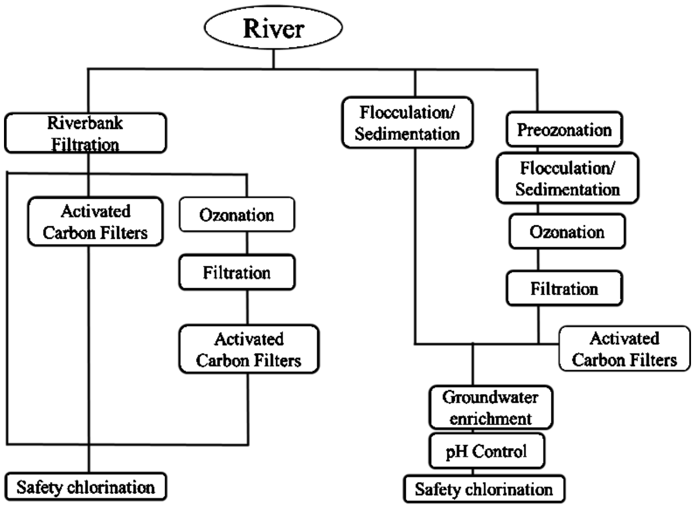

Fig. 2: Process scheme for river water treatment

The purification process of the underground station started in the access zone where suspended matter and sediments are accumulated that raises an adsorption power. Purification processes are alike the self-cleaning properties exhibited by surface waters. The self-cleaning of bank filtration and artificial groundwater recharge does not require any treatment of hazardous chemicals. Thus it would be cost effective process in terms of achieving divergent water quality standards. The turbid surface of infiltration layer mostly contains active biofilm which comprises of algae, bacteria, fungi and protozoa along with organic and inorganic pollutants. The dissolved components intensify the self-cleaning mechanisms during infiltration.

3. Result and discussion

For chemical spillage, the Bank filtration has provided an excellent protection tool to control the concentration of chemicals, as seen in figure 4. The figure depicts a contamination of hazardous chemical in the Mahi River. The example establishes how a short-term pollution in the river turns into a long-lasting pollution of very low concentration in the aquifer bank filtrate.

Underground passage reduces the effects of concentration peaks because of the varying distances covered by the water molecules from the river to the well. In the production well, the withdrawn water is a mixture of water that left the river at different times within a large period. As a rule of thumb, the waterworks in the Mahi valley calculate that in case of a sudden short lasting spill, only about one to five percent of the concentration can be found in the bank filtrate. Therefore, bank filtration is a safety barrier against high peak concentrations following accidents.

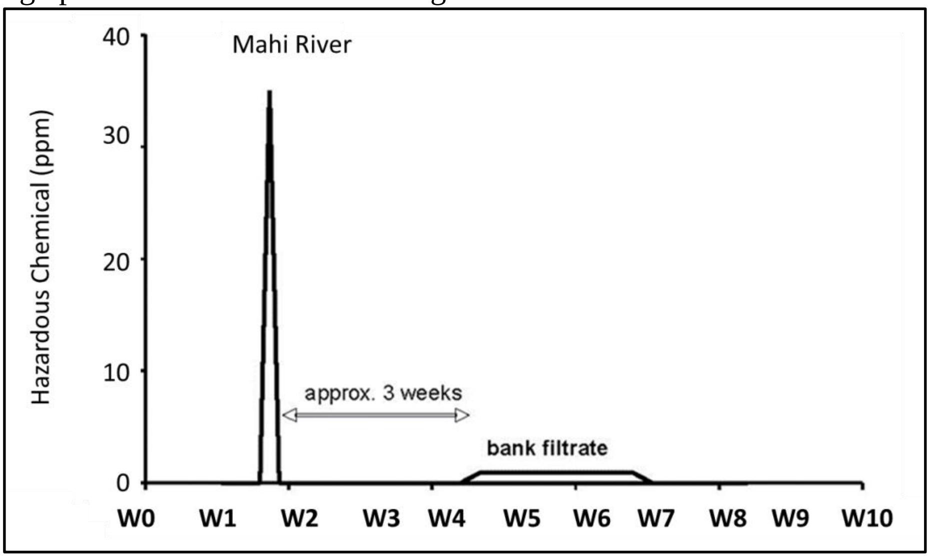

Fig. 3: Example of the protection against shock loads by bank filtration

The aquifers showed excellent property for the removal of trace elements such as iron, manganese, and various heavy metals by sorption processes. The removal of the metals and other turbid materials are accomplished by ion exchange processes as clays is loaded with amorphous ferric oxides and alumina, and organic solid matter. The removal of metal ions can also be achieved by precipitation reactions with sulphide. Removal efficiencies for heavy metals during riverbank filtration at the River Mahi are presented in Table 1. It is apparent from the table 1 that the percentage removals vary widely for the different elements, ranging from 0 to 96 %. Overall interactions with the ground provide a considerable retention of heavy metals in subsoil.

Table 1: Heavy metal removal by riverbank filtration at Mahi River

Metal	Concentration in ppm		Percentage Removal
	Mahi River	Bank Filtrate	
Zn	190	31	84
Cu	32.3	8	75
Pb	12.8	3.2	75
Ni	10.5	5.1	51
Cr	8.2	0.75	91
Sn	4.5	3.2	29
As	4.7	0.2	96
Cd	2	0.7	65
Se	1.6	1.42	11
Ag	0.4	0.3	25
Hg	0.3	0.2	33
Be	0.1	0.1	0

4. Removal of organics

Natural organic material is a mixture of dissolved and substantial organic matter present in surface waters including Lewis acids, proteins, lipids, amino acids and hydrocarbons. Many authors reported on the removal potential of bank filtration and artificial infiltration for NOM after monitoring various sum parameters, such as dissolved organic carbon (DOC) and assimilable organic carbon (AOC).

