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Importance of Groundwater as Compatible with Environment

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Abstract Groundwater is highly useful and often with abundant sources and it is highly useful for the human beings. But it can cause major problems to the society and environment. It is also ecologically important. The importance of groundwater and even of fresh water to Ecosystem is often overlooked by biologists and ecologists. Groundwater is a prime natural resource in the Earth. It not only supports all types of life forms to exist in the Earth but also helps in the growth of human civilization. It quenches thirst and fulfils all the house-hold demands. Groundwater is used for the irrigation purposes. The newly growing up industries catering to the various needs and luxuries of people consume volumes of water for their use. Arsenic contamination of groundwater is often due to naturally occurring high concentrations of arsenic in deeper levels of groundwater. A high profile problem arises because the use of deep-tube wells for water supply in the Ganges Delta causes serious arsenic poisoning to a large number of people. In the beginning, water from rainfall, snow and rivers was the only source of water to mankind. As these surface water sources were dependent on rainfall, local shortage was often witnessed. But men were not able to build sustainable water reservoir which can be useful for them in the drought period. Then, man came to know about groundwater and his dependence on it increased with the progress in civilization. At present about two billion people in the world are dependent on groundwater. Fortunately, groundwater is a renewable source that is recharged every year through rainfall. Groundwater in a large part of Bengal Basin contains high levels of arsenic. To combat this deadly arsenic menace we need to make people aware and to educate villagers about the problem. We should also preferable utilize our vast available surface water and rainwater instead of reckless use of groundwater to control the arsenic poisoning.

Keywords Groundwater, Arsenic, Environment, Bengal, Rainfall

Groundwater is highly useful and often with abundant sources and it is highly useful for the human beings. But it can cause major problems to the society and environment. It is also ecologically important. The importance of groundwater and even of fresh water to Ecosystem is often overlooked by biologists and ecologists. Groundwater is a prime natural resource in the Earth. It not only supports all types of life forms to exist in the Earth but also helps in the growth of human civilization. It quenches thirst and fulfils all the house-hold demands. Groundwater is used for the irrigation purposes. The newly growing up industries catering to the various needs and luxuries of people consume volumes of water for their use. Arsenic contamination of groundwater is often due to naturally occurring high concentrations of arsenic in deeper levels of groundwater. A high profile problem arises because the use of deep-tube wells for water supply in the Ganges Delta causes serious arsenic poisoning to a large number of people.

Arsenic contamination of groundwater is often due to naturally occurring high concentrations of arsenic in deeper levels of groundwater. It is a high-profile problem due to the use of deep tube wells for water supply in the Ganges Delta, [1] causing serious arsenic poisoning to large numbers of people. A 2007 study found that over 137 million people in more than 70 countries are probably affected by arsenic poisoning of drinking water. Arsenic contamination of ground water is found in many countries throughout the world, including the USA. [2]

Arsenic contaminated water typically contains and arsenic acid or their derivatives. Their names as "acids" is a formality, these species are not aggressive acids but are merely the soluble forms of arsenic near neutral PH. [2] These compounds are extracted from the underlying rocks that surround the aquifer. Arsenic acid tends to exist as the ions $[HAsO_4]^{2-}$ and $[H_2AsO_4]^-$ in neutral water, whereas arsenics acid is not ionized.

Groundwater is the water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs

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at springs and seeps, and can form oases or wetlands. [3] 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.

Typically, groundwater is thought of as liquid water flowing through shallow aquifers, but, in the technical sense, it can also include soil moisture, permafrost (frozen soil), [4] immobile water in very low permeability bedrock, and deep geothermal or oil formation water. Groundwater is hypothesized to provide lubrication that can possibly influence the movement of faults. It is likely that much of the Earth's subsurface contain some water, which may be mixed with other fluids in some instances. [4] Groundwater may not be confined only to the Earth. The formation of some of the landforms observed on Mars may have been influenced by groundwater. There is also evidence that liquid water may also exist in the subsurface of Jupiter's moon Europa. [5]

In November 2006, the Environmental Protection Agency published the Ground Water Rule in the United States Federal Register. The EPA was worried that the ground water system would be vulnerable to contamination from focal matter. The point of the rule was to keep microbial pathogens out of public water sources. [5] The 2006 Ground Water Rule was an amendment of the 1996 Safe Drinking Water Act.

