Groundwater pollution - challenges and solutions

On the threshold of the 21st century, we are faced with set of new challenges in the scientific sphere. The closet relationship that any living being can ever have with anything is "WATER". It has been incredible part of our culture and tradition from ages unknown. As a natural endowment the Uttarakhand has had a plethora of rivers, lakes, waterfalls, streams and rivulets to hold or carry rainwater precipitation. Kumaun region is origin of five major rivers namely Kali, Alkananda, West Ramganga, Kosi and Gaula (Gopal *et al.*, 2000). All these rivers pour in Ganga system and basin. But due to topographical constraints this water originating in the region cannot be retained within the region.

Groundwater is the water present beneath earth's surface in soil pore spaces and in the fractures of rock formations. Groundwater is also often withdrawn for agricultural, municipal, and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology. The upper surface of this zone of saturation is called the water table. The saturated zone beneath the water table is called an aquifer. An aquifer can be contaminated by many things we do on the earth surface. Contaminants reach the water table by any natural or man-made pathway along which water can flow from the surface to the aquifer (Fig. 1). Aquifers are natural filters that trap sediment and other particles (like bacteria) and provide natural purification of the ground water flowing through them. Despite natural purification, concentrations of some elements in ground water can be high in instances where the rocks and minerals of an aquifer contribute high concentrations of certain elements.

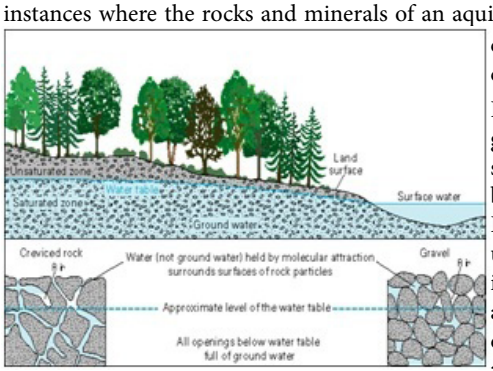

Fig. 1. Zones of aquifer and percolation of water to water table

Kumaon region is gifted with lots of springs which are boon for the region. People depend upon these springs in form of naulas and dharas for drinking purpose and for animal use, irrigation and other miscellaneous purpose (Manikant *et al.*, 2012). Even though the naulas (step wells lined masonry structure) and dharas (flowing springs) sometimes serve as only source of drinking water in the region still their maintenance and conservation remains highly neglected. Due to rapid urbanization and increasing anthropogenic activities the springs which were considered to be pure and sacred form of water have detoriated to that extent that quality of some of the springs is no more worth drinking. Hardness, sulphate and most of the water quality parameters have increased beyond the permissible limits in the region. The water quality of the region shows no sign for turbidity. The nitrate, MPN, DO in water affects the oxidation-reduction state of many other chemical variables, such as nitrate, ammonia, sulphate and sulphite, and ferrous and ferric ions. The important desirable and permissible limits for drinking water are given by IS 10500:2012 (Table 1).

Table 1. The important desirable and permissible limits for drinking water

S.N	Characteristic	Acceptable Limit	Permissible limit in the absence of alternate source
1.	Color	5 Hazen	15 Hazen
2.	Odor	Agreeable	Agreeable
3	pH value	6.5-8.5	No relaxation
4	Turbidity (NTU)	1	5
5.	Total dissolved solids(mg/l)	500	2000
6	Chloride (mg/l)	250	1000
7	Nitrate(mg/l)	45	No relaxation
8	Total hardness(mg/l)	200	600

Source: IS 10500 (2012) Drinking water specification

Remediation of the groundwater pollution:

The region being geologically fragile needs to opt for properly designed system for carrying the wastewater from the houses which is major cause for the contamination of groundwater. Proper disposal of the solid waste needs to be encouraged, open disposal of wastes ultimately contaminates groundwater. Groundwater typically becomes polluted when rainfall soaks into the ground, comes in contact with buried waste or other sources of contamination, picks up chemicals, and carries them into groundwater and this is done through the lechate formation (Kumar *et al.*, 2003). Groundwater tends to move very slowly and with little turbulence, dilution, or mixing. Therefore, once contaminants reach groundwater, they tend to form a concentrated plume that flows along with groundwater. Despite the slow movement of contamination through an aquifer, groundwater pollution often goes undetected for years, and as a result can spread over a large area. There are various methods to treat the contamination as bioremediation which is a treatment process that uses naturally occurring microorganisms to break down some forms of contamination into less toxic or non-toxic substances. By adding nutrients or oxygen, this process can be enhanced and used to effectively clean up a contaminated aquifer. Because bioremediation relies mostly on nature, involves minimal construction or disturbance, and is comparatively inexpensive, it is becoming an increasingly popular cleanup option (Marve *et al.*, 2001). Some of the newest cleanup technologies use surfactants (similar to dishwashing detergent), oxidizing solutions, steam, or hot water to remove contaminants from aquifers. These and other innovative technologies are most often used to increase the effectiveness of a pump-and-treat cleanup. Depending on the complexity of the aquifer and the types of contamination, some groundwater cannot be restored to a safe drinking quality. Under these circumstances, the only way to regain use of the aquifer is to treat the water at its point of use. For large water providers, this may mean installing costly treatment units consisting of special filters or evaporative towers called air strippers. Domestic well owners may need to install an expensive whole-house carbon filter or a reverse osmosis filter, depending on the type of contaminant (BSI 2012). The conservation of water resources is essential and along with that the restoration of the quality of the water is also equally important in the himalayan mountains.

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