Figure 4 compares DOC concentrations in river water with those in bank filtrate for a waterworks in the Mahi River over the time of 10 weeks. In this time the DOC concentration in the Mahi River fell significantly due to progress in wastewater treatment. A consistent decrease was also observed in the bank filtrate. Within the time interval the graph shows the percentage of the DOC reduced concerning the river and bank filtrate was nearly constant at approximately 47 %.

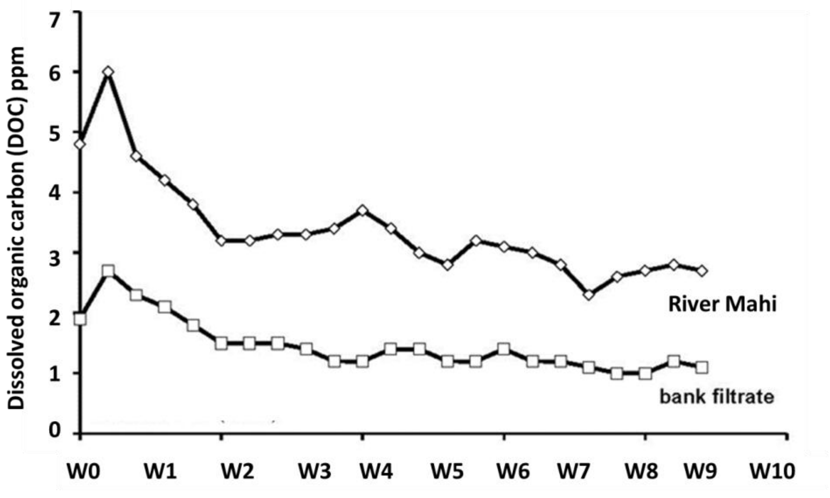

Fig. 4: DOC concentration in river water and bank filtrate

Figure 4 reveals that the mean dissolved organic carbon concentrations of filtrate from the Mahi River, retention time in the aquifer is a significant as pectto lead the removal capability of riverbank filtration. The data clearly exhibits the favorable effect of higher residence times on water quality.

Resultantly the microbiological quality of the water is also improved by bank filtration, which is shown as a decrease in the concentration of assailable organic carbon (AOC) that implies the fraction of total organic carbon in water available for microbiological growth and characterizes the ability of a water to support bacterial growth. Figure 5 gives an example of AOC concentrations in the course of various treatment steps in a waterworks.

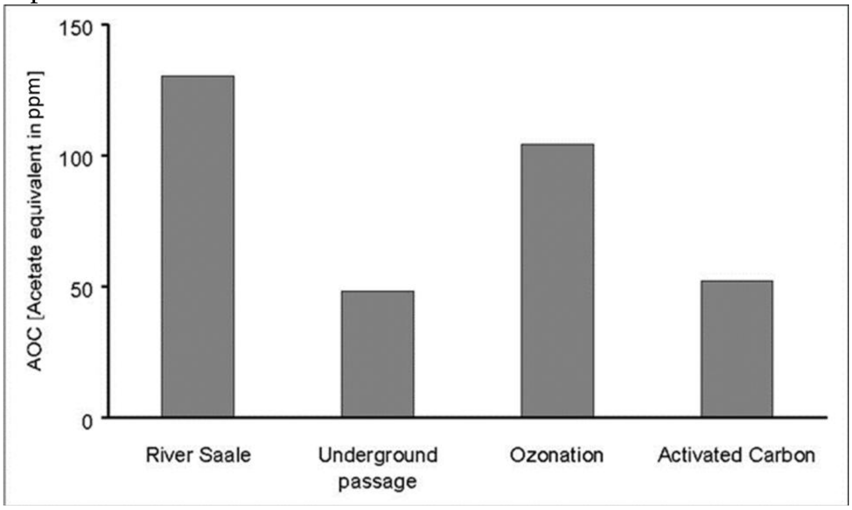

Fig. 5: Effect of bank filtration on biological re growth

Underground passage caused a clear decrease in AOC. As expected, a subsequent ozonation step increased the AOC again due to the oxidation of organics, which become more biodegradable.

Due to their physico-chemical properties lipophilic industrial chemicals and pesticides like DDT or heptachlor are mostly sufficiently reduced by sorption processes at inorganic and organic soil materials. Another point of recent concern are cyano bacteria and their toxins that can adversely affect water quality, especially in summer through algae growth. Though, non-natural groundwater restoration and bank filtration resulting effective eradication of contaminants, except in high concentration conditions.

5. Conclusions

Riverbank filtration and artificial groundwater recharge are well established techniques in Gujarat and are most often used as an important component of the established multiple obstruction system. Passage of water underground provides several benefits for drinking water treatment. Significant improvements in raw water quality was observed after infiltration and underground transport, processes such as filtration, and sorption. Underground passage of water treatment technique withholds removal of pathogens, suspended particulates, organic and inorganic chemical elimination, spillage reduction and production of a pathogen free water. Though, polar, persistent organic substances are often not completely removed during underground passage. Elimination rates of these substances vary with residence time and length of the subsoil passage and sometimes depend on the redox status. This deficiency is obvious; hence, many water-treatment systems rely on additional treatment barriers such as oxidation and adsorption.

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