West Bengal is one of the 29 states in India. It extends to the east longitude $85^{o}50^{'}$E and $89^{o}50^{'}$E and north latitude $21^{o}10^{'}$N and $27^{o}38^{'}$N. The area of West Bengal is 89193 sq. km having a population of about 80.1 million. Its administrative structure consists of several districts: each district has several blocks/police stations; each block has several Gram Panchayets (GPs), which are cluster of villages. There are 19 districts, 341 blocks and 37910 villages in West Bengal. We have covered all 19 districts covering 241 of 341 total blocks, and 7823 villages from West Bengal India. [6]

150-250m thick granular zone occurring as alluvial fans in the extreme northern part of West Bengal acts as the recharge zone for the unconfined aquifers with high permeability. This zone receives on an average 3000mm of rainfall annually. This granular zone gets separated in most of the areas by 2 to 10 m thick clay layers within a depth of about 300m where confined groundwater occurs. These aquifers at depth to the south of the fan zone are hydraulically connected to the recharge zone and contain groundwater mildly affected by arsenic. The recent flood plain deposits of Malda district, [7] however, recorded high concentration of groundwater arsenic.

The subsurface geological picture of the southern part of West Bengal to the east of the Achaeans shield area is nearly similar to its northern counterpart except the absence of cobbles and pebbles in the sequence and the Pleistocene sediments covering almost one-half of the area to the east of the shield area. Eastward Holocene deltaic sediments that by nature are characterized by frequent change in facieses from sand to clay and vice-versa at short distances both laterally and vertically follow it. At the delta head located in Murshidabad and Nadia districts, 150-250m thick granular zone containing groundwater with high concentration of arsenic under unconfined condition occurs. It forms the recharge zone for the deeper aquifers down south. [7] Like the Northern part, here also this thick granular zone gets separated by several clay layers, the thickness of which gradually increases southward. Beside, a clay layer appears at the top of the sequence with thickness gradually increasing southward from 2 to 30m precluding direct rainfall recharge to the group of aquifers below the top clay. These aquifers constitute the confined aquifer system receiving water from the recharge area to the north as well as to the west formed by the weathered sections within the crystalline rocks in the shield area.

In and around Kolkata beside the top clay layer, another 20-30m thick clay layers occurs at around 150m depth, the thickness of which increases to 50-60m further south. It is followed by alternating sequence of sand and clay layers down to a depth of about 300m.

According to the latest available data, we analyzed 1,40,150 hand tube well water samples for arsenic in all 19 districts covering 241 of 341 total blocks from West Bengal in India. **Table 1** shows an overview of arsenic contamination situation of West Bengal up to December 2005.

Table 2 shows the distribution of tube wells in three seasons from each of the 19 districts of West Bengal. Out of 1, 40,150 samples analyzed, 48.1% had arsenic above 10µg/L (the WHO guide line value) and 23.8% above 50µg/L (the Indian standard value). Importantly, 3.3% of the analyzed tube wells had arsenic concentrations above 300µg/L (the concentration predicting overt arsenical skin lesions (*Rahman et al, 2001*). A total of 187 (0.13%) hand tube-wells were highly contaminated (>1000 µg/L). The maximum arsenic concentration (3700 µg/L) was found in Ramnagar village of GP Ramnagar II, Baruipur block, in South 24 Parganas district. [12]This tube well was a private one and all the nine members of the owners' family had arsenical skin lesions and seven of them who had severe arsenical skin lesions, had already died, five of them died within age range below 30 years.

Beginning of 20th century witnessed demand for groundwater in industrial sector rising phenomenally at a faster rate than that in agriculture and domestic sector West Bengal is the only state in India that stretches from Mountain to the Sea and truly a "Asamudra himachalam" state as the meaning goes. West Bengal has a very good groundwater potential. The reason of such affluence is due to her geographical location, high rainfall and favourable geological setting .The state have land area of about 2.7% but have about 6% of total replenishible groundwater resources of India. Groundwater is the most exploited resource in west Bengal particularly in agriculture sector With the introduction of water intensive high yielding variety , the

need for groundwater have skyrocketed. Quinquennial census of minor irrigation structures indicated a 64% growth in number of STWs over last 16 years, @4% annually. [8]

Table 1. Present Groundwater Arsenic Contamination Status of West Bengal, India

Physical Parameters	West Bengal
Area in sq. km.	88,750
Population in million	80.2
Total number of districts (no. of district surveyed)	19 (19)
Total number of water samples analyzed	1,40,150
% of samples having arsenic > 10 g L^{-1}	48.1
% of samples having arsenic > 50 g L^{-1}	23.8
No. of severely arsenic affected districts *	9
No. of mildly arsenic affected districts*	5
No. of arsenic safe districts*	5
Total population of severely arsenic affected 9 districts in million	50.4
Total area of severely arsenic affected 9 districts in sq. km.	38,861
Total number of blocks/ police station	341
Total number of blocks/ police station surveyed	241
Number of blocks / police station having arsenic >50mgL^{-1}	111
Number of blocks / police station having arsenic >10mgL^{-1}	148
Total number of village	37910
Total number of village surveyed	7823
Number of villages/paras having arsenic above 50 gL^{-1}	3417
People at risk of drinking arsenic contaminated water >10 mgL^{-1} (in million)	9.5
People at risk of drinking arsenic contaminated water >50 mgL^{-1} (in million)	4.6
No. of districts surveyed for arsenic patients	9
No. of districts where arsenic patients found	7
Villages surveyed for arsenic patients	602
Number of villages where we have identified people with arsenical skin lesions	488
People screened for arsenic patients including children (preliminary survey)	96,000
No. of adults screened for arsenic patient	82,000
Number of registered patients with clinical manifestations	9,356 (9.7%)
No. of children screened for arsenic patient	14,000
No. of children showing arsenical manifestation	778 (5.6%)
Total hair, nail, urine analyzed	39624
Arsenic above normal/toxic level in hair, nail and urine samples	91%, 97% and 92%

Table 2. Arsenic concentrations by depth of tubewells in three seasons of 19 Districts

Depth (feet) of tubewells	No. of tubewells	Mean (standard deviation) arsenic concentration (µg/L)		
		Summer 2003	Monsoon 2003	Winter 2003
≤60	21	622 (486)	766 (842)	660 (585)
61–100	33	729 (338)	1063 (898)	940 (702)
>100	20	714 (418)	796 (646)	693 (580)
All	74	694 (403)	906 (822)	794 (644)

West Bengal Groundwater Resources (Management, Control & Regulation) Act 2005 was promulgated with effect from 15th September '2005. This act stipulates obtaining mandatory permit for installation of groundwater extraction structures operated by engine or motor driven pump. This act also, stipulate registration of all such structures existed before the act came into force. Apart from West Bengal, other states viz. Himachal Pradesh, Kerala, Goa and Tamil Nadu have already passed suitable acts for control and regulation of groundwater. Andra Pradesh had enacted Water, land and tree act in 2002. Maharashtra enacted groundwater (regulation for drinking water sources) Act in 1993 for limited purpose of regulating public drinking water. [9] For the remaining states either the groundwater bill is under drafting or draft bill is under consideration of the respective government.

Conclusions

Crisis of Water is probably the worst curse any civilization would like to face. It will be tragic for the next generation facing this crisis due to lack of foresight in part of the present generation. The groundwater resources, although renewable, are limited and vulnerable. Crisis of water may not be only quantitative; quality degradation may also add a different dimension to the problem.

West Bengal, which is considered to have tremendous groundwater potentialities, is no exception. Crunch is already felt in drinking water sector in rural west Bengal during Boro cultivation season precipitating a situation of artificial draught in almost every year. Unpredictable monsoons, destruction of green coverage, siltation of rivers, uncontrolled urbanization have compounded this problem. Area under arsenic and fluoride are increasing day by day. Failures in part of the authority to implement the Groundwater Act and lack of awareness in part of the users have failed to check unrestricted growth of tube wells in the state. Stages of groundwater development with 2004 as base year that show a meagre 42% stages of groundwater development in the state as against a national average of 58%, needs to be upgraded. The 4th Minor Irrigation Census is presently underway and results might reflect a higher Stages of groundwater development for this state. The act for controlling extraction of groundwater is probably not adequate in itself for total management of groundwater resources unless people is made to aware about the adverse situation which may arise from unplanned and indiscriminate use of groundwater. The other strategies involve co-ordinate approach to conservation, augmentation and conjunctive use of groundwater, wherever possible. This can be successfully achieved through rain water harvesting and artificial recharge that make it possible to: 1. Restore supply in aquifer, depleted due to overexploitation 2. Improve chemical quality. 3. Prevent salinity ingress. To implement rain water harvesting and artificial recharge to be implemented, it is necessary to adopt policy decisions like mandatory installation of roof top rain water harvesting and artificial recharge structures in urban areas and restoration of all derelict tanks in the villages, building check dams etc in high slope areas. Groundwater is not an isolated resource. It is a phenomenon within the hydrological cycle. So depending on the hydro geological condition, water level condition and stage of development proper measure for augmentation of groundwater should be taken.